DOCUMENT RESUME

ED 290 839 CE 049 250

AUTHOR	O'Malley, Peggy, Comp.; Person, Jean, Comp.
TITLE	The Indiana Implementation Handbook for Principles of Technology.
INSTITUTION	Indiana Univ., Bloomington. Vocational Education Services.
SPONS AGENCY	Indiana State Board of Vocational and Technical Education, Indianapolis.
PUB DATE	[87]
NOTE	185p.
PUB TYPE	Guides - Non-Classroom Use (055)
EDRS PRICE	MF01/PC08 Plus Postage.
DESCRIPTORS	Course Content; Course Organization; High Schools; Occupational Information; Physics; *Program Implementation; *Secondary School Science; State Curriculum Guides; Student Recruitment; *Technology; Vocational Education
IDENTIFIERS	Indiana; *Principles of Technology (Course)

ABSTRACT

Principles of Technology (PT) is an applied science course intended for high school vocational students. It emphasizes the basic principles of physics that form the foundation of modern technology, combining science and mathematics concepts with extensive hands-on laboratory experiences. This handbook helps teachers and administrators in Indiana implement the PT course for statewide use. The guide is organized in eight sections. The first section describes the implementation plan for the state of Indiana, providing information on course design and content. In the second section, information is provided to help schools plan and organize a PT course. The third section contains information for teachers on recruiting students and using the textbook effectively, and the fourth section provides occupational information for counselors. An implementation timeline occupies the fifth section. The sixth section is a guide to information dissemination, including press releases and informational materials. The final two sections explain how to order materials and manage the laboratory and equipment. (KC)

The Indiana Implementation Handbook for

PRINCIPLES OF TECHNOLOGY

Indiana State Board of Vocational and Technical Education

VES
VOCATIONAL EDUCATION SERVICES

The Indiana Implementation Handbook for PRINCIPLES OF TECHNOLOGY

For Further Information Contact

Jean Person, Coordinator for Supportive
Services and Program Improvement
State Board of Technical and Vocational Education
401 Illinois Building, 17 W. Market Street
Indianapolis, IN 46204
Phone (317) 232-1823

Scott Gillie, Director of Consultation and Field Services
Vocational Education Services
Indiana University
840 State Road 46 Bypass
Bloomington, IN 47405
Phone (812) 335-6711

Project Information

Title: The Indiana Implementation Handbook for Principles of Technology

Sponsoring Agency:

Indiana State Board of Vocational and Technical Education
Clinton J. Frank, Jr., Chairman.
Geneva Shedd, Executive Director/State Director of Vocational/Technical Education.
401 Illinois Building
17 West Market Street
Indianapolis, Indiana 46204

Permission granted by the Center for Occupational Research and Development/Agency for Instructional Technology to reprint materials from Principles of Technology Implementation Notebook.

Published by Vocational Education Services, Indiana University, Bloomington, Indiana 47405. James A. Pershing, Executive Director.
SBVTE Project No. 234-86-2B-CUR, 2A-SE, 2A-SPH

Compiled by Peggy O'Malley, State Coordinator for Supportive Services and Program Improvement, and Jean Person, Coordinator for Supportive Services and Program Improvement.

Notice of Nondiscrimination

The State Board of Vocational and Technical Education complies with all federal regulations prohibiting discrimination on the basis of race, religion, national origin, sex, age, handicap, or veteran status in matters pertaining to admissions, employment, and access to programs.

CONTENTS

INTRODUCTION

Principles of Technology (PT) is an applied science course intended for high school vocational students. It emphasizes the basic principles of physics which form the foundation of modern technology. It combines science and mathematics concepts with extensive hands-on laboratory experiences. It is occupation-oriented and heavily emphasizes how the basic concepts are applied in actual technology jobs.

PT is part of a state focus to expand vocational and technical preparation opportunities through Indiana's vocational/technical education delivery system. This focus includes:

- preparation for entry level employment upon completion of vocational/technical education;
- preparation for entry into technical education at the postsecondary level (tech prep);
- strengthening the application of mathematics and science components of vocational/technical education programs;
- automatic credit transfer;
- competency based curriculum;
- articulated curriculum and programs;
- expanded secondary/postsecondary offerings; and
- transferable skills for lifelong learning; and
- increased opportunities for students at the high school level who have chosen neither employment skill development nor preparation for additional education.

Principles of Technology is an integral component in tech. prep.; strengthening the application of science; and could be part of articulated curriculum and programs. It is an excellent starting place for involvement in a focus which will prepare students for a future which we cannot accurately predict. The infusion of basic education concepts in the applied format of vocational/technical education prepares individuals with a foundation of transferable skills for lifelong learning.

The State Board of Vocational and Technical Education (SBVTE) is committed to emphasizing strengthening math, science and other basic skills through vocational/technical education at the secondary and postsecondary levels. The State Board Management Plan for 1986 to 1990 specifically links the pilot projects in this area, including Principles of Technology, to this commitment and to the inventory of skills for vocational/technical education being developed by the Standing Technical Committee for Curriculum Review.

The Indiana State Board of Vocational and Technical Education responded to the need to strengthen the technical concepts and principles of vocational/technical education by approving a project, "Strengthening the Science and Math Components in Vocational Programs Principles of Technology", and a $98,057 grant to participate in a consortium of states on January 3, 1984. This Principles of Technology program was developed by the Center for Occupational Research and Development (CORD), the Agency for Instruction (AIT), and the consortium of thirty-two (32) states and Canadian provinces.

In April, 1984, the SBVTE selected four (4) Indiana sites to pilot test the materials. Of the four (4) sites selected, three sites actively participated in the pilot, which began June, 1984 and ended June, 1986. These sites were: Fort Wayne Community Schools Regional Vocational Center; Evansville-Vanderburgh Schools Area Vocational Center; and New Albany-Floyd County School Corporation, C.A. Prosser Area Vocational Center.

One unique aspect of "Principles of Technology" is that it is flexible, enabling it to blend into various types of vocational/ technical programs. Students completing this technology-preparation (Tech. Prep.) program have a choice of immediately entering employment, entering apprenticeship training, or pursuing additional education at the postsecondary level.

The Fort Wayne pilot site has received national recognition for its innovative implementation of Principles of Technology. The Fort Wayne Regional Vocational School Principles of Technology program is delivered in fourteen (14) units of instruction. Delivery takes place in a two-year period with three (3) hours of instruction per day, five (5) days per week. The seven (7) units are taught using general classroom instruction with print and video materials, laboratory activities, and on-the-job experience. The seven (7) units include electricity, pneumatics, hydraulics mechanical systems, metal trades, environmental systems and introduction to modern concepts.

Evansville-Vanderburgh School Corporation uses Principles of Technology as a one (1) hour, five (5) days a week, technical information course related to multiple vocational education programs. The students are receiving related math credit.

C.A. Prosser Area Vocational Center in New Albany is using materials as part of its automation lab. Their focus is on using the applied concepts to understand automated processes. The course material is infused into the lab.

Articulation

Principles of Technology can provide the impetus for articulation, particularly between the secondary and postsecondary systems in vocational/technical education. It may also inspire working agreements between math and science departments and vocational education. Program articulation has been described as a "planned process" linking two (2) or more education systems within a community to help students make a smooth transition from one level of instruction to another without experiencing delays or loss of credit "(NCRVE, Avenues for Articulation, 1986, page 1). The goal is to develop an articulated curriculum which allows for student flexibility and simultaneously develops employable skills and knowledge at any level.

The Columbus, Terre Haute, Lafayette, and Indianapolis articulation projects approved and funded by SBVTE for 1986-87 are discussing and planning programs of Technical Preparation (Tech. Prep.). A possible component for this type of activity is Principles of Technology.

IMPLEMENTATION PLAN
FOR THE STATE OF INDIANA

IMPLEMENTATION PLAN FOR THE STATE OF INDIANA

Length of Course

The course is a two (2) year program designed to be taught one hour per day; however, it has flexibility. There are 104 laboratory exercises, 52 teacher demonstrations and approximately 500 minutes of video tapes. One of Indiana's pilot sites has used PT as part of a vocational program for three (3) hours of instruction per day. Two (2) of the other sites have used PT as a one (1) hour course. PT has been approved as a vocational program by the State Board of Vocational and Technical Education and as an experimental course through the Department of Education for three (3) hours of credit.

Indiana's vocational pilot site teachers indicate that there is a wealth of materials for a one (1) hour course and not enough for a three (3) hour course, particularly for two (2) years. In the one (1) hour format, the instructor can pick and choose activities to fit his or her needs because it is extremely difficult to complete everything. In the three (3) hour format, some curriculum development will be required in the laboratories. One of the pilot site instructors is working on developing needed curriculum.

Type Of Students This Course Would Serve

The course is designed for 10th, 11th, and 12th grade vocational students and is intended to provide a solid science and mathematics foundation. Students entering this course will be most successful if they have had some previous physical science training and have completed one year of algebra.

Design Of The Course

Principles of Technology explores the following areas:

YEAR 1	YEAR 2
FORCE	MOMENTUM
WORK	TIME CONSTANTS
RATE	WAVES AND VIBRATIONS
RESISTANCE	ENERGY CONVERTERS
ENERGY	TRANSDUCERS
POWER	RADIATION
FORCE TRANSFORMERS	OPTICAL SYSTEMS

Each of the above units is divided into subunits. The subunits explore how the basic principle is applied in one of four (4) systems: Mechanical, Fluid, Electrical, and Thermal. The course materials include written materials, videotapes, demonstrations, math labs, and laboratories.

FOR EXAMPLE: Unit one examines how the concept of FORCE is applied in Mechanical Systems, Fluid Systems, Electrical Systems, and Thermal Systems.

Class Size

Class size can vary, but generally 20-25 students is suggested.

Background of the Teacher

The Principles of Technology instructor should be a vocational teacher who has had courses in college physics and mathematics. Team teaching with a vocational teacher and physics teacher working together is also a possibility.

Facilities Needed

Principles of Technology may be taught in most vocational or science laboratories. It will require convenient access to water and enough electrical outlets to accommodate approximately ten (10) work stations. No gas outlets are required. No special ventilation system is required. A videotape player (VHS), and television monitor are required.

Materials Needed and Cost

Due to the large number of hands-on labs, the course requires a number of items that are not commonly found in a vocational laboratory. Some of the items needed are physics and chemistry laboratory equipment. Other items are specialized and will not likely be available in the school.

The cost of equipment will vary, depending upon what is presently available in the school. However, a general guideline of initial costs for schools that need to purchase all or most of the needed materials and equipment is as follows:

YEAR 1:
$4,000 - $6,000 for one (1) Laboratory Work Station (generally, a minimum of five (5) work stations will be needed)

YEAR 2:
$2,000 - $2,600 for one (1) Laboratory Work Station (generally, a minimum of five (5) work stations will be needed)

AIT/CORD put out a national PT newsletter in 1985-86. Several of the articles discussed equipment and related topics. Instructors from other states have shared some innovative ideas on equipment. To determine needs for equipment, Instructor Nicholas Murgo of Davies Vocational-Technical High School in Lincoln, Rhode Island, began by checking the PT equipment requirements. He wrote up a hardnosed list of equipment needed-materials not currently in his school's possession. He decided, for example, that certain labs could be conducted as well with existing vector force tables as with new equipment. Murgo thinks every teacher must take the initiative in this area. "Look at what you have", he advises, "and decide honestly whether you can still use it, or if it would be better to purchase new equipment. If money and storage are not problems, of course, you have a good argument for buying new", he emphasizes.

In Terre Haute, Indiana Vocational Technical College and the Western Indiana Private Industry Council cooperated in order to build laboratory equipment for the Vigo County School Corporation. This approach uses youth in summer employment to assemble lab components. For more information, contact the SBVTE.

Mr. R.G. Dunn and Mr. Jim Everett of the Platte County Area VoTech School, Missouri, have developed an equipment data base for PT for their own use. They tried to ease the ordering of equipment and the headache of typing PO's by putting information about equipment vendors, equipment ordered, ID numbers, unit costs, quantity and total costs on a data base (dBaseII). For more information, contact R.G. Dunn or Jim Everett, Platte County Area VoTech School, Box 889, Platte City, MO 64079, (816)464-5505.

Summary

Principles of Technology provides students a good knowledge of the basic principles of physics upon which their jobs will depend. It also provides the necessary mathematics knowledge and skills to fully apply those principles. The strengths of the program include excellent text materials, videos, a variety of good laboratory learning experiences, and its applied focus.

Questions which must be addressed by each school system considering implementing the program are:

1. What type of credit may a student receive for the course?

2. What support can an administrator give to ensure the success of the program?

3. How can administrators, guidance counselors, vocational and science teachers work together in sharing equipment and other resources?

4. What are the best ways to identify students who would benefit most from the program and promote the program to them?

5. How can administrators and teachers in secondary vocational schools work together with other secondary programs and with postsecondary institutions to develop articulation agreements?

6. What inservice is needed to support the program and who needs to be involved?

ADDITIONAL MATERIALS AND RESOURCES AVAILABLE

All are available for loan from Vocational Education Services, Indiana University, 840 State Road 46 Bypass, Room 110, Bloomington, IN 47405, (812) 335-6711. The call numbers are at the beginning of the listing.

1. ED264445 Avenues of Articulation: Coordinating Secondary and Postsecondary Programs; J.P. Long, C.P. Warmbrod, C.R. Faddis, and M.R. Lerner; National Center for Research in Vocational Education; 1986
2. IN001828 Implementation of Principles of Technology - 3 Case Studies;, Agency for Instructional Technology, July, 1986
3. IN001827 Principles of Technology: Issues Related to Student Outcomes; Agency for Instructional Technology, August, 1986
4. IN001835 Two-Plus-Two Articulation: A book for education planning; Center for Occupational Research and Development, September, 1985

IMPLEMENTATION MATERIALS FOR PRINCIPLES OF TECHNOLOGY

Implementation Materials

for

PRINCIPLES OF TECHNOLOGY

This handbook is for local administrators, teachers, and counselors who are involved in introducing *Principles of Technology* into the curriculum of a vocational or comprehensive high school. It provides information about why and how the course was created; about who should take the course and who should teach it; about what instructional materials are needed, what they cost, and how to get them; and about how to disseminate information on the course. The material is intended to help, not to limit or to dictate. It should be used flexibly and adapted to local needs.

Selections from

Principles of Technology

Implementation Notebook

TECHNOLOGY: NEW WORKERS, NEW MODES OF TRAINING

In the past several years, rapid changes in the applications of science and computers have brought about a technical revolution that has significantly altered the way we live and work in our homes, offices, and factories. This has not been a silent revolution. Technological advances have drastically changed the equipment and methods for a growing number of fields, including manufacturing, energy production, information management, health care, agriculture, and transportation. These marked technological breakthroughs—this revolution—is frequently called "high technology."

Technology will continue to create new jobs, eliminating some old jobs and modifying others. Today's technicians are confronted by the diversity, complexity, and rapid evolution of equipment. For example, 25 years ago, offices had manual typewriters, and workers who were called on to adjust or repair them were called "typewriter mechanics." They were mechanics in the literal sense—they dealt with the physical principles of mechanical systems. Then electric typewriters—electro-mechanical devices—began to appear. Repairs required someone who knew more than mechanics, someone who knew at least some of the principles of electrical systems. Soon, electric typewriters were replaced by electronic typewriters that could "remember" a line or a page of what had been typed. These electronic systems are now giving way to more elaborate "word processors," which may include optical character readers and sophisticated ink-jet printers. Such devices are remarkably efficient but cannot be repaired—much less designed and constructed—by a mechanic or an electrician.

Today's office machines are typical of complex modern equipment, which often involves a mixture of mechanical, fluid, electrical, and thermal systems. Technicians who work with, or on, high-tech equipment must have a broad understanding of the technical concepts and principles that govern the behavior of the systems and subsystems that make up this equipment. The skills training in a narrow specialty that has been typical of vocational education in recent years is no longer adequate. The trend throughout the remainder of this century must be to prepare technicians and operators who understand the entire system with which they work and the technical principles of all the complex systems involved—which generally include mechanical, fluid, electrical, and thermal subsystems.

But teaching technical principles in vocational education should not mean turning to the traditional, theoretical science courses that are designed as prerequisites for academic pursuits in colleges and universities. What is needed is a focus on the practical principles in physical science that help students understand the behavior (and misbehavior) of modern equipment. What is needed is *Principles of Technology*.

What is *Principles of Technology*?

Principles of Technology is a high school course in applied science for vocational-technical students in the eleventh and twelfth grades. It is a two-year curriculum covering fourteen units in applied physics. The units are:

1. Force
2. Work
3. Rate
4. Resistance
5. Energy
6. Power
7. Force Transformers
8. Momentum
9. Waves and Vibrations
10. Energy Convertors
11. Transducers
12. Radiation
13. Optical Systems
14. Time Constants

Seven units are taught in the first year and seven more units are taught in the second year. Each unit typically requires 26 50-minute class periods and shows how a technical concept can be analyzed and applied to equipment and devices in mechanical, fluid, electrical, and thermal energy systems.

Materials developed and tested for *Principles of Technology* include student texts, videocassettes, demonstrations, math labs, hands-on labs, and tests. A teacher's guide for each unit provides suggested presentation strategies, information about how to perform classroom demonstrations, and additional information for problem-solving labs.

Principles of Technology was designed to:

- increase the employability of vocational students.
- emphasize principles rather than specifics of technology and provide an understanding of the mathematics associated with these principles.
- increase the appeal of instruction by using an interest-holding instructional system incorporating video presentations, demonstrations, hands-on laboratory exercises, special exercises for students requiring additional help in mathematics, recommendations for "teaching paths" for the teacher and "learning paths" for the students, and a teacher's guide that explains how to orchestrate the learning package.
- maintain the academic rigor needed to meet some of the increased requirements for high school graduation in science.

As noted by the National Commission on Secondary Vocational Education, many states have responded to recent criticisms of the secondary school by increasing the number of academic courses required for graduation. The Commission recommends that students who do not plan to go to college and who purposefully choose a vocational program "be allowed to satisfy some requirements for high school graduation—for example in the areas of mathematics, science, English, or social study—with selected courses in areas of vocational education that are comparable [to academic courses] in content and coverage and rigor."

How did *Principles of Technology* evolve?

Principles of Technology was developed through a cooperative activity of 35 state and provincial education agencies (see list, page 31) in association with the Agency for Instructional Technology (AIT) and the Center for Occupational Research and Development (CORD). The education agencies are providing approximately $3,000,000 for the creation of *Principles of Technology* and are testing the curriculum in approximately two schools per state. Following the test phase, they plan to take a lead role in introducing and implementing broad use of the course within their service areas.

Drafts of print materials and scripts of video components, prepared by CORD and AIT, have been reviewed for content by an eight-member team of specialists in vocational education and instructional media. (See Content Review Team, page 31.) Materials have also been reviewed by the consortium agencies. In addition, the pilot test teachers have been invaluable evaluators.

CORD is a nonprofit organization established to conduct research and development activities and to disseminate curricula for technical and occupational education and training. In the past ten years, CORD has developed over 36,000 pages of instructional materials for technicians on fourteen major curriculum projects in advanced-technology areas. These projects were sponsored by contracts with federal and state agencies, and by industrial support from the private sector. The products developed by CORD are used by technical institutes, community colleges, and vocational high schools, and in industry training programs throughout the United States.

AIT is a nonprofit American-Canadian organization established in 1973 to strengthen education through technology. In cooperation with state and provincial agencies, AIT develops instructional materials using television and computers. AIT also acquires and distributes a wide variety of television and related printed materials for use as major learning resources. It makes many of these materials available in audiovisual formats. From April 1973 to July 1984, AIT was known as the Agency for Instructional Television. Its predecessor organization, National Instructional Television, was founded in 1962.

Principles of Technology is based on a course entitled Unified Technical Concepts (UTC) in Physics, which was developed by CORD for postsecondary technical training. The central idea in this course is that a technically valid, unifying approach to physics is beneficial in the study of the basic energy systems—mechanical, fluid, electrical, and thermal. This approach is achieved by demonstrating that concepts such as force, work, rate, and resistance apply and operate analogously in each of the four energy forms. The UTC course is currently being used successfully in associate degree technician programs. UTC exhibits particular effectiveness in:

- generating student interest,
- helping students retain the technical principles, and
- making course content relevant and applicable to the technician's field of work.

The *Principles of Technology* curriculum is an adaptation of the UTC curriculum tailored to the needs of high school students. The existence of UTC considerably shortened the development time of this new course.

Why should *Principles of Technology* be taught?

We all live and work in a sophisticated, rapidly changing society that is becoming increasingly dependent upon an understanding of technology to make informed decisions about governmental policies, equipment selection for the home or office, and the operation and maintenance of complex devices and systems. But most science courses in physics and chemistry—well written for the 25 percent of high school students who plan to pursue academic degrees at universities—do not present the course material in a manner or at a level that can be mastered or used by the majority of high school students. More than 90 percent of today's high school graduates do not complete a course in physics.

For over 20 years, vocational education has earned a reputation for successfully preparing nonacademically oriented students for employment. These students learn current employable skills that are directed toward a particular occupational objective to be met upon high school graduation. In some fields, this type of curriculum will continue to be effective for job training, although it may offer little orientation for the technological society in which we live.

However, to educate modern technicians we must have a curriculum that not only teaches currently employable skills, but also provides technical principles that will not become obsolete as equipment and technologies change. *Principles of Technology* is designed to be a practical science course for vo-tech students. It does not replace all the technical courses that relate to job requirements, and it is not an academically oriented science or mathematics course. It is an applied physics course, oriented toward modern technology. *Principles of Technology* strengthens needed mathematics skills and is designed to complement the existing vo-tech curriculum.

Principles of Technology is not an easy course. The scientific content and the academic rigor of the course are carefully sustained, both to provide a high quality of instruction and to meet the goal of filling high school science requirements. Although the course is not easy, pretesting and posttesting in the pilot year indicate that most students achieve significant learning and find the course interesting and useful. *Principles of Technology* is a course that gives students technological literacy.

Where should *Principles of Technology* be taught?

Principles of Technology is designed to be taught either in comprehensive high schools or in vocational technical centers to eleventh- and twelfth-grade students who plan to pursue careers as technicians and who do not plan to enroll in four-year colleges and universities in engineering or science programs. However, field tests have shown that the course is being used successfully for other student populations:

- vocational students in all fields (first year, or seven units, only).
- students in the tenth grade.
- students in an academic (college-bound) track.

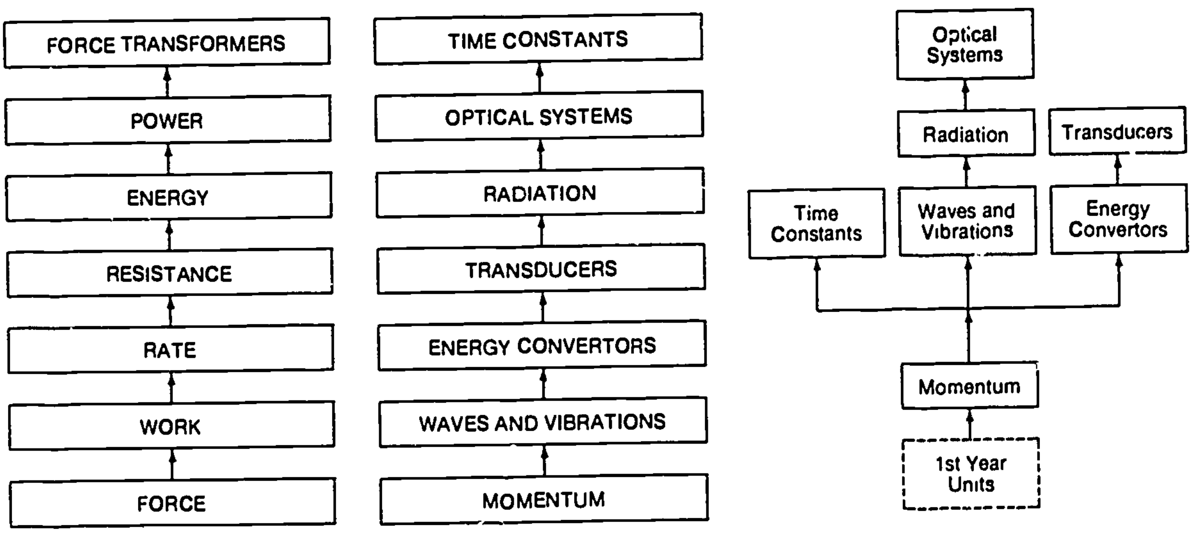
Dr. Dale Parnell, president of the American Association of Community and Junior Colleges, has reviewed *Principles of Technology*, and considers it to be the foundation course for a high school "pre-tech" or associate degree track for technically oriented students who plan to complete their education in two-year postsecondary associate degree programs. CORD is currently developing curricula for "2+2 Articulated Programs," using *Principles of Technology* as a foundation. Most vocational/technical students who are employed in technical occupations after high school graduation will be required to continue their education and training through company-sponsored programs. *Principles of Technology* is designed to prepare students for this type of training.

Field-test results indicate that *Principles of Technology* can be taught successfully in either comprehensive high schools or area vocational schools. Some organizations are considering the use of *Principles of Technology* for retraining technical workers for high-technology jobs. The course may also be appropriate for remediation in community colleges.

How should *Principles of Technology* be taught?

These charts show the suggested sequencing of the units:

FIRST-YEAR UNITS Suggested Sequence — **SECOND-YEAR UNITS** Numerical Sequence — **SECOND-YEAR UNITS** Optional Sequence



*In the second year, Momentum must be taught first. The order of instruction is then flexible, with some exceptions. Radiation must precede Optical Systems; Waves and Vibrations must precede Radiation; Energy Convertors must precede Transducers.

The first seven or eight units can be used as a stand-alone course for students who need a one-year applied science course and require a background in the technical fundamentals. The second year of the course (Units 8-14) is most useful to students who plan to continue their study and to work as technicians in advanced-technology occupations.

The suggested teaching plan (see section entitled "Information for Teachers") indicates that the average unit will require the equivalent of 26 50-minute class periods. These periods are:

- unit overview class and unit summary class, with readings, video presentations, discussions, and unit test.
- eight class discussions that include reading assignments (four based on subunit video segments and four based on hardware demonstrations).
- four "problem-solving" math labs.
- eight hands-on physics labs.
- four review periods (repeating the use of the four subunit video segments).

Considerable variation in time required for presentation of a unit has been experienced at the field-test sites, depending upon the level of student abilities.

A detailed discussion of the approaches to teaching *Principles of Technology* is found in the section entitled "Information for Teachers."

To whom should *Principles of Technology* be taught?

The target audience specified in the curriculum design is eleventh-grade vocational students interested in technical careers; however, the course has been found useful and appropriate for tenth and twelfth graders, students with other vocational interests, and students who are in academic pursuits.

The level of the material assumes that students have at least an eighth-grade reading level, have one year of high school general mathematics, and have—if possible—one year of algebra or concurrent enrollment in algebra.

A complete listing of the Curriculum Design Guidelines can be obtained from your state or provincial consortium representative or from CORD.

Who should teach *Principles of Technology*?

Ideally, *Principles of Technology* should be taught by a vocational teacher with industrial experience and a strong background (two or three college courses) in physics. Practically speaking, this type of person is atypical and, in most instances, alternate selections must be made. The following types of teachers have successfully taught *Principles of Technology* in the field tests:

1. Vocational electronics or electro-mechanics teachers (some drafting teachers with one or more courses in college physics).
2. Industrial arts teachers with one to three courses in college physics.
3. Physics teachers with some industrial or applications background and an interest in the *Principles of Technology* course format.
4. Teams of teachers with a physics teacher doing the classroom (frontal) teaching and math labs, and a vocational teacher doing the hands-on labs. The team teaching approach has been found to be particularly successful where the two teachers sit in on each other's classes.

Whichever selection of teacher is made, it is extremely important that the new *Principles of Technology* teacher(s) attend a *Principles of Technology* workshop, be given several weeks planning time prior to the beginning of classes, and be given some release time during the first year of instruction to get labs organized and lesson plans prepared.

What does *Principles of Technology* cost?

Materials—If your state or provincial agency is a member of the *Principles of Technology* consortium, you have the right to make unlimited copies of the print and video materials for use at

21

your school. You may also purchase copies of the materials at preferred prices. The section, "Ordering Materials," beginning on page 29 provides detailed information on sources and prices for *Principles of Technology* teaching materials.

Facilities—*Principles of Technology* can be taught in a high school science laboratory or a vocational lab supplied with 115-volt AC electrical power, water, drain, and gas. Compressed air is useful but not required. It is recommended that five lab stations be provided; however, implementation of the course is possible with two or three lab stations. A videotape player (VHS, Beta, or ¾-inch) and television monitor are required.

Equipment—A complete lab equipment list for the *Principles of Technology* labs can be obtained from your state or provincial consortium representative or from CORD. Cost of equipment is $4,000-$6,000 per lab station for the first year (Units 1-7) and approximately $2,000 additional per lab station for the second year (Units 8-14). Lab management information, technical facilities requirements, and a detailed equipment listing are available through your state's or province's consortium representative.

Does *Principles of Technology* work in the classroom?

An extensive pilot test was an integral part of the developmental process for *Principles of Technology*. Ample evidence indicates that *Principles of Technology* works in the classroom. Effects included:

- **Learning gains:** As indicated by several hundred student pre/posttests, the *Principles of Technology* units resulted in statistically significant learning gains. These gains were consistent among grade levels and sites and between male and female students.
- **Positive student attitudes:** Students were quite positive about the *Principles of Technology* units. They indicated that they liked the material, particularly the video programs and the hands-on labs. Students found the material relevant, most indicating that they thought the material was important for them to understand. Again these findings were consistent among grade levels and sites and between male and female students.
- **Positive teacher attitudes:** Teachers were also positive about the material. Almost all teachers indicated that they felt comfortable teaching *Principles of Technology*.

These positive findings do not mean that implementing *Principles of Technology* is easy. The field-test results indicated that certain conditions can enhance the successful implementation of *Principles of Technology*.

- **Teacher preparation time:** The majority of teachers reported spending, on average, more than 30 minutes preparing to teach each *Principles of Technology* class. Several reported more than an hour of preparation. This suggests that adequate preparation time should be allowed for a teacher who is initially implementing *Principles of Technology*.
- **Teacher background:** Teachers with a more extensive physics background tended to be more successful in implementing *Principles of Technology*. Although most students demonstrated a learning gain, those students whose teachers had a more extensive physics background tended to have more pronounced learning gains.
- **Class time:** Both a comparison of student test scores to teachers' reports of time spent in class and the teachers' own comments indicate that 50 to 60 minutes per session is optimum.
- **Lab equipment:** The problem that pilot test teachers most frequently reported was getting the lab equipment on time. Since the school's ordering system and the vendor delivery process will likely be time-consuming, lab equipment should be ordered well in advance of anticipated use.

The pilot test has indicated that *Principles of Technology* does work in the classroom. However, like any educational innovation, *Principles of Technology* requires hard work. Clearly, well-coordinated effort among school administrators, counselors, and teachers is the best way to ensure success.

INFORMATION FOR TEACHERS

Teacher Information

INFORMATION FOR TEACHERS

Although this section is specifically addressed to teachers, there is useful information for teachers throughout the document.

Teaching *Principles of Technology* requires that you begin by planning the procedures you will use to structure the class. Your first priority will be to look over the teacher's guide for the first unit of this two-year course. The guide begins with a preface that explains many aspects of the course. You should read the preface before you begin planning your methods of teaching the course, keeping in mind that the guide is intended only as a framework of suggestions, always subject to modification to suit your particular needs.

You may be planning to team teach this course. If so, you'll need to consult the other members of the teaching team. You can then determine which teaching responsibilities you will assume. To get ready to teach *Principles of Technology* you will need to:

- **Familiarize yourself with the components of the learning package.** These components include a teacher's guide, the student text, and the video segments for each unit of the fourteen-unit course.
- **Decide how you will structure *Principles of Technology* to fit the time frame of your institution.** The course is designed for 50-minute classes; however, the suggested teaching plan is flexible enough to accommodate a variety of learning formats. (See the preface to the teacher's guide for more information about this plan.)
- **Establish priorities.** The course was created with a particular target audience in mind. Students whom you recruit should be interested in a course that teaches applied science and mathematics principles in an industrial setting. Since the course is two years long, you will probably want to select juniors as students; however, *Principles of Technology* has been taught to tenth-graders successfully. The first year of *Principles of Technology* can be viewed as a stand-alone course if you decide to offer it on that basis. Students whom you select for the course should read on an eighth-grade level or higher, should have had at least one year of mathematics, and should enroll in—or already have taken—the first year of algebra. Data from the pilot test of *Principles of Technology* indicate that both male and female students do well in this course. Certainly, the job market for technicians is not limited to males. You will need to work with the counseling office to make sure that you are reaching all students—including females, minorities, and the handicapped—whose needs can be met through this course. Recruiting the right students should be your first priority once the time frame has been established.

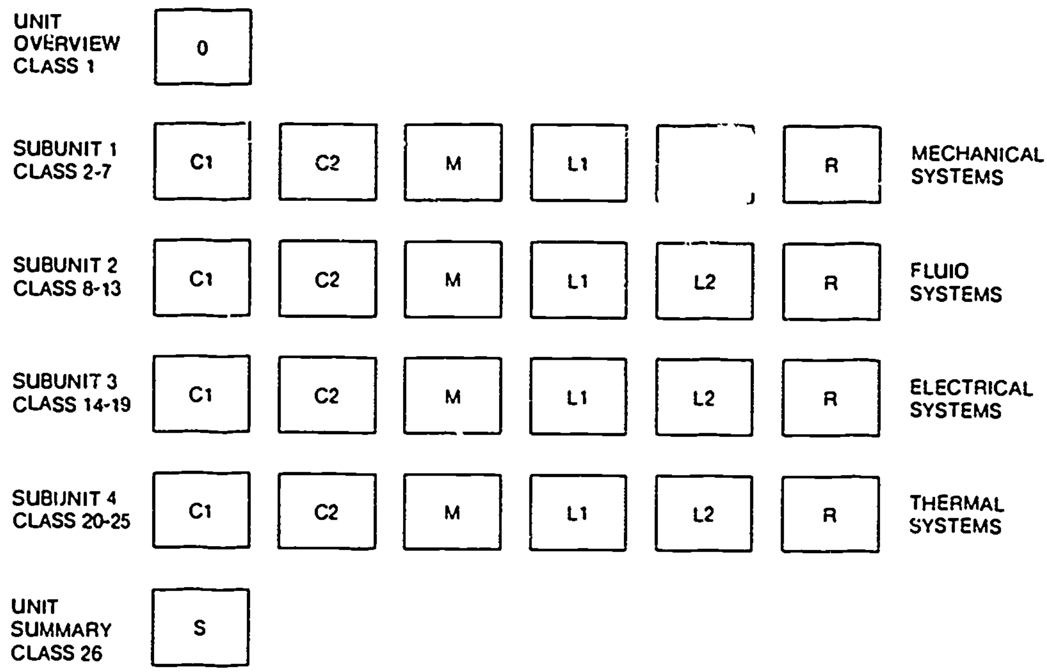
- **Order equipment.** This step should be taken at the earliest opportunity. A list of equipment needed and suggestions for ordering equipment in the most efficient manner are available from your state or provincial consortium representative or from CORD. Before you order equipment, you will want to inventory existing equipment. For example, some of the equipment may be available in a science or home economics laboratory. You may also want to look in vocational shops for useful equipment.
- **Understand the academic rigor of the course.** This course is different. It's neither traditional physics nor traditional mathematics, since the emphasis is on the industrial application of concepts. This course is also innovative in its approach to physics and mathematics, taking a "principles" approach rather than a theoretical approach. It's important that your students understand—in the beginning—that the course is designed to enable them to function effectively in the workplace. The students who take this course will be required both to read and to think. Then they will be asked to take the knowledge they have just acquired and put it to work in the applied laboratories.
- **Explain the purpose of the course to your students.** You may wish to tell your students how *Principles of Technology* was developed—that the course grew out of a national concern for providing physics and mathematics skills to students who will one day be responsible for developing, maintaining, and operating advanced-technology equipment. You will find the introductory program "About *Principles of Technology*" a good way to show your students what the course is about. You may also wish to use this program to explain the course to other teachers, to counselors, to school board members, to advisory council members, to members of your community, and to the parents of your students.
- **Explain to local industry representatives that this course has been designed to meet their needs, as well as the needs of students.** The work force of the future is in today's classrooms. You may wish to invite selected industry representatives for an orientation to the course. You may wish to follow that activity by asking these industry representatives to identify those skills they see being developed in *Principles of Technology* that they believe will be beneficial in the workplace. If you are having difficulty securing enough funds for equipment, you may wish to explain your situation to these industry representatives and ask for their support or assistance.
- **Realize that you, or the team of teachers guiding students through this course, make a difference.** It's your creativity, excitement, and ingenuity that will motivate students to study the materials in *Principles of Technology*. As you know, it's not often that an instructor gets the opportunity to pioneer a new approach—a new course. Technology is a new frontier. That frontier is expanding every day, requiring educators to be explorers with a taste for adventure. Educational institutions are in a race with technological advancement, and teachers are the "front line" who will determine whether or not educational institutions can meet the demands of tomorrow's technological society. It is today's teachers who will give students the skills they must have to cope with the challenges on the horizon.
- **Ask for assistance when you need it.** Call the *Principles of Technology* staff in Waco (CORD) and Bloomington (AIT). Waco *Principles of Technology* staff (CORD) created the print portion of this learning package (including the laboratories) and are prepared to answer any questions you may have. The *Principles of Technology* staff in Bloomington (AIT) created the video segments and are prepared to answer any questions you may have about this part of the learning package. In addition, we suggest that you work closely with your administration. They will be working closely with your state consortium representatives to achieve a smooth implementation of this course. Perhaps some of the best answers and advice available to you are right in your own backyard. Other teachers who have introduced a new curriculum, teachers whose areas of expertise complement your own, and teachers with background in teaching the student population for whom *Principles of Technology* was designed should be sources of practical knowledge about how to handle everyday challenges. Find out who piloted *Principles of Technology* in

your state. Teachers who have participated in the pilot test have experience with this course that can be invaluable to you.

- **Remain flexible if you fall a little behind the projected schedule for the course.** Since each unit in the first year builds upon the preceding units, it's important that your students internalize the information. But you can improvise, making up time by combining two classes—putting two lecture days into one or combining laboratories, for example—and this should put you back on schedule.

- **Understand the instructional system.** Like any other curriculum, this one is easiest to implement under the conditions for which it was designed. Basically, you have three tools with which to do this teaching job:

  1. **The student text, systematically divided into fourteen units.** Each unit contains an overview, up to four subunits, and a summary. Each subunit has lecture material, a suggested demonstration to use with the lecture portion, a math skills lab, and two hands-on physics applications labs. Each unit covers one technical concept. Each subunit explains that concept and how it applies in one of the four energy systems.



Each rectangle represents 50 minutes of instruction. Most units require 26 sessions. The first two sessions (C1 and C2) of the subunit include the video presentation and lecture/discussions; the third (M) is the math lab; the next two (L1 and L2) are hands-on labs. The sixth session (R) is a review of the material.

2. **The video.** Video segments provide direct instruction about the principles and systems. They introduce and explain the ideas presented in the text, take your students to workplace settings where technicians are employed, and help put variety in the course.

3. **The teacher's guide.** This portion of the learning package gives suggestions for teaching the class on a page-by-page basis.

You should keep in mind that the teacher's guide is not a set of rigid rules. It cannot substitute for the ingenuity within you—and the creativity you will continue to employ—as you teach this class.

SAMPLE STUDENT MATERIALS

Fig. 1-18 Earth-weight and moon-weight of the same object are different.

the astronauts weighed only one-sixth as much, and the forces that their leg muscles could exert were essentially the same as on earth, they were able to jump six times higher on the moon than they were able to jump on earth.

Mass and weight, as well as other units of time and length, are designated by certain words and abbreviations. These abbreviations will appear many times in these materials. You'll need to know them as part of your understanding of the terminology of the technician.

Some useful information on units is organized in two tables that follow. Table 1-1 lists SI and English units for length, time, mass, and weight (force). Table 1-2 lists some useful data for converting weight and mass units. You may want to refer to these tables later.

TABLE 1-1: ENGLISH AND SI UNITS

	Length	Time	Mass	Weight
ENGLISH	foot (ft)	second (sec)	pound mass (lbm)	pound (lb)
SI	meter (m)	second (sec)	kilogram (kg)	newton (N), or kilogram weight (kgw)

TABLE 1-2: WEIGHT AND MASS CONVERSIONS

1 pound = 16 ounces
1 pound = 4.45 newtons (weight)
1 kilogram = 1000 grams
1 pound mass (lbm) weighs one pound
1 kilogram mass weighs 9.8 N or 2.2 lb

WHAT IS TORQUE? HOW IS TORQUE RELATED TO ROTATION?

Torque is a forcelike quantity in the rotational mechanical system. Gears, crankshafts, flywheels, fans, motors, bolts and screws all turn or rotate. Their turning (or rotation) is caused by torques. A torque is the effect of a force applied on a body at some distance from the axis of rotation of that body.

Since torques cause rotations, torques can be classified as those that cause either ***clockwise*** rotations or ***counterclockwise*** rotations. Clockwise rotations move like the hands of a clock. The abbreviation for clockwise rotation is "cw." Counterclockwise rotations are in the opposite direction. The abbreviation for counterclockwise rotation is "ccw."

SAMPLE TEACHER MATERIALS

NOTE: Table 1-1 is an introduction to basic units in SI and the English system. Emphasize that technicians will need to learn units and keep them straight. When technicians measure quantities such as force, mass, voltage, pressure, temperature, etc., they'll have to record/report measurements in the correct units, or the measurements will be useless

NOTE: Table 1-2 closes out the text material to be covered for Class C1 The subject of "How Is Torque Related to Rotation?" makes up the student text material for Class C2.

NOTE: The student text material for Class C2 begins with "What Is Torque? How Is Torque Related to Rotation?" Refer to Teaching Path for Class C2 for outline of class activities. **DON'T FORGET** to work in a 10- or 15-minute classroom demonstration on torque. See instructions for equipment and demonstration details in Demonstration 1DM at the back of your Teacher's Guide in the Teacher's Appendix.

HOW TO RECRUIT STUDENTS FOR PT

(IN SEVEN EASY STEPS..)

1. Sell yourself on the idea that PT is of benefit to your students. It's almost impossible to sell anything <u>you</u> don't believe in. Sincerity is the key to motivating others.
2. Think long-range. Start recruiting students while they're in junior high.
3. Never miss an opportunity to tell others about PT. Basically, you have three target audiences. These are (1) counselors, administrators and other teachers, (2) parents of students, and (3) students themselves. Then you have the even wider audience of the community-at-large.
   a. Counselors, administrators and other teachers have the power to make or break your enrollment. The key to getting their support is information. Have a meeting. Inform them about what the course can do for students and for vocational programs. Invite them to your classes.
   b. Parents of students can be reached through a variety of means. You can invite them to your classes. You can reach them through (1) local newspaper articles (including the school newspaper); (2) through other local media (including radio and television talk shows); (3) through conferences: (4) by having a community meeting; (5) by having an open house at school. and (6) by starting your own newsletter for students, teachers and community opinion leaders; and (7) through awards and student reports that you could send home (such as a quarterly or trimester progress report).

Emphasize to your colleagues and others that PT isn't a substitute for their programs; it's a door into other programs.

c. Students can be reached in a formal manner by showing a copy of the course overview preview tape to them while they're in other vocational classes and while they're in industrial education classes--both in the high school and in junior high. You can reach students by advertising your program. This can be done with something as simple as a hall display or something as elaborate as an assembly program showing PT as an inroad to technical careers. Use your present classes to advertise for future enrollment. Nothing sells like students feeling that they're preparing for a bright future while they're having fun learning. Students say they enjoy the labs and video. Invite students to your classes as guests.

4. Concern yourself with what kind of credit will be given to PT. An "elective" isn't as easy to sell to students as a required course. In some cases, this may be a turf battle. In all cases, it is an <u>important</u> question.

5. Look for new kinds of students. Emphasize the importance of PT as a gateway into a technological society. Don't neglect female students. We have a tendency to deter female students by using the term "technician" in the same breath as "mechanic." Yet there are a significant number of women working as technicians.

6. Send commendation reports home with your better students in other classes. Praise their good work. Than add that they would be a good candidate for PT.

7. Decide what kind of students you want in the class. Because if you're doing a good job of recruiting, it won't be long before you will need to be more specific in what kind of students you're seeking and them you'll need to target your recruiting efforts to a more specialized kind of market. Field-test PT teachers tell us the best kind of student is one who is interested--not necessarily the student with the best grades, although a studious attitude helps. You'll want to motivate your students to read the book. You'll want students with enthusiasm--exactly the same quality that makes for good teaching.

PRINCIPLES OF TECHNOLOGY

FREDERICK COUNTY VOCATIONAL-TECHNICAL CENTER
7922 OPOSSUMTOWN PIKE, FREDERICK, MARYLAND 21701
TELEPHONE 694-1658

February 20, 1986

Dear Parent or Guardian:

Your son/daughter recently attended a meeting at his/her school concerning a new course, Principles of Technology, which will be taught at the Vocational Technical Center beginning next year.

Frederick County is in an area of growing high technology industries. Careers in advanced technology are expanding rapidly, and skilled technicians are in great demand. The Vocational Technical Center is responding to these changes by expanding its facilities and adding new courses. The addition of Principles of Technology is part of this effort to meet new high technology demands.

Principles of Technology is designed for students interested in technical careers and other secondary students wishing to further their understanding of the physical principles underlying modern technology. Principles of Technology has a dynamic instructional system of audiovisual presentations, texts, demonstrations, and hands-on laboratory experiences. It provides an understanding of the physical principles of technology and the mathematics associated with them. Each of the seven (7) units deals with one principle as it applies in the four energy systems - mechanical, fluid, thermal and electrical - that make up both simple and complex technological devices and equipment.

Each high school conducts orientation trips to the Vocational Technical Center during pre-registration. The Center also encourages parents and students to visit the school to see and learn more about the programs offered. Principles of Technology information is available at the Center and from Helen Magaha, 694-1394.

Students will register for Principles of Technology as part of a Technical Elective Survey Course at the Vocational Technical Center, and will have the opportunity to earn 1 merit credit in math or science. Additionally, students receive 2 vocational credits, one of which counts as a practical arts credit, now required for graduation.

Guidance counselors in the schools will register students for the Technical Elective Survey and Principles of Technology. Interested students should request additional information during the pre-registration period.

Sincerely yours,

Paul Stull

Paul Stull, Principal
Vocational Technical Center

Using the Textbook Material Effectively
or
How to Motivate Students to Read Textbooks with Ease

(NOTE: The following formal and informal techniques may help you to facilitate learning through a more effective use of the textbook. The techniques were compiled by reading consultant Doris Manning, Ed.D.)

A. INFORMAL METHODS

1. KEY WORDS

Introduce key words creatively. (Avoid giving a list of words or simply calling attention to a glossary.)

Example: Manometer -- The root "manu-" refers to something done by hand -- something you manipulate.
Mass -- Brainstorm about the different connotations of this word.

2. INTERESTING VISUAL

Select a visual in the chapter that's interesting. (It could be placed on a transparency.) Discuss this before introducing the chapter.

3. PARADOXICAL CONCEPT

Select a concept that appears to be paradoxical. (Note it on the board or on a transparency.) Have students debate or decide if this is a fact or opinion. They will read later to verify their answers.

4. HYPOTHESIS

Develop a hypothesis and have students predict its outcome. They will read to verify answers.

5. DRAWING CONCLUSIONS

Choose a visual or graphic that will allow students to draw conclusions. Based on their knowledge, what could happen under certain circumstances? Why could this happen? Could there be any other reaction or result?

(NOTE: If the teacher can perform the experiment in front of the class, rather than use a graphic, this would be more effective.)

6. DECISION READING

Give students a chart with headings "Advantages and Disadvantages" of a particular method or technique. Have them complete the chart while they read.

7. BRAINSTORMING

Before they read a unit, have students list (as a group) all they know about a particular concept. Accept all answers. This exercise could be repeated after students have read the material.

8. PREVIEWING (CHAPTER)

a. Outline chapter with class. (Be creative!)
   Example: Divide class into groups and have each group outline a portion, then put it together.
b. "Walk through" chapter with class, having them mark parts that you consider vital to comprehension.

9. PREDICTING

a. Give students a list of statements; have them mark each "true" or "false." Later, students read to verify their answers.
b. Give students a list of possible outcomes or results of an event or an experiment and have them follow the same procedure as above.
c. Have students read the introduction, or have a capable student read it to the entire group. Students then develop questions they predict the chapter will answer. This may be an individual or group activity.

(NOTE: Research by Oriz in 1977 indicated that students learn more from developing questions than from responding to them.)

B. FORMAL METHODS

(NOTE: For additional material on each of these formal methods, please see the bibliography for the book *Reading Strategies and Practices* by Tierney, Readence, and Disner.)

1. REQUEST PROCEDURE (Developed by A. V. Manzo)

Uses a questioning technique by both students and teacher to encourage comprehension. Students and teacher take turns forming the questions. The role of the teacher is to help students form suitable questions and to provide feedback on the answers. This procedure may be used at all levels of instruction.

2. CLOZE PROCEDURE (Developed by W. L. Taylor)

Purpose is to improve comprehension skills by requiring students to use the context of the sentence or an entire selection to fill in words or phrases that have been deleted. Several patterns for deletion are used; the deletion of every fifth word is most common.

3. REAP (Developed by A. V. Manzo)

Uses writing as a method to help students internalize what they have read. Students are required to read material and then to discuss and write their understanding of the material in their own words.

Steps are:
R - Read the material.
E - Encode (Put into your own language.)
A - Annotate (Put into writing.)
P - Ponder (Consider what you have written.)

4. GUIDED READING PROCEDURE (Developed by A. V. Manzo)

Uses a system of read and recall and self-correction to help students improve comprehension. After students read material (all or part), they list, as the teacher records, everything they can recall unaided. This is later checked with the actual material. The element of self-correction is a vital step in this procedure. Finally, the students -- with the teacher -- form a modified outline with the material that has been recalled.

5. STUDY GUIDES (Developed by Earle and Herber)

Purpose is to guide students through a reading selection by focusing on its major ideas or concepts (as chosen by the teacher). The teacher decides the objectives for reading the material and prepares a guide that will enable the students to follow. The guide will also help students acquire the information through the use of (1) levels of comprehension and (2) patterns of organization.

6. SELECTIVE READING GUIDE-0-RAMA (Developed by Cunningham and Shablak)

Major objective is to lead students to locate both the major ideas and the minor points, and to help students read with different speeds. A major premise is that students need help in selecting what must be read carefully and what material may be skimmed.

7. STRUCTURED OVERVIEW (Developed by Earle)

This procedure is designed to provide a framework for pre-teaching a technical vocabulary to students. The teacher goes through the material and selects the vocabulary that will be required for comprehension. Then the teacher organizes these words into a diagram, chart, timeline, etc., that will help students learn the words not by rote, but by understanding how they are related. Transparencies are often used for this.

8. SQ3R (Developed by Robinson)

Purpose is to provide students with a systematic method for reading a textbook. Steps are:

Question -	Students take each heading, read it, and restate it in a question form.
Read -	After forming the question, the students return to the beginning of that division and read the material in order to answer the question made.
Recite -	Now the students stop and attempt to recite (to verbalize) the answer to the question.
Review -	If students cannot recite the answer, then they return to the material and review it in order to answer it.

33

Helping Poor Readers Succeed

By Roger P. Collins

INDUSTRIAL arts/technology education is often presented as a subject suitable for students with low academic abilities. Many administrators and guidance counselors think that industrial arts/technology education requires minimal reading ability. Siedow (1983) tells from experience of a school superintendent who boasted in a speech to reading teachers of one method for solving a student's problems. The superintendent placed the student in vocational and industrial arts programs, promising that in this way he could graduate from high school without having to read a word!

Both students can benefit from pairing a student who has a reading problem with one possessing high reading ability

It is not uncommon to find students in IA/technology education who read as many as three or four grade levels below their own grade level. IA/technology education programs dealing with new high-tech material have a growing problem. Students with a 6.7-grade reading level, for example, will most likely feel overwhelmed by words like holography, piezoelectric, electrostatic, or lithography. I'll discuss in this article what instructors can do to help.

Background on students' reading. Using four different readability formulas, Lee (1981) determined that the grade levels of junior and senior high school textbooks range from 9.3 to 13.3 with a mean of grade 11. This high mean grade level poses no problem for senior high students with normal reading abilities. However, in junior high classes it places the material beyond students' abilities. When you combine high-grade-level material in a junior high program with students who read three to four levels below their grade level, the student and teacher have a serious problem.

Roger P. Collins is an industrial arts/technology education teacher, North Carroll High School, Hampstead, Maryland.

Industrial arts/technology education can generate high levels of interest among students. According to Johnson (1984), this quality can help students improve their reading ability. Walsh (1976) believes that the field's increased use of hands-on activities will actually increase reading demands.

Effective methods. First, educators must identify students who have a reading problem. Checking the student's permanent record file often proves the quickest way to determine whether a problem exists.

An instructor who finds a reading problem has several options. Lee recommends rewriting the textbook material in a less-complex form. Simplified vocabulary and sentence structure and a lower difficulty level could help.

Another method, recommended by Neill (1983), involves the use of audiovisual materials. Having teachers tape-record lectures and videotape demonstrations, as well as having parents or students tape parts of textbooks or equipment manuals, provides additional material to support the course. Commercially produced slides, films, and filmstrips that supplement textbooks are also available.

I have found very helpful use of the buddy system (Lee, 1981) and of a reading guide. Both students can benefit from pairing a student who has a reading problem with one possessing high reading ability for assignments, worksheets, and project activities. One student receives help with reading difficulties and the partner benefits from covering the material again by explaining it to his or her buddy.

From my experience, the buddy system is most effective when combined with use of a reading guide. A reading guide gives a poor reader the specialized help he or she needs (Lee, 1981). Developing a guide, I find, depends on the student's abilities and the level and extent of detail of the reading assignment. Generally, I follow Lee's recommendations.

Table 1 provides a general outline for a reading guide. It should begin with a vocabulary list. Any technical terms, new words, or words used in an unfamiliar manner should be included. The student covers the list before beginning the reading assignment. The reading guide relates the reading assignment to material the student already knows. It should contain a numbered list of comments and questions. I include items for the student to look for concerning diagrams, photographs, and il-

Table 1—Developing a Reading Guide

I. Identify a vocabulary list
  A. New words
  B. Technical terms
  C. Words used in an unfamiliar manner

II. Introduction to the reading assignment
  A. Review of previous student knowledge
  B. Relate new material to previous knowledge

III. Chapter comments and questions
  A. Identify items of student interest
    1. Diagrams
    2. Photographs
    3. Illustrations
  B. Identify important passages
  C. Develop questions for student to consider while reading the assignment

lustrations, as well as directions to specific paragraphs that will help answer the questions. Students use the buddy system to go through the reading guide, working together on vocabulary assignments or quizzing each other on chapter questions.

I then conduct the reading assignment itself following the guide. The assignment begins with a review of the vocabulary list. This is followed by an introduction to the lesson, which relates it to previous lessons.

Following the introduction, a preview of the assignment looks at the title, introduc-

Having both partners work on the same activity allows them to learn from each other not just from the teacher

tion, any bold-faced type, figures and tables, and the summary (Shaffer and Seifert, 1984). I have found that students with reading problems have less trouble completing assignments if they follow this reading guide format. Because the buddy system allows the students to help each other, I can concentrate on those who need more individual help.

Follow-up takes place with both a review of the answers to the completed chapter questions and performance of a hands-on activity associated with the written lesson. The buddy system helps here as well. Having both partners work on the same activity allows them to learn from each other, not just from the teacher. Buddies can work on review sheets together. Tests are individual but written on a level that the student can understand. □

References

Johnson, K. B. "Dealing with the Variations in Students' Reading Skills." SCHOOL SHOP January 1984: 24.

Lee, Howard D. "Dealing with Reading in Industrial Arts." *Journal of Reading* May 1981: 663-66.

Neill, Shirley Boes. "Twenty Tips for Content Area Teachers to Help Remedial Readers." *Curriculum Review* December 1983: 29.

Shaffer, Dolores, and Joan Charlton Seifert. "Careful Introduction of Material Is Key to Reading Success." SCHOOL SHOP January 1984: 25-26.

Siedow, Mary Dunn. "Reading in Vocational Education: A Review of Recent Literature." *Reading World* December 1983: 158-165.

Walsh, Lawrence A. "The Role of the Textbook in Vocational Education." SCHOOL SHOP December 1976: 19-21.

INFORMATION FOR COUNSELORS

Counselor Information

INFORMATION FOR COUNSELORS

Technology is making enormous demands on high school counselors. Students must plan for the future. Counselors are responsible for helping students make career decisions. Yet no one knows what the future holds. The only thing we can count on is change, so we must prepare our students for that change as best we can.

This challenge is being answered with the development of new curricula—courses like *Principles of Technology*. The implementation of new curricula requires that counselors become lifelong learners—predictors of the future who can act as a bridge between technological expansion and educational change. For it is in sessions between students and counselors that important choices are made—choices that will not only influence the lives of students, but will also affect the ability of society to keep pace with the demands of the future.

That's what makes *Principles of Technology* a good choice. If you've read the first two sections of this handbook, you already know that this two-year course offers students a broad base of information that they can build on in the years to come. This course helps students learn technological basics—basics that will enable them to respond to changes in the marketplace as their career paths unfold.

There are some prerequisites that should be considered before students enroll in *Principles of Technology*. Preparation for *Principles of Technology* actually begins in the eighth or ninth grade, because:

- students must have at least an eighth-grade reading level. Those who don't will have difficulty with the academic rigor of the course. Therefore, in preparing students for this course, it's advisable that an assessment of reading levels be made. This way, students can get any remedial reading help they may need before beginning the course. Local school personnel should use their own discretion in establishing admission guidelines.

- students should have completed a general mathematics course before starting *Principles of Technology*. Students should plan to enroll in Algebra I—either before or concurrent to—their enrollment in *Principles of Technology*.

Because careers in advanced-technology areas are expanding every day, students who are interested in these careers should not have to select a specialty while in high school. That's why *Principles of Technology* is designed as a "core" course. The knowledge this course transmits is the basic information for an increasing variety of advanced-technology occupations—some of which do not yet exist. Fields that will need more workers in the future include:

- Laser/Electro-Optics
- Computer Technology
- Microelectronics/Telecommunications
- Nondestructive Testing
- Instrumentation and Control
- Automated Manufacturing/Robotics
- Computer-Assisted Drafting/Design
- Biomedical Electronics

Principles of Technology prepares students to enter a postsecondary—or industrial—training program that leads to successful employment in these occupations. The technical information in *Principles of Technology* has longevity; laboratory experiences in the course emphasize current applications.

In modern technical careers, there are four major career opportunities: scientist, engineer, technician, and operator. For example, consider the activities and responsibilities of the employees in robotics and automated manufacturing. (Robotics encompasses the design, building, installation, and operation of robots in the industrial workplace.)

- **Robotics Scientist**—This person works in the design phase to produce state-of-the-art advances in artificial intelligence—that is, better "eyes" and "hands" and "brains" for new robots. The scientist might then talk with the engineer to ensure that the system designed on paper could, in fact, be built with existing computers, sensors, fiber optics, pneumatic devices, etc.
- **Robotics Engineer**—This person is responsible for turning the concept into a functioning robot. The engineer identifies precisely what parts are needed, redesigns certain parts if necessary, predicts performance limits by testing the new robot, and interacts with the scientist and the robotics technician while these activities are taking place.
- **Robotics Technician**—This person works under the supervision of the engineer or scientist and performs the actual assembly of the final robot. The technician works from drawings and uses a variety of tools in the assembly phase of projects. Technicians fine-tune the products of the scientist and the engineer and serve as liaison between them and the robotics operator.
- **Robotics Operator**—This worker operates the robot in the workplace. A robotics operator works on the outside of the robot; workers at the other levels concern themselves with the inside of the product. Robotics operators must, therefore, be concerned with real-time operation and routine maintenance of the robot. They will need an increasing level of skill as technological advances unfold.

Principles of Technology is designed for students who are preparing for careers as technicians; however, *Principles of Technology* is also useful for students who wish to become scientists, engineers, and operators. Keep in mind, however, that *Principles of Technology* is a foundation that can grow according to the student's motivation or opportunity for further study. Our society is developing a renewed respect for those who perform operations that are crucial to the performance of objectives. The trend is toward preparing students—who are those potential workers—with a combination of skills, both academic and vocational/technical. The trend also is moving toward lifelong skills development, rather than the cessation of formal training after traditional schooling. *Principles of Technology* introduces students to the kinds of changes technological advancement is bringing to *society* as well as the changes technology is bringing to the workplace.

More information about this course can be found by reviewing the introductory video program, "About *Principles of Technology*." Doing this before advising students will be extremely helpful because the overview video explains the advantages of—and need for—a course like *Principles of Technology*. You may also wish to show this video to parents who are assisting their youngsters in making career choices. You can then explain to parents and students that the reason mathematics and science seem to be the concern of so many educators and politicians is that technology has created a need for technological literacy. *Principles of Technology* is the first step toward technological literacy—as well as technological training.

More information on advanced-technology careers can be found in *High Technology Careers: A Guide for Counselors*. This book is available from the Center for Occupational Research and Development, 601C Lake Air Drive, Waco, TX 76710 (or by phone at 1/800/231-3015).

PRINCIPLES OF TECHNOLOGY

November 1985

OCCUPATIONAL INFORMATION

HOW TO USE THIS INFORMATION

This information is designed to be used with Principles of Technology to provide teachers and students with occupational information. Designed to be part of each unit, it was to be inserted and discussed right after the overview. Since the publishers elected to bind the copies, it was not possible to insert. Therefore, this material should be used as teachers see the need when students desire occupational information. We hope the teacher will cover all the occupations with the students to assist them with career choices.

Phil Rollain
Project Coordinator

OVERVIEW: OCCUPATIONAL INFORMATION

The selection of an occupation is one of the most important decisions in a person's life. For the young preparing for a career, questions abound as to what skills are required in each field and how those skills may be attained or refined. Furthermore, while you may be aware of your own interests and abilities, you face the perplexing choice of selecting a field which promises the greatest economic and personal satisfaction.

How much training does it take to enter a particular occupation? Is experience important? How much can I expect to earn? Is it difficult to find a job in this field? Finding the answers can be difficult. However, more resources are available than ever before to help you make an informed career choice.

Each unit will contain occupational information on 46 different technical positions. The information shall be brief and to the print, and students desiring additional information should contact their guidance department or public library for these particular references:

1. Occupational Outlook Handbook, published and revised every two years by U.S. Department of Labor, Bureau of Labor Statistics.

2. Dictionary of Occupational Titles (D.O.T.) published by U.S. Department of Labor (fourth edition).

3. Many trade associations, professional societies, trade unions, industrial organizations, and state and federal government agencies are able to provide career information that is valuable and up to date.

4. North Carolina Careers is a microcomputerized, comprehensive career guidance system designed to find occupations that match the student's own personality characteristics and preferences. North Carolina Careers also provides in-depth, accurate, and up-to-date information on 300 occupations and 143 training sites.

   North Carolina Careers contains 141 different ways to describe oneself or to obtain concise information on occupations in 11 topic areas including:

   - Interests
   - Aptitudes
   - Temperaments
   - Education Level
   - Environmental Conditions
   - Employment Outlook
   - Wage/Salary
   - Hours of Work/Travel
   - Physical Demands
   - Physical Activities
   - Indoor/Outdoor Considerations

Technologists and Technicians. Technologists and technicians provide the technical assistance necessary for engineering, computer, library, legal, and similar professional activities. They focus on the practical elements of a job, leaving the policy, theory, and design aspects to others.

Technologists and technicians perform the day-to-day tasks needed to carry out a project or run an operation. They may operate testing and measuring equipment in a laboratory; make drawings of new designs; build models of new projects; program computers; or guide airplanes to their destinations. They are employed in nearly every industry, wherever technical assistance in a specialized area is needed.

Most technologists and technicians work closely with and are supervised by professional workers; for example, engineering technicians work with engineers. They are usually part of a team that is engaged in a particular project or operation.

In most specialities, technologists and technicians use complex electronic or mechanical instruments, technical manuals, or other specialized materials. Because of the diversity of technologists and technician occupations, training requirements vary widely. A high school diploma is a minimum requisite; most jobs, in fact, require specialized postsecondary training. Training is offered at junior and community colleges, technical institutes, vocational schools, and extension divisions of colleges and universities. These programs usually emphasize practical courses and "hands-on" experience in a particular specialty. Programs vary in length. For example, most legal assistant programs require two years' work. On the other hand, programmers complete four-year bachelor's degree programs.

In addition to acquiring a formal education, technologists and technicians often receive on-the-job training; for example, programmers generally work under close supervision for several months. Occasionally, technologists and technicians take additional courses to keep abreast of technological advances in their specialty.

The knowledge and personal characteristics required in these jobs vary, but most technologists and technicians need a good foundation in mathematics and the basic sciences--physics, chemistry, and biology. They must be able to apply practical knowledge to solve particular problems. Because they are often part of a team, technologists and technicians must follow directions well and effectively communicate their findings to others. They must be patient, precise, and organized in their work habits. Also, most need manual dexterity to work with various kinds of equipment.

This course, Principles of Technology, is designed to give the student the first course in a technical career. It offers students a broad base of the principles and concepts of technology so that they can build on it in the years to come. This course helps students learn technological basics that enable them to respond to changes in the marketplace as their career paths unfold. The knowledge this course transmits is the basic information for an increasing variety of advanced technology occupations, some of which do not yet exist.

Electromechanical Instrumentation and Maintenance Technologies. A group of instructional programs that prepare individuals either to support or assist mechanical and electrical engineers, or to install and service electromechanical equipment. Programs stress specialized, practical knowledge related to the mechanical, mathematical, scientific, or technical aspects of mechanical and electrical engineering, biomedical engineering, computer science, and instrumentation design.

Biomedical Equipment Technology. An instructional program that prepares individuals to manufacture, install, calibrate, operate, and maintain sophisticated life-support equipment found in hospitals, medical centers, and research laboratories. Includes instruction in the use of testing and diagnostic instruments; calibrating techniques; potential hazards and safety precautions; and methods of installation, repair, maintenance, and operation of the equipment.

Computer Servicing Technology. An instructional program that prepares individuals to install, program, operate, maintain, service, and diagnose operational problems in computer systems arising from mechanical or electrical malfunctions in computer units or systems. Includes instruction in the underlying physical sciences and supporting mathematics of computer design, installation, construction, programming, operation, maintenance, and functional diagnosis, and how to detect, isolate, and correct malfunctions. Programs describe the electrical and electronic circuits and mechanical devices used in computer construction and their combination into systems in individual computers or computing installations, as well as instruments used to detect weaknesses or failures in electrical systems in computers.

Electromechanical Technology. An instructional program that prepares individuals to assist mechanical and electrical engineers and other managers in the design, development, and testing of electromechanical devices and systems such as plant automated control systems, servomechanisms, vending machines, elevator controls, missile controls, tape-control machines, and auxiliary computer equipment. Includes instruction in assisting with feasibility testing of engineering concepts; systems analysis (including design, selection, testing, and application of engineering data); and the preparation of written reports and test results.

Instrumentation Technology. An instructional program that prepares individuals to design, develop prototypes for, test, and evaluate control of measurement devices on systems, and to prepare graphs, written reports, and test results in support of the professional personnel working in the field of instrumentation. Includes instruction in the fields of electricity, electronics, mechanics, pneumatics, and hydraulics as they pertain to the principles of control, recording systems, automated devices, and the calibration of instrumentation units or systems.

UNIT 3 RATE

Electrical and Electronic Technologies. A group of instructional programs that prepare individuals to support and assist electrical and electronic engineers, and other engineers and scientists concerned with the development of lasers. Programs stress specialized, practical knowledge related to the mechanical, mathematical, scientific, or technical aspects of electrical engineering, electronic engineering, and laser development.

Computer Technology. An instructional program that prepares individuals to support engineers and scientists in the design, development, and testing of computer and peripheral devices. Includes instruction in electronic circuitry; prototype development and testing; systems design, selection, installation, and testing; solid state and microminiature circuitry to data storage devices; an' the preparation of reports and documentation of test results.

Electrical Technology. An instructional program that prepares individuals to support an electrical engineer in the design, development, and testing of electrical circuits, devices, and systems for generating electricity and distributing electrical power. Includes instruction in model and prototype development and testing; systems analysis and integration, including design and development of corrective and preventive maintenance techniques; application of engineering data; and the preparation of reports and test results.

Electronic Technology. An instructional program that prepares individuals to support the electronic engineer and other professionals in the design, development, modification, and testing of electronic circuits, devices, and systems. Includes instruction in practical circuit feasibility; prototype development and testing; systems analysis, including design, selection, installation, calibration, and testing; solid-state and microminiature circuits; and the application of engineering data to specific problems in the electronics field.

Laser Electro-Optic Technology. An instructional program that prepares individuals to assist engineers, scientists, or plant managers in the assembly, installation, testing, adjustment, and operation of various types of lasers for various applications. Includes instruction in safety precautions and the optical, physical, and chemical theory and application of each laser device.

UNIT 4 RESISTANCE

Environmental Control Technologies. A group of instructional programs that prepare individuals to assist in controlling either the internal temperature of commercial and industrial buildings, or the levels of toxicity of industrial wastes.

Air Conditioning, Heating, and Refrigeration Technology. An instructional program that prepares individuals to work in engineering departments or independently as entrepreneurs capable of designing, installing, maintaining and operating small or medium air conditioning, heating, and refrigeration systems. Instruction prepares individuals to work in a commercial organization performing special tasks relating to design, assembly, installation, servicing, operation, and maintenance of heating or cooling systems, according to the standards of the American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc. Includes instruction in air conditioning, heating, and refrigeration devices, equipment, techniques, and systems; evaluation of amount of heating, air conditioning, or refrigeration capacity needed to accomplish a particular task; and instruction in the maintenance and operation of a system that meets the requirements of the task.

Air Pollution Control Technology. An instructional program that prepares individuals to detect, measure, and control air pollution. Includes instruction in the chemistry of combustion from which the majority of polluting elements in the air are derived; the major sources of air pollution, such as internal combustion engines, power plants, and industrial or home use of fuels; methods of sampling smokestack; detection and source identification and analysis of air pollutants, both gaseous and particulate; and the construction, use, calibration, and maintenance of automatic samplers, recorders, and other analytical devices.

Energy Conservation and Use Technology. An instructional program that prepares individuals to support engineers or work independently to identify and measure quantities of energy used in heating and cooling or operating a facility or industrial process; assess efficiency in the use of energy or the amount lost through wasteful processes or lack of insulation; and prescribe remedial steps to conserve energy within the system. Includes instruction in the utilization and conversion of energy in its various forms; techniques for improving use or preventing loss of energy; and the quantification of the net minimum or optimum energy required in a given system or process.

Sanitation Technology. An instructional program that prepares individuals to support sanitarians, and others responsible for health and sanitation factors, by determining the nature and amount of bacteria and chemical contaminants in water, wastewater, and food processing. Includes instruction in sampling, culturing, and identifying pathogenic or other organisms; determining the relative amounts of contaminants in food, soil, water, or other materials by taking samples and performing analyses using sophisticated chemical and biological equipment and procedures; and sanitation-related aspects of water and wastewater purification and processing systems and food processing, storage, and service. Programs prepare individuals for the licensure or certification that is required in some states for employment in government sanitation or health-related agencies.

Solar Heating and Cooling Technology. An instructional program that prepares individuals to work with heating, cooling, and refrigeration engineers and scientists in research, design, installation, and maintenance for maximum efficiency of solar heating units for space heating, cooling, and water heating for factory, home, or institutional use. Includes instruction in the design and dynamics of solar heat collecting systems; heat collection, storage, and distribution in modern heating and cooling systems; theory, procedures, and measuring devices for air conditioning, heating, and refrigeration systems; and the individual mechanisms and controls used in solar heat collecting units for air conditioning, heating, or refrigeration systems.

Water and Wastewater Technology. An instructional program that prepares individuals to process, purify, store, control pollution in, distribute, and dispose of wastewater. Includes instruction in the design, construction, operation, and maintenance of equipment for water or wastewater collection, processing pollution control, and distribution; operation of machines, devices, and control systems which use sophisticated modern instrumentation; testing of samples of materials at various stages in the process design; hydraulics; liquid collection; liquid-processing equipment; pumping and conveying; sampling and testing, both chemically and biologically; processes of purification digestion, biological deterioration, and disintegration of wastewater products; plant layout, operation, and safety; and the regulations and standards controlling water or wastewater purification.

Civil Technologies. A group of instructional programs that prepare individuals to support and assist civil engineers and urban planners. Programs stress specialized, practical knowledge related to the mathematical, scientific, or technical aspects of civil engineering and urban planning.

Civil Technology. A group of instructional programs that prepare individuals to assist a civil engineer in designing, surveying, materials control, testing, and building of various structures. Includes instruction in physical sciences; mathematics; surveying; laying out roadways; preparing plans and specifications for the construction of highways, railroads, buildings, dams, and airports; structural detailing and design testing; construction estimating; and operations management.

Drafting and Design Technology. An instructional program that prepares individuals to assist mechanical, electrical and electronic, architectural, chemical, civil, or other engineers in the design and drafting of electrical circuits, machines, structures, weldments, or architectural plans. Includes instruction in the preparation of engineering plans, layouts, and detailed drawings according to conventional projection principles and techniques or as specified; preparation of charts, graphs, or diagrams; model making; and the use of handbook data germane to design and drafting in various engineering fields.

Surveying and Mapping Technology. An instructional program that prepares individuals to technically assist civil engineers and urban planners in the determination and description of the shape, contour, location, and dimensions of geographic areas or features.

Urban Planning Technology. An instructional program that prepares individuals to work as team members with civil engineers, social scientists, and urban-planning professionals. Includes instruction in methods used in urban design and land utilization; methods of demographic study, including population growth, transportation in urban settings, and housing; building and construction codes and regulations; urban traffic management and control; distribution of water and wastewater systems; electrical systems relating to the overall planning for redevelopment of an urban area; urban mapping and engineering drawing; reading architectural or engineering drawings; methods of urban growth determination and projection; cost determination; analysis and comparison of different types of configurations and the sociological aspects of housing, transportation, recreation, park and living space, employment, and logistics in an urban setting.

Architectural Technologies. A group of instructional programs that prepare individuals to support and assist architects and architectural engineers. Programs stress specialized, practical knowledge related to the mathematical, scientific, or technical aspects of architecture and architectural engineering.

Architectural Design and Construction Technology. An instructional program that prepares individuals to assist the architect and architectural engineer in planning and designing structures and buildings; testing materials; constructing and inspecting structures; model building and design estimating; utilizing, transporting, and storing construction materials; and dealing with contracts and specifications.

Architectural Interior Design Technology. An instructional program that prepares individuals to assist architects in planning and designing interior layouts. Includes instruction in designing architectural structures; analyzing and using various types and colors of floor, wall, and ceiling coverings; windows and doors; accoustical materials; functional furnishings; electrical, heating, cooling, and other outlets; and in assessing costs related to design and furnishings.

UNIT 7 FORCE TRANSFORMERS

Industrial Production Technologies. A group of instructional programs that prepare individuals to supervise industrial processes or to support engineers, scientists, and other professionals who are employed by industry. Programs describe the mechanical, scientific, or technical aspects of a variety of industries, including chemical, manufacturing, food processing, forest products, marine products, plastics, and textiles.

Chemical Manufacturing Technology. An instructional program that prepares individuals to support chemists in the chemical-manufacturing fields. Includes instruction in material handling, crushing, grinding and sizing; extraction, distillation, evaporation, drying absorption, and heat transfer; and assisting in design, installation, and operation of pilot plants for chemical-manufacturing processes.

Food Processing Technology. An instructional program that prepares individuals to assist food chemists and food-processing engineers in processing raw foodstuffs into marketable food products by selecting and grading raw materials, and by industrial processes for extracting, converting, drying, freezing, preserving, canning, pickling, smoking, radiating, chemically treating, and packaging products. Includes instruction in the basic sciences and supporting mathematics of chemistry, microbiology, and physics as they relate to food processing, and in the processes, equipment, sanitation, inspection, handling procedures and techniques, process control and scheduling, product storage, shipping and cost analyses of alternative processes in the industry as applied to specific products and localities.

Industrial Technology. An instructional program that prepares individuals to assist an industrial engineer in production and planning; design and installation of integrated systems of materials, equipment, and personnel; and measurement, testing, and management of quality control in the manufacturing, transportation, assembly, installation, and operation of processes and products. Includes instruction in the operating of testing equipment (destructive and nondestructive), measuring devices, specification reading, and design and measurement for levels of tolerance compatible with overall production specifications.

Manufacturing Technology. An instructional program that prepares individuals to technically assist in the optimization of the design, construction, and application of machinery tools, equipment, and processes used in the production of goods.

Marine Products Technology. An instructional program that prepares individuals to supervise processing of marine products, including seaweed, non-vertebrate and vertebrate marine products. Includes instruction in the anatomy and identification of marine products; the construction, mechanics, and operation of equipment; procedures, techniques, and sanitation aspects of processing, including refrigeration and chemical preservation; safe working practices; sanitation and inspection; and potential chemical, biological, or bacteriological problems encountered, including any pathological condition of the product during processing.

Optical Technology. An instructional program that prepares individuals to grind lenses from optical glass or from modern plastic, according to engineering specifications or optometrist prescriptions. Includes instruction in the science of optics, optical glass, and plastics used in optics; optical design and drawing; machinery, materials, and techniques required for production of optical lenses; and in the polishing of lenses or optical elements for mounting in eyeglasses or holding devices.

Plastic Technology. An instructional program that prepares individuals to support plastic design engineers, scientists, managers, or entrepreneurs in the application, production, and fabrication of plastic products. Includes instruction in the chemistry and applied engineering sciences related to thermosetting, pressing, forming, molding, and producing of fiberglass or other plastics; drawings for dies, form molds, or plastic assemblies; molding, extruding, jointing, finishing, inspecting, and controlling the quality of the products; packaging for shipment or storage; and hazards associated with production and design.

Quality Control and Safety Technologies. A group of instructional programs that prepare individuals to support a variety of engineers and industrial managers. Programs describe the mechanical, scientific, or technical aspects of industrial production, occupational health, and quality control.

Occupational Safety and Health Technology. An instructional program that prepares individuals to work with safety engineers and managers in analyzing working conditions in places of employment to ensure maximum safety to workers and occupants. Includes instruction in safety engineering principles and science; related federal, state, and local legislation; procedures, practices, techniques, and methods used in analyzing all aspects of working conditions in an employment establishment, including physical, water, atmospheric, and other environmental elements which may constitute hazards; determination of potentially unsafe working practices; chemical contamination of workers through the air they breathe; methods for correcting unsafe conditions or preventing them; cost analysis of various corrective measures for working conditions or practices on the job; capability in reading engineering drawings; and use of orthographic projection practices in drawing, diagramming, or sketching safety devices or plant layouts.

Quality Control Technology. An instructional program that prepares individuals to support engineers or managers by utilizing the sciences of measurement and quality control, quality design, production and inspection, testing (both destructive and nondestructive), statistical sampling, and mathematical probability as it relates to quality control in mass-produced items manufactured by modern production procedures and processes. Includes instruction in the intensive study of the physical and related engineering sciences and supporting mathematics related to material testing devices; testing; inspection techniques; organization of systems of quality control; statistical sampling; management of quality in manufacturing, transportation, assembly, installation, and operation; assurances of maximum accuracy or quality control in all phases of manufacturing; and utilization of all components and units in modern sophisticated machine devices or systems. Special study is required to understand the operation of testing equipment (particularly nondestructive equipment), measuring devices, reading of specifications, design and measuring of tolerances to assure that a certain level of quality will be met in producing a component, unit, or system. Includes instruction in the preparation of scientific or technical reports and in the development of interpersonal skills required in the performance of tasks or in the supervision of the work of others.

Safety Technology. An instructional program that prepares individuals to technically assist in the maintenance of materials, equipment, and personnel for industrial, commercial, and fire safety systems.

Textile Technology. An instructional program that prepares individuals to assist scientists, engineers, or managers in the textile industry or in related research, development, production, or servicing. Includes instruction in the nature and characteristics of textile fibers; spinning, weaving, dyeing, mordanting, fireproofing and static arresting, testing of fibers for tensile strength, heat resistance, crease resiliency, and laundering; equipment and machines used in marking textiles; and textile production, packaging, storage, shipment, and uses.

Welding Technology. An instructional program that prepares skilled workers at the technician level to understand, perform, and supervise or inspect a wide variety of welding processes. These include gas welding, brazing, flame cutting, metallic arc welding (manual or automatic), metallic gas or inert gas welding of ferrous and nonferrous materials, resistance welding, and fusing of glass and plastics in a welding mode. Includes instruction in the applied physics and metallurgy of the various welding processes and techniques, the composition and metallurgy of the various metals, the chemistry and physics of the welding process, the shielding elements in the welding processes, and the various types of equipment used to accomplish each process. Programs develop an elemental understanding of design for welding fabrication; an understanding of the elements of cost and economics of welding of various types; a knowledge of the methods of nondestructive inspection of welding and welded products; and an understanding of auxiliary equipment used in the process, such as jigs, fixtures, and annealing equipment related to welding.

UNIT 9 WAVES AND VIBRATIONS

Mechanical and Related Technologies. A group of instructional programs that prepare individuals to support and assist a variety of engineering professionals, including aeronautical, agricultural, automotive, mechanical, electrical and electronic, architectural, chemical, civil, mining, and petroleum engineers. Programs describe the mathematical, mechanical, scientific, and technical aspects of these engineering specialities.

Aeronautical Technology. An instructional program that prepares individuals to assist the aeronautical engineer in collecting research data relevant to the operation of aircraft and the design, testing, and development of propulsion, control, and guidance of aircraft and aerospace vehicles.

Agricultural Equipment Technology. An instructional program that prepares individuals to assist agricultural engineers. Includes instruction in farm machinery, farm structures, and rural electrification.

Automotive Technology. An instructional program that prepares individuals to support an automotive engineer in diagnosing normal or abnormal operation and in maintaining and repairing automotive equipment. Includes instruction in the installation, maintenance, operation, repair, adjustment or modification of automobiles, trucks, buses, and light industrial or farm equipment powered by gasoline, diesel, or turbine engines and equipped with electrical, hydraulic, pneumatic, or mechanical controls. Also includes instruction in the use and calibration of diagnostic and testing instruments and equipment.

Marine Propulsion Technology. An instructional program that prepares individuals to support propulsion engineers, ship officers, and managers of marine units and fleets, or to work as manufacturers' representatives of marine propulsion units. Includes instruction in various marine propulsion units and systems and their related controls; various fuels and fuel systems, and problems and hazards involved in their use; power capacity of various units; the basic design, installation, operation and maintenance, and servicing of various marine propulsion units and systems; the use and design of cooling systems; operational controls; cost efficiency of various alternative propulsion systems; and maintaining operation and service logs.

Mechanical Design Technology. An instructional program that prepares individuals to assist a mechanical design or equipment-systems engineer in designing, detailing, producing, and testing machines, using appropriate available materials, processes, techniques, and facilities. Includes instruction in drafting; strength of materials; manufacturing or fabrication procedures and practices; material testing; component inspection; machine or unit operation; evaluation; basic physics and mechanics and the supporting mathematics; basic mechanisms; hydraulics and pneumatics; quality control and testing; machine design; materials; specification preparation; and technical reporting.

UNIT 10 ENERGY CONVERTORS

Mining and Petroleum Technologies. A group of instructional programs that prepare individuals to support and assist mining and petroleum engineers and managers. Programs stress specialized, practical knowledge related to the mechanical, scientific, or technical aspects of mining and petroleum engineering.

Coal Mining Technology. An instructional program that prepares individuals to assist mining engineers or managers or to assume responsibility with a degree of independence in various aspects of mining operation. Includes instruction in methods, equipment, processes, techniques, and procedures employed in underground coal mining or in strip mining; coal beneficiation and conditioning for marketing; mapping and planning the exploitation of a coal field; managing for safe mining operations; disposing of mine waste; reclaiming strip-mine areas after coal has been removed; testing and analyzing the quality of coal; measuring the levels of impurities in air in mines and identifying the nature of the impurities; constructing, operating, and maintaining specialized machinery and equipment; and planning for maximum exploitation of deposits of coal by the most economical modern methods.

Mining (Excluding Coal) Technology. An instructional program that prepares individuals to work in a supportive role to mining engineers and managers in the development and exploitation of metal or other mineral ore deposits (excluding coal and other fossil fuels). Includes instruction in elementary geology; mechanical drawing and drafting; mining methods, both open pit and underground; surveying as it applies to planning the mining of a particular ore body; mining machinery; equipment and methods used in drilling, blasting, conveying, hoisting, crushing, and beneficiation; mine safety; environmental impact; production, storage and disposal of solid or liquid wastes; and collecting, screening, filtering, drying, processing, storing, and shipping of finished ore.

Petroleum Technology. An instructional program that prepares individuals to assist in petroleum production; on-shore or off-shore exploring for petroleum fields; seismic testing of promising geological formations; drilling test wells; improving drilling technology; analyzing cores from drilling; logging cores; collecting petroleum from producing wells; delivering oil to holding points or pipelines for transporting to refineries; or capturing gas and retaining it in holding points for marketing. Includes instruction in the methods for increasing productivity of oil fields; seismic exploration; sophisticated scientific and production methods; instrumentation, machinery, equipment, techniques, and processes used in obtaining and refining crude oil into salable products; oil- or gas-well drilling; oil- or gas-well control by use of drilling muds or other techniques; charting and diagraming oil fields, oil wells, and pipelines; and designing refineries.

UNIT 11 TRANSDUCERS

Allied Health, Diagnostic, and Treatment Technologies. A partial list of instructional programs that prepare individuals to assist a qualified health professional in providing diagnostic, therapeutic, preventive, restorative, and rehabilitative services. Many times in the health care field a technician is expected and/or required to make minor repairs on his/her equipment.

Cardiopulmonary Technology. An instructional program that prepares individuals to perform a wide range of tests related to the functions and therapeutic care of the heart-lung system; operate and maintain a heart-lung machine for extra-corporeal circulation; assist in cardiac catheterization and cardiac resuscitation; and assist in the post-operation monitoring, care, and treatment of heart-lung patients.

Dialysis Technology. An instructional program that prepares individuals to provide dialysis and intensive care to patients in a renal service, including cardiac monitoring, respiratory therapy, isolation procedures, and adjustment and maintenance of dialysis equipment.

Electrocardiograph Technology. An instructional program that prepares individuals to operate and maintain an electrocardiograph machine to record electromotive variations in the action of the patient's heart muscle. Includes instruction in making minor repairs.

Dental Laboratory Technology. An instructional program that prepares individuals to make and repair restorative appliances required for the oral health of the patient, as prescribed by a dentist.

Nuclear Medical Technology. An instructional program that prepares individuals to prepare and administer radioactive isotopes and to measure glandular and other bodily activity in therapeutic, diagnostic, and tracer studies, using a variety of equipment.

Electroencephalograph Technology. An instructional program that prepares individuals to operate and maintain the electroencephalograph to measure impulse frequencies and differences in electrical potential between the various areas of the brain to obtain data for the physician to use in diagnosing brain disorders. Includes instruction in making minor repairs.

Broadcast Technicians. Broadcast technicians operate and maintain the electronic equipment used to record and transmit radio and television programs. They work with microphones, sound and video tape recorders, light and sound effects, television cameras, transmitters, and other equipment.

In the control room of the radio or television broadcasting studio, these technicians operate equipment that regulates the signal strength, clarity, and range of sounds and colors in the material being recorded or broadcast. They also operate control panels that select the source of the materials being broadcast. Technicians may switch from one camera or studio to another, from film to live programming, or from network to local programs. By means of hand signals in television and by use of telephone headsets, they give technical directions to personnel in the studio.

When events outside the studio are to be broadcast, technicians go to the site and set up, test, and operate the remote equipment. After the broadcast, they dismantle the equipment and return it to the station.

As a rule, broadcast technicians in small stations perform a variety of duties. In large stations and at networks, on the other hand, technicians are more specialized, although specific job assignments may change from day to day.

Transmitter operators monitor and log outgoing signals and are responsible for operating the transmitter.

Maintenance technicians set up, adjust, service, and repair electronic broadcasting equipment.

Audio control engineers regulate sound pickup, transmission, and switching.

Video control engineers regulate the quality, brightness, and contrast of television pictures.

Recording engineers operate and maintain video and sound-recording equipment.

Field technicians set up and operate broadcasting equipment.

Some technicians operate equipment designed to produce special effects, such as the illusion of a bolt of lightning or the sound of police sirens, when programs originate outside the studio. The terms "operator," "engineer," and "technician" often are used interchangeably in describing the above jobs.

Supervisory personnel with job titles such as chief engineer or transmission engineer direct activities concerned with the operation and maintenance of studio broadcasting equipment.

Training, Other Qualifications, and Advancement

Federal law requires that anyone who operates broadcast transmitters in radio and television stations must have a restricted radiotelephone operator permit for which no examination is required. A person who works with microwave or other internal radio communications equipment, however, must have a general radiotelephone operator license, issued after the applicant passes a series of written examinations. These cover communications law and regulations, radio operating practices, and basic communications electronics.

Technical school, community college, or college training in engineering or electronics is the best way to prepare for a broadcast technician job, particularly for those who hope to advance to supervisory positions or to the more specialized jobs in large stations and in the networks. High school courses in algebra, trigonometry, physics, electronics, and other sciences also provide valuable background for a career in this occupation. Building electronic hobby kits and operating a "ham" or amateur radio also are good introductions to broadcasting technology. Some persons gain work experience as temporary employees while filling in for regular broadcast technicians who are on vacation.

Broadcast technicians must have an aptitude for working with electrical and mechanical systems and equipment. Manual dexterity - the ability to perform tasks requiring precise, coordinated hand movements - is necessary for success in this occupation.

Entry level workers are instructed and supervised by the chief engineer, or by other experienced technicians, concerning the work procedures of the station. They generally begin their careers in small stations, operating the transmitter and handling other technical duties after a brief instruction period. As they acquire more experience and skill, they are assigned to more responsible jobs. Those who demonstrate above-average ability may move into top-level technical positions such as supervisory technician or chief engineer. A college degree in engineering is becoming increasingly important for advancement to supervisory and executive positions.

Related Occupations

Broadcast technicians need the electronics training and hand coordination necessary to operate technical equipment; they generally complete specialized postsecondary programs, including courses in electronics and engineering. Others whose jobs have similar requirements include drafters, engineering and science technicians, surveyors, air traffic controllers, radiologic technologists, respiratory therapy workers, electrocardiograph technicians, electroencephalographic technicians, and medical laboratory technicians.

<u>Technical Writers</u>. An instructional program that describes the theory, methods, and skills needed for writing scientific, technical papers and monographs.

Technical writers put scientific and technical information into readily understandable language. They prepare manuals, catalogs, parts lists, and instructional materials used by sales representatives to sell machinery or scientific equipment and for use by technicians to install, maintain, and service equipment.

Technical writing requires a knowledge about specialized fields such as electronics, mechanics, chemistry, or one of the other sciences. Relatively few technical writers enter the occupation directly from school. The majority work initially in areas of less responsibility. Some begin as research assistants, editorial assistants, or trainees in a company's technical information department. In time, these people may assume writing duties and develop technical communications skills.

UNIT 14 TIME CONSTANTS

New and Emerging Technical Careers. Many of tomorrow's jobs are here today. We call them emerging careers: occupations demanding new knowledge and new skills, and offering new and exciting opportunities for those who are ready for them.

New careers are emerging so rapidly, and in some cases, changing so continuously, that it is not possible to present for each new field standardized information on its advantages and disadvantages, education or training needed, working conditions, numbers of workers, typical earnings, or where the job will be located.

Robot Technicians

The robotics industry gives every indication of taking off and moving ahead as fast as the computer industry did a few years ago. Business analysts predict an annual growth rate of over 30 percent through the rest of this decade. Forecasters predict robot sales will range from $214 to $500 million a year for the next five years.

If the robot industry is to continue its projected growth, it must have an adequate supply of robot technicians and engineers.

The frontiers for robots and microprocessor (minicomputer) industries have moved beyond creating mechanical workers to creating machines that think. This artificial intelligence is attempting to duplicate some of the brain's function with machines.

Changes in the manner in which goods are produced and services are provided also affect occupational and industrial employment. For example, as an industry automates production (installs robots), the mix of workers is likely to change, which in turn will have different effects on an occupation's employment growth.

Technological change is expected to affect employment in many industries and occupations through the mid-1990's. The increasing use of robots in automobile manufacturing, for example, is one factor expected to limit employment growth in that industry. The increasing use of word-processing equipment will limit growth of employment of typists. Despite widespread technological advances, however, employment should continue to increase in most industries and occupations during the 1980's and early 1990's.

The continued growth in the importance of technology to national defense, office work, manufacturing, and other activities is expected to cause much faster than average employment growth for technologists and technicians such as legal assistants, programmers, and electrical and electronics technicians. The employment opportunities for technologists and technicians should increase 30 to 49 percent between 1982 and 1995.

IMPLEMENTATION TIMELINE

IMPLEMENTATION TIMELINE

This is a suggested timeline for key activities in the implementation of *Principles of Technology*. You should alter it to meet your needs. Some schools, for example, may wish to begin instruction mid-year and will need to alter other activities accordingly.

September, one year before implementation	Make decision to implement. This should be a joint decision by administrators, teachers, counselors, school board members, etc. Early involvement will instill a sense of pride in all those involved.
October	Hold a planning meeting to prioritize and sequence such activities as selecting teachers, training teachers, recruiting students, and obtaining equipment. Discuss such topics as how the course will fit into existing curricula, what students' needs and interests are, and how the course relates to postsecondary training.
November	Identify teachers.
November	Determine budget needs.
January	Begin public awareness activities using "Guide to Information Dissemination."
January	Meet and discuss relation of course to postsecondary training with appropriate audiences (academics, community colleges, etc.).
January	Order equipment.
January	Begin recruitment of students.
January-July	Conduct teacher training.
September	Begin instruction.

GUIDE TO INFORMATION DISSEMINATION

GUIDE TO INFORMATION DISSEMINATION

This section of the Implementation Handbook provides you with an explanation of the materials available for your awareness activities. It explains how to use those materials most effectively to gain maximum understanding of the course. And it provides you with ideas to promote the curriculum.

A clear understanding of *Principles of Technology* among students, teachers, administrators, counselors, parents, and community leaders is essential to the successful implementation of the curriculum.

Understanding is not something that simply happens. Implementors must take the initiative to conduct awareness activities that will help these individuals understand the project and its benefits.

Awareness can benefit implementation at your school in several ways. It can help you recruit students. Awareness can help to create a positive image of the curriculum and vocational education in general. If properly informed, students, teachers, counselors, administrators, parents, and civic leaders will pass the word to others, inside and outside the school. Finally, these activities can generate community and parental support—an important element of success.

You must make these materials work for *you*. You know your constituents best. These activities and materials have been designed to allow you the flexibility to meet your individual needs.

What's Available to You?

There are several information pieces available for awareness activities. Beginning on page 20 you will find editorial materials. They can be easily localized and then reproduced for distribution. They include:

Two open news releases: one release allows you to announce the implementation of *Principles of Technology* in your school. The other is a feature release that probes the ideas and concepts of the project.

Radio/TV spot copy for use as public service announcements.

An open letter to introduce the curriculum to individuals or groups that might be interested in it.

Your state/provincial representative can provide you with sufficient quantities of hands-on information materials that when combined with the above editorial pieces will provide you with a comprehensive promotion package. The following items are available from your representative:

Project literature folder: A 9" x 13" folder to be used for a press kit or information packet.

Photographs from the video portions of the project: Quantities of photographs to be used in a press kit, newsletter, or guide.

Logo slide: To be used with the public service announcement copy for television purposes.

Logo sheets: Photostatic copies of the project's logo for reproduction purposes.

Photostatic copies of news release paper/letterhead: For mass distribu . , the sample news releases can be reproduced on 8½" x 11" letterhead printed from this stat.

Information brochure: An 8½" x 11" brochure which, when folded, fits into a regular business envelope for background information purposes.

Orientation program: A video introduction to the course, which can be used in meetings or workshops.

Planning Is the Key to Success

Now that you know exactly what is available to help you in your promotion efforts, you can begin work.

It is always a good idea to develop a simple plan of action—a laundry list of activities that you plan to conduct. Before you can sit down and develop your plan you must answer a few questions:

- What is the objective of your plan?
- Who is/are your audience/s for these activities?
- Taking into consideration your objective and audience/s, what is your schedule?

Once these questions are answered, you can begin to write your plan. This plan does not have to be an extensive document, but it should provide you with enough detail to ensure that your efforts will be implemented in a timely fashion and will be effective.

Putting the Information Materials to Work for You

The editorial materials in the guide and the hands-on items you can obtain from your state or provincial representative should be used creatively to assist you in promotion activities. Let your imagination be your guide.

Local Press Activities

The sample news releases in the guide, naturally, are to be used for press activities. Editors have to be sold on a story idea before they will even consider it for use. Remember, you are competing with several other news items. It is important that you make yours as interesting and "newsworthy" as you can.

There are several elements an editor looks for in a story:

A local angle—Editors are interested in items of local interest to their readers or listeners.

Scope—Editors are interested in items that have a profound effect on many people or are large in scale.

Topical interest—They need items on topics of current interest.

The news releases in this handbook were designed with these criteria in mind.

Once you've given the sample news releases a local slant, you can put together a press kit using your "local" news releases, photos from the series, and the information brochure. You could go one step further and provide copies of photographs you've taken in your school. Just tailor them to the format of the other photographs. Remember to reproduce the news releases on news release paper/letterhead that you've printed from the stats provided to you. *Make sure you've included the name of a contact person, with telephone number and address. These can be typed at the top of the release before it is duplicated.*

You'll want to do a little thinking about the people you want to receive your press kit. When in doubt, send it to the city editor at a newspaper or the news director at a radio or television station. Some newspapers might even have an education editor. If these specific positions don't exist, send it to the top person at each outlet: managing editor or station manager. This applies to other publications as well, such as magazines, community newsletters, and school publications. You might want to make some follow-up phone calls to see if you can answer any questions or provide assistance.

Placing Articles

You can also use the press materials with local sources (teachers, students, and others) to develop your own article for publication. Sometimes this is more effective than a blanket press mailing. Some publications, such as magazines and school district newsletters, don't use press materials. Rather, they solicit articles.

It is always a good idea to contact the publication first to see if it will accept an article, and to find out a little bit about the slant or focus of the publication.

Public Service Announcements

Radio and television can be instrumental in disseminating information. The guide provides sample public service announcements.

The *radio copy* public service announcement (PSA) can be localized and reproduced and sent to the public service director or program manager at your local radio stations. Remember who your audience is when sending out these PSAs. For instance, if you are interested in recruiting students, you might want to send one to the radio station listened to by teenagers; for community support, you might want to send one to a station with adult listeners.

The *television copy* public service announcement (PSA) can be sent out with the logo slide. Again, send it to the station manager or the public service director.

Remember, broadcast outlets are required by the FCC to give public service time for community affairs. Take advantage of a station's generosity.

Community/Information Meeting

You or one of your colleagues should try to get on the agenda of periodic meetings of groups such as the PTA, Chamber of Commerce, or Rotary Club. In addition, you may be called upon to go to local businesses to talk to several people about the project. Of course, you will have to talk to groups of teachers and students for recruitment purposes.

The first step in this process is to use the open letter in the handbook to try to get on the agenda of these local meetings. Once they've accepted your offer, you'll want to use the following meeting format, modifying it to meet your individual needs:

Community/Information Meeting (50 minutes)

Introduction (5 min.)

Prior to the meeting, hand out the project information brochure provided to you by your state or provincial representative.

Introduce yourself and the purpose of the meeting. The following remarks may help you in this portion of the presentation:

> My name is (representative) and I represent (school, district, or agency). I'm here tonight (today) to introduce you to an innovative vocational resource that we are introducing in our school this year. Many of your youngsters or those of your friends may already be enrolled in this curriculum.
>
> I'm talking about *Principles of Technology*. The course is designed for vocational students interested in technical careers and other secondary students wishing to further their understanding of the physical principles underlying modern technology. The small brochure you have in your hand will give you an understanding of the course.
>
> We are offering the course to high school students here in (city). Our (state/province) was involved in the early development and implementation of the course. Over 30 other states and provinces helped fund the project. It was developed under the management of the Agency for Instructional Technology and the Center for Occupational Research and Development.
>
> I'd like to show you an overview videotape program that will provide you with a good understanding of this curriculum resource.

Program Presentation (15 min.)

In this part of the meeting you will be showing an orientation program on *Principles of Technology*. This will give attendees an overall understanding of the project and its goals.

Question and Answer (20 min.)

Now that you know a little more about *Principles of Technology*, you might have some questions that I will attempt to answer.

Conclusion (1 min. plus . . .)

Students are involved in some pretty exciting educational activities at (school, district, or agency). I hope I've helped you to gain a better understanding of one of those. I want to invite you to visit us and learn more about *Principles of Technology* firsthand. Thank you very much.

Principles of Technology Newsletter

You might want to start your own newsletter to send to students, teachers, and others interested in the curriculum. You already have a pretty good start with the editorial materials in this handbook.

Open House/Tour

One of the great mysteries for parents and the community is what goes on inside schools. How about showing them? Plan an open house for those interested in this curriculum. Some of your best salespersons are students. They can recite the virtues of *Principles of Technology*.

Awards

You might want to initiate an award for the top *Principles of Technology* student, then use the award in promotion. This is called "events marketing." It requires, however, the creation of a genuine event. Fabricating and promoting an event that editors do not find newsworthy can damage your credibility with the press.

Talk Shows

In your work with the news media, you might attempt to get informed individuals on local talk shows—both radio and television. Again, there is much public service time available. Use some for *Principles of Technology*. Contact the station's public service director to find out how to do this in your area.

66

SAMPLE NEWS RELEASE

(Information to be filled in and local photographs attached by school district/school.)

For Immediate Release
(date)

Contact:
(Name and phone number of contact person at school district/school)

'Principles of Technology'

New in (name of school district/school)

(CITY, State/Province)—They're doing something new in (name of school—maybe even name of teacher) vocational classes this year. And for good reason.

In today's rapidly changing technical job market, a worker with narrow skills—however expert—can be outdated even before finishing school. Technicians need training that is applicable to more than a single job. They must understand the physical principles on which modern equipment operates and be able to apply those principles to new tasks as the need arises.

Beginning (date), *Principles of Technology*, an innovative course designed to meet these urgent needs, (will be/was) introduced to local students.

The new course has been developed cooperatively by (state/provincial agency) and 34 other state and provincial education agencies in association with the Agency for Instructional Technology and the Center for Occupational Research and Development. The education agencies are providing approximately $3 million for the creation of *Principles of Technology* and will facilitate its use within their service areas.

Based on CORD's Unified Technical Concepts course, *Principles of Technology* incorporates the findings of pilot testing in comprehensive high schools and vocational centers throughout the United States and Canada With an appealing instructional system of audiovisual presentations, texts, demonstrations and hands-on laboratories, it provides an understanding of the physical principles of technology and the mathematics associated with them.

The new course is designed to be both academically rigorous and practical for students planning technical careers, and for other non-college-bound secondary students interested in applied science. A typical instructional unit requires 26 regular 50-minute class sessions. Each of the 14 units deals with one principle as it applies in the four energy systems—mechanical, fluid, electrical and thermal—that make up both simple and complex technological devices and equipment.

- more -

In most schools, the units will be presented over a two-year period. Students will progress from units on force, work, rate, resistance, energy, power and force transformers to units on momentum, waves and vibrations, energy convertors, transducers, radiation, optical systems and time constants.

Throughout the course, video segments present the concepts and illustrate many of their industrial applications. Math skills labs meet students at their own level. Some students need to complete preparatory work before doing the regular math lab; highly skilled students can be challenged by more difficult mathematics exercises.

Because (state/provincial agency) has participated in developing *Principles of Technology*, local schools already own the right to use and freely duplicate the new course materials, or to buy them at preferred prices.

SAMPLE FEATURE NEWS RELEASE

(Information to be filled in and local photographs attached by school district/school.)

For Immediate Release
(date)

Contact:
(Name and phone number of contact person at school district/school)

'Principles of Technology'

Prepares High School Students for Technical Careers

(CITY, State/Province)—Careers in advanced technology are expanding every day, and skilled technicians are commanding salaries higher than those of many college graduates.

Comprehensive high schools and vocational schools are harder pressed than ever to provide up-to-date equipment on which their students can learn and training that will enable them to adapt to continuing change.

"We're in the center of high-tech industries," says J. Wilkinson, who teaches at St. Johnsbury Academy, a combined college preparatory and vocational school in Vermont. "They want troubleshooters. They want our people to complete our program and then take their technical training courses."

Terry Rencher, Jr., a high school student in Fort Wayne, Ind., wants to "be able to repair a burned-out computer and be able to build parts for it that are necessary—to just know, to have a real good understanding of what the circuitry is about, and all the basic parts of computers and any other types of machines used in industry today."

"They talk about high tech, but we needed to start with low tech," says Junius Toups, a small engine mechanics instructor at Terrebonne Parish Vocational Technical High School in Louisiana.

All three are enthusiastic about a new kind of practical physics course called *Principles of Technology*, now in its (first/second) year of use at (name of local school/vocational center).

The rapid pace of technological change demands that technicians not only learn skills in one narrow specialty, but also understand the entire complex systems with which they work and the technical principles on which they are based. But how best to teach those principles?

Traditional academic courses often fall short of meeting the needs and engaging the interest of high school students who purposefully choose a vocational program, and who do not intend to go to college, contends the National Commission on Secondary Vocational Education in its 1984 report.

- more -

"It's not a problem to teach," says Bill Thomas, an instructor at Fort Wayne Regional Vocational School, which Terry Rencher attends. "The material is well organized. It doesn't make gross assumptions about what a student knows. It tends to explain and define the areas well. And it's rather interesting. I think it gives the students a great deal of mental variety. There's a lot of very hard mental work. We've asked our home schools to send us young people who are interested in the theory, but at the same time want hands-on experience."

Toups says that his students are at all levels. "If I can teach some of my lowest ones, it must be terrific for students who are more advanced. For me, the video is the number-one plus. These kids were born and raised in front of a TV. Video doesn't scare them, and they learn. For the first two weeks, I didn't tell them what we were really doing."

Some of the students in Carolina Sylvestri's *Principles of Technology* class at West Side High School in Omaha, Neb., are taking physics at the same time. A chemistry teacher team-teaching with an electronics teacher, Sylvestri doubts that her students know that they are learning the same things in both courses because, she says, with *Principles of Technology* "they are learning them in a direct, functional way. So much of what I teach is all foundation for higher education. This is a course from which kids can take off on their own."

Sylvestri's class recently visited a plastics manufacturing company. "Without *Principles of Technology*," she reports, "they wouldn't have had the faintest idea what was going on. They asked really good questions of the personnel manager and the quality control manager. They had a good foundation and were working from it."

All four teachers intend to continue using *Principles of Technology* after the two pilot years.

"I really see a need for it," says Sylvestri.

"It has a place in Louisiana education, because the requirements are going up," says Toups. "I'm training a young math and physics teacher to work with me next year."

Thomas likes it because it gives students something between going to college and learning hands-on without theory. "The new technologies are forcing schools to rethink those old policies."

With degrees in mathematics and science, Wilkinson tried some years ago to design an applied mathematics course for his students. "I found it was a lot of work," he says. "Finally I gave up. But this is tailor-made."

What do students think?

- more-

"The assumption is that more academics, which may be the best preparation for college, is also the best preparation for life," the commission writes. "This assumption is wrong."

This 14-member commission of educators, university faculty members, and representatives of business and labor recommends that students "be allowed to satisfy some requirements for high school graduation—for example in the areas of mathematics, science, English, or social study—with selected courses in areas of vocational education that are comparable in content coverage and rigor."

One such course is *Principles of Technology*.

Developed in response to the urgent need to improve the physics and mathematics skills of high school students who will one day be responsible for maintaining, developing and operating high-technology equipment, *Principles of Technology* also offers a practical, academically rigorous alternative for other students interested in applied science.

Thirty-five state and provincial education agencies throughout the United States and Canada have cooperated with the Agency for Instructional Technology and the Center for Occupational Research and Development to create the new course. The project's approximately $3 million budget was provided by the education agencies. *Principles of Technology* is based on CORD's Unified Technical Concepts curriculum, which is used successfully for postsecondary technical training.

"*Principles of Technology* does not replace all the technical courses needed for certain jobs," says Leno Pedrotti of CORD, who developed the UTC and worked with the participating education agencies to adapt it for secondary schools.

"What it does is to dress applied physics in the clothes of modern technology. It strengthens needed mathematics skills and complements the existing vo-tech curriculum.

"It's not an easy course, but field test results indicate that students do learn, and that they find the course both interesting and useful."

Principles of Technology has been field-tested extensively in selected schools and vocational centers throughout the United States and Canada. In (state/province) the materials were tested at (schools/centers) with some (approximate number) students.

(NOTE: You might include comments from teachers and students who tested the materials in your area, administrators, science teachers or even major employers who recognize the value of such training for their potential employees.)

- more -

The best thing about *Principles of Technology*, says Terry Rencher, is that it's divided into sections and builds on a basic idea until there is a common understanding. "The labs are wonderful. I wish we had more of them. I have great interest in them."

According to Daniel Troxell, a student who had trouble with geometry and algebra due to what he calls his "lack of willingness to do the work," the course is interesting.

"I like to learn the stuff I don't already know. Every now and then M Thomas will surprise us with something. He'll bring in something new and it kind of clicks in the back of my brain and I have the urge to grasp it."

Glen Boston, Daniel's classmate, puts it simply: "It's the best thing available in the school system."

-30-

SAMPLE OPEN LETTER FROM SCHOOL DISTRICT/SCHOOL REPRESENTATIVE TO PARENTS, PARENT GROUPS, CIVIC GROUPS, OR EMPLOYERS

Dear ( ):

Careers in advanced technology are expanding and changing every day, while skilled technicians are commanding salaries as high or higher than those of many college graduates. It is more important than ever before for high schools and vocational schools to prepare students to adapt to technological change.

Beginning (date), (name of school) (will offer/offered for the first time) a new kind of course to help them do just that. *Principles of Technology* is a practical, rigorous course in physics and mathematics designed especially for vocational students interested in technical careers and for other students to whom emphasis on the application of the physical principles underlying modern technology appeals more than a theoretical approach.

Developed cooperatively by (state/provincial agency) and thirty-four other states and provinces and pilot tested extensively throughout the United States and Canada, *Principles of Technology* meets individual students where they are. It builds on their strengths and interests. It uses an appealing instructional system of audiovisual presentations, texts, demonstrations, and hands-on laboratories to teach the principles of mechanical, fluid, electrical, and thermal systems and the mathematics associated with them.

(We/I) consider it important to get the word about this innovative course out to students and to the community that will eventually depend on them to maintain, develop, and operate high technology equipment. (We/I) (are/am) asking for your support.

(NOTE. End the letter in the way that best suits your purpose. You might want to volunteer a speaker to take video programming and other course materials to a meeting of the group to which you are writing. You might use such a presentation to recruit students, or to increase understanding among teachers and parents. You might suggest specific ways in which organizations could support the new endeavor. A business or civic group might consider stocking a laboratory station, perhaps from its own surplus. Employers might be willing to visit classrooms to help students understand how the skills taught in *Principles of Technology* are needed in industry.)

For more information, please call or write (contact person) at (phone number, address).

Sincerely,

(Your name/s)

SAMPLE RADIO SPOT

(date)
'Principles of Technology'
Public Service Announcement

10 seconds with upbeat music intro and exit

High school sophomores! Get technical about your future. Talk to your high school counselor about *Principles of Technology* . . .

SAMPLE RADIO SPOT
(Information to be filled in by school district/school.)

(date)
'Principles of Technology'
Public Service Announcement

30 seconds

High school students—if you're looking forward to a technical career, or you're more interested in applied science than in abstract ideas, there's a new kind of training just for you. And it's free! Find out how *Principles of Technology* can help you keep up with the pace of modern industrial change. Ask your counselor, or call (name of school district/school) at (phone number) to ask about *Principles of Technology* That's (repeat phone number).

SAMPLE TELEVISION SPOT
(Information to be filled in by school district/school.)

(date)
'Principles of Technology'
Public Service Announcement

20 seconds

(Slide: *Principles of Technology* title slide)

High school students—if you want a technical career and you don't want to find your skills outdated by new industrial technology, there's a new kind of training just for you. And it's free! Find out about *Principles of Technology* now at (school/vocational center). Ask your counselor, or call (phone number).

75

For Further Information:
Judy Allensworth (800) 457-4509
Cassy Jordan (800) 231-3015

FOR IMMEDIATE RELEASE
(Monday, March 10, 1986)

Principles of Technology Prepares Nation's
High School Students for Technical Careers

(BLOOMINGTON, Ind. and WACO, Texas)—"The assumption is that more academics, which may be the best preparation for college, is also the best preparation for life.

"This assumption is wrong."

These are the words that 14 educators and representatives of business and labor, who served as the National Commission on Secondary Vocational Education, wrote in their 1984 report, *The Unfinished Agenda.*

They further recommended that students "be allowed to satisfy some requirements for high school graduation—for example in the areas of mathematics, science, English or social study—with selected courses in areas of vocational education that are comparable in content coverage and rigor" to courses taught on the "college-prep" side of the school.

Responding to this challenge, vocational educators from 41 states and Canadian provinces came together to fund the development of a curriculum called *Principles of Technology.* The course puts physics and mathematics "in work clothes" and is two years long.

Mary Hatwood Futrell, president of the National Education Association, told 50,000 vocational educators that *Principles of Technology* is a "promising new curriculum initiative"—a way to "recharge vocational curriculums."

With 14 student texts, 14 teacher's guides and over 700 minutes of video interspersed throughout the course, *Principles of Technology* is a mammoth undertaking. The course has been field-tested in over 50 U.S. and Canadian classrooms and is set for release as a final product this coming fall.

It's what educators call "a Cadillac course," but one targeted for middle-range students, not just the exceptionally gifted.

-more-

Principles of Technology doesn't claim to take the place of traditional physics and mathematics courses taken by students who plan careers that require university study.

"*Principles of Technology* doesn't replace the technical courses needed for specific jobs, but it puts them all on a firmer foundation," according to its principal author, Dr. Leno Pedrotti, who is employed by the Center for Occupational Research and Development in Waco, Texas—one of two agencies developing the curriculum. The other is the Agency for Instructional Technology, located in Bloomington, Ind. (CORD is a developer of advanced-technology curriculum in print and computer-based instruction. AIT is a well-known American-Canadian developer of instructional materials using television and computers.)

"*Principles of Technology* is a foundation course. It presents applied physics and mathematics in the 'clothes' of modern technology. It strengthens mathematics skills—and includes sections to help students overcome math anxiety. It complements the existing vocational education curriculum," explained Pedrotti.

"It's not an easy course," he added. "But our field-test results over the last two years have shown that students experience significant learning gain—and that they find the course both interesting and useful."

Bill Thomas, an instructor at a regional vocational school in Fort Wayne, Ind., believes that the "material is well organized. It's not a problem to teach.

"It doesn't make great assumptions about what a student knows. And it's rather interesting. I think it gives the students a great deal of mental variety. There's a lot of hard mental work. We've asked our home schools to send us young people who are interested in theory, but at the same time want hands-on experience," Thomas said.

Junius Toups, a small-engine mechanics instructor at Terrebonne Parish Vocational Technical High School in Louisiana, said that his *Principles of Technology* students are working at all levels. "If I can teach some of my lowest ones, it must be terrific for students who are more advanced. For me, the video is the number-one plus. These kids were born and raised in front of a TV. Video doesn't scare them, and they learn. For the first two weeks, I didn't tell them what we were really doing."

Some of the students in Carolina Sylvestri's *Principles of Technology* class at West Side High School in Omaha, Neb., are taking physics at the same time. A chemistry teacher team-teaching with an electronics teacher, Sylvestri doubts that her students know that they are learning the same things in both courses because, she said, with *Principles of Technology* "they are learning them in a direct, functional way. So much of what I teach is all foundation for higher education. This is a course from which kids can take off on their own."

-more-

Sylvestri's class recently visited a plastics manufacturing company. "Without *Principles of Technology*," she reported, "they wouldn't have had the faintest idea what was going on. They asked really good questions of the personnel manager and the quality control manager. They had a good foundation and were working from it."

All three teachers intend to continue using *Principles of Technology* after their two pilot-teaching years.

"I really see a need for it," said Sylvestri.

Thomas likes the course because it gives students an alternative to attending college or learning hands-on without theory. "The new technologies are forcing schools to rethink those old policies," he said.

What do students think?

The best thing about *Principles of Technology*, said Terry Rencher, a vocational education student in Fort Wayne, is that it's divided into sections and builds on a basic idea until there is a common understanding. "The labs are wonderful. I wish we had more of them."

According to Daniel Troxell, a student who had trouble with geometry and algebra because of what he called his "lack of willingness to do the work," the course is interesting.

"I like to learn the stuff I don't already know. Every now and then Mr. Thomas will surprise us with something. He'll bring in something new and it kinds of clicks in the back of my brain and I have the urge to grasp it."

Glen Boston, Daniel's classmate, put it simply: "It's the best thing available in the school system."

For Further Information
Judy Allensworth (800) 457-4509
Cassy Jordan (800) 231-3015

FOR IMMEDIATE RELEASE
(Monday, March 10)

Industry, Education Call *Principles of Technology*
Answer to Vocational Education Needs

(BLOOMINGTON, Ind. and WACO, Texas)—U.S. and Canadian industry, engaged today in an all-out race against the other manufacturing nations of the world, has never needed—or paid—highly qualified technicians more. As our school systems upgrade themselves and reach for "excellence," will vocational education, the source of those technicians, receive its share of respect and resources?

Many industrial leaders doubt whether the vocational education taught in today's schools can prepare the ideal technicians of the future.

Educators, too, see the need to overhaul vocational education. The National Commission on Secondary Vocational Education recently studied vocational classes with that aim, conducting hearings and reading testimony to produce its recommendations, published as *The Unfinished Agenda*.

An ambitious effort to meet these demands of industry and education is a course in vocational education called *Principles of Technology*. Created over the past four years by a group of 41 state and provincial education agencies, *Principles of Technology* seeks to modernize the skills of tomorrow's technicians.

The National Commission's educators and representatives of business and labor criticized schools that raised the number of required high school courses but reduced the hours available for elective vocational education classes. The members thought that schools might be creating a false "head vs. hands dualism," with vocational education seen as preparing students for low-status blue-collar jobs only.

The Unfinished Agenda announced a need for special programs to bridge the gap between academic, theoretical courses and practical, vocational ones. It called on industry to help schools stay current with "robotics, fiber optics, lasers and other high technologies."

-more-

In its turn, industry has specific recommendations to make. Three people in a position to evaluate the worth of a worker's vocational background are Dave Evans, former manager of high-tech training at the General Motors Assembly Center in Wentzville, Mo.; Art Peters, vice president of TII Robotics, Palatine, Ill.; and Bob Walker, technical training manager of Metropolitan Edison, Reading, Pa.

"We've got to be honest," said Peters. "We can say the schools aren't doing something right, but we have to look at how little support they've gotten from industry. As long as we in industry sit back and do nothing, we don't have any right to cry about it."

Evans agreed, saying the academic environment and the industrial environment have been "too far apart." Industry can help schools, said Evans, in keeping up with technological change, which may occur faster than schools can respond. He wants to see industrial representatives work with students in high schools, vocational schools and colleges.

Walker also advocated the reverse: programs that bring teachers into industrial settings so schools "can get up to speed on the specialized technologies" actually used in the workplace.

Technicians of the future won't work in a blue-collar ghetto, all three men agreed. With proper training, they can expect positions that are more rewarding than assembly-line work. But these elite workers must have broad, adaptable knowledge that applies to more than a single job.

Tomorrow's technicians must know how to troubleshoot, said Evans, "whether it be for a computer or a robot or some other piece of the operation." They must "know how to learn, how to change as technologies change," according to Walker. And communications skills cannot be ignored, added Evans. "As a technician, you must be able to talk problems out with fellow employees, express to them what you're seeing and what you recommend for change. And listen to what they recommend," he emphasized.

A vital link between the Commission's call for change in vocational education and industry's interest in better-skilled technicians is *Principles of Technology*, a two-year vocational education course now being taught in over 200 high schools in the United States and Canada. The course, taken mainly by high school juniors and seniors, teaches a practical understanding of the physical principles of technology and the mathematics associated with them.

Principles of Technology bridges the head-vs.-hands gap the National Commission on Secondary Vocational Education criticized. And it gives students the broad education they will need to adapt themselves to the changing demands of the work force.

-more-

Mary Hatwood Futrell, president of the National Education Association, recently told 50,000 vocational educators that *Principles of Technology* is a "promising new curriculum initiative," a way to "recharge vocational curriculums." And industrial manager Evans called *Principles of Technology* "a step in the right direc · n," one that gives future technicians the right kind of educational background.

Modern equipment often involves a combination of mechanical, fluid, electrical and thermal systems, so *Principles of Technology* is organized into 14 units of physics applied to all four systems. Unit One, for example, shows students how one technical principle, force, applies in all these systems. These relations are explored in two days of lecture/discussion, a math skills lab, two days of hands-on physics applications labs and a review. Six video programs—an overview of force, one dealing with force in each of the four systems and a summary—introduce the classroom activities.

Educational leaders endorse *Principles of Technology* because it helps vocational education students—and others interested in applied science— meet high school science and mathematics requirements that are becoming increasingly demanding. Industry leaders are enthusiastic about how the course highlights up-to-the-minute technology. Many of its video segments were filmed in plants heavily involved with robotics and computerization.

Principles of Technology was developed through the cooperation of 41 state and provincial education agencies in association with the Agency for Instructional Technology (AIT), of Bloomington, Ind., and the Center for Occupational Research and Development (CORD), of Waco, Texas. The agencies provided $3.3 million for the creation of the course.

Its curriculum was tested for two years in over 50 classrooms in participating states and provinces, and its materials were evaluated by education agencies and pilot test teachers. The course designers wanted to upgrade the science knowledge of tomorrow's technicians and show vocational education students that high school has something valuable to teach them.

A course such as *Principles of Technology*, the three industry leaders emphasized, is needed to expand the background of the modern technician so he or she won't require expensive training and retraining on the job.

Peters identified that ideal technician as a person who "may specialize in a particular area, but must have broad-based knowledge of the various technologies in the workplace and be able to address them." As Evans pointed out, many of the functions once performed physically by technicians are now carried out by robotic equipment the technician must troubleshoot. And that equipment often works on mechanical, fluid, electrical and thermal principles all operating together.

-more-

Evans summarized the position of the industrial leaders this way: "Programs like *Principles of Technology* give people the kind of background that can be built on. Schools and industry must work together to come up with answers to the type of problems we have discussed here. We have to be able to talk to each other, so that we can improve in the right direction."

"Tomorrow," Evans concluded, "we have to take the foundation of today and continue to build and build."

Principles of Technology Fact Sheet

Figures

Principles of Technolology was developed by 45 states and provinces in association with the Agency for Instructional Technology (AIT), of Bloomington, Ind., and the Center for Occupational Research and Development (CORD), of Waco, Texas.

Educational agencies provided $3.3 million to fund the development of *Principles of Technology.*

For two years, teachers and students of participating states and provinces tested and evaluated *Principles of Technology* instructional materials in over 50 classrooms.

Principles of Technology is currently being taught in 400-500 high schools ar · ocational schools across the United States and Canada, and will be taught in many more schools in the fall of 1987.

Organization of the Course

Principles of Technology provides 14 units of instruction—half taught during the first year, half during the second. Each unit focuses on the principles that underlie today's high technology. Students examine the effect of these principles on the four kinds of systems that make up both the simplest and the most complex technological devices and equipment: mechanical, fluid, electrical and thermal systems.

First-Year Units
1. Force
2. Work
3. Rate
4. Resistance
5. Energ.
6. Power
7. Force Transformers

Second-Year Units
8. Momentum
9. Waves and Vibrations*
10. Energy Convertors*
11. Transducers*
12. Radiation*
13. Optical Systems*
14. Time Constants*

*order may vary; all units may not be taught

Instructional Methods and Media

Unit One, Force, as an example, examines force in each of the four types of systems: mechanical, fluid, electrical and thermal. Students view *videotapes* that introduce each of the systems, and additional tapes that give an overview of and summarize the unit. Then, in classroom *discussion* with teachers, *demonstrations, labs* and *reviews*, students go on to explore the implications of the principle—here, force—that the unit treats. Each unit also features special *mathematics labs* to cover the mathematics needed to understand and apply technological principles. These labs are supplemented with both preparatory and challenge material.

-more-

Participating Agencies

Alabama State Board of Education
and a consortium of local school districts

Alaska Department of Education

Alberta Education/ACCESS Network

Arizona Department of Education

Arkansas State Department of Education
Vocational and Technical Education Division

California Department of Education
Division of Vocational Education

Colorado State Board for Community Colleges
and Occupational Education
Colorado Department of Education
and a consortium of local school districts

Delaware Department of Public Instruction
and the New Castle County
Vocational Technical School District

Florida Department of Education
Division of Vocational Education and
Office of Instructional Television and Radio

Georgia Department of Education
Office of Vocational Education

Idaho Division of Vocational Education

Illinois State Board of Education
Department of Adult, Vocational and
Technical Education

Indiana State Board of Vocational and
Technical Education

Iowa Department of Public Instruction
Career Education Division

Kansas State Department of Education
Community College and Vocational
Education Division

Kentucky Department of Education
Division of Vocational Education

Louisiana State Department of Education
Office of Vocational Education

Maine State Department of Education and
Cultural Services
Bureau of Vocational Education/Division
of Program Services

Maryland State Department of Education
Division of Vocational/Technical Education

Massachusetts Department of Education
Division of Occupational Education

Minnesota Special Intermediate School
District 916

Mississippi State Department of Education
Vocational-Technical Division

Missouri Department of Elementary and
Secondary Education

Montana Office of Public Instruction
Department of Vocational Education
Services

Nebraska Department of Education
Division of Vocational Education

New Mexico State Department of Education
and a consortium of secondary and
postsecondary schools

North Carolina State Department
of Public Instruction.
Division of Vocational Education

North Dakota State Board for Vocational
Education

Ohio Department of Education
Division of Vocational and Career Education

Oklahoma State Department of Vocational and
Technical Education

TVOntario

Oregon Department of Education
Division of Vocational Education

Pennsylvania Department of Education

Rhode Island State Department of Education
Division of Vocational Education

South Carolina Department of Education
Office of Vocational Education

Tennessee Department of Education
Division of Vocational Education

Texas Education Agency
Division of Vocational Education

Utah State Office of Education

Vermont State Department of Education
Division of Adult and Vocational-Technical
Education

Virginia Department of Education
Vocational and Adult Education

West Virginia State Department of Education
Bureau of Vocational, Technical and Adult
Education

Wisconsin Department of Public Instruction
Bureau of Vocational Education

Wyoming Department of Education
Vocational Programs Unit

-more-

Center for Occupational Research and Development

CORD is a nonprofit organization established to conduct research and development activities and to disseminate curricula for technical and occupational education and training. In the past 10 years, CORD has developed over 40,000 pages of instructional materials for technicians on 14 major curriculum projects in advanced-technology areas. These projects were sponsored by contracts with federal and state agencies, and by industrial support from the private sector. The products developed by CORD are used by technical institutes, community colleges, and vocational high schools, and in industry training programs throughout the United States.

Agency for Instructional Technology

AIT is a nonprofit American-Canadian organization established in 1973 to strengthen education through technology. In cooperation with state and provincial agencies, AIT develops instructional materials using television and computers. AIT also acquires and distributes a wide variety of television and related printed materials for use as major learning resources. It makes many of these materials available in audiovisual formats. From April 1973 to July 1984, AIT was known as the Agency for Instructional Television. Its predecessor organization, National Instructional Television, was founded in 1962.

Addresses

Center for Occupational Research and Development
601C Lake Air Drive
Waco, Texas 76710
(800) 231-3015
Contact: Cassy Jordan, Coordinator of Information Services

Agency for Instructional Technology
Box A
Bloomington, Ind. 47402
(800) 457-4509
Contact: Judy Allensworth, Information Specialist

ORDERING MATERIALS

Ordering Materials

ORDERING MATERIALS IN INDIANA

Each state or provincial agency participating in the project will receive two copies of the student test and the teacher's guide (high quality Xerox) and one set of videotapes. Schools may reproduce materials provided by the state of provincial agency or they may order materials directly from AIT, Box A, Bloomington, IN 47402. (See price list and order form on the next page.)

A complete set of PT materials and videotapes can be borrowed for review from the Indiana Curriculum Center: Vocational Education Services, Indiana University, 840 State Road 46 Bypass, Room 111, Bloomington, IN 47405, (812) 335-6711. Please contact Mr. Scott Gillie or Mrs. Susan Lowe for more information.

Vocational Education Services also has PT videotapes available on VHS format. These can be purchased. Please order from Mr. Scott Gillie and allow three weeks for delivery. The prices are:

Overview	$ 15.00 each
Units 1-7	$100.00 per set
Units 8-14	$100.00 per set

PRINCIPLES OF TECHNOLOGY

It's here! **Principles of Technology** is now available on VHS videotape at prices that you won't want to pass up!

Vocational Education Services is selling the first year's curriculum, units 1 through 7, and the second year's curriculum, units 8 through 14, in seven-tape sets for $100 per set. In addition, an overview tape titled "About Principles of Technology" is available for $15. Prices include shipping and handling.

Order your tapes today!

Name____ Date__________________

Institution____

Address____

City______________________________________ State______ Zip_________

Purchase Order Number___________________ Telephone________________

__Overview tape: About Principles of Technology @ $15

__Set 1 @ $100
Unit 1: Force
Unit 2: Work
Unit 3: Rate
Unit 4: Resistance
Unit 5: Energy
Unit 6: Power
Unit 7: Force Transformers

__Set 2 @ $100
Unit 8: Momentum
Unit 9: Waves & Vibrations
Unit 10: Energy Convertors
Unit 11: Transducers
Unit 12: Radiation
Unit 13: Light & Optical Systems
Unit 14: Time Constraints

Send to: Vocational Education Services, 840 State Road 46 Bypass, Room 111, Indiana University, Bloomington, IN 47405 812/335-6711

VES

SBVTE Indiana State Board of Vocational and Technical Education

ORDERING MATERIALS

Each state or provincial agency participating in the project has received two copies of the student text and the teacher's guide (high-quality Xerox) and one set of videotapes for Units 1-14. Schools may reproduce materials provided by state or provincial agencies or they may order materials directly from AIT, Box A, Bloomington, IN 47402. (See price list below and order form on the next page.)

Cost of Additional Copies of Print and Video*

Materials	Cost
Set of seven student texts	
Year 1	$17.85
Year 2	$17.85
Set of seven teacher's guides	
Year 1	$122.15
Year 2	$122.15
Set of seven 60-minute videotapes**	
Year 1	$525.00
Year 2	$525.00
Overview program	
One 15-minute tape**	$40.00

*Prices subject to change

**Tapes available on 3/4" and 1/2" (VHS and BETA) formats.

Note: Prices do not include actual shipping costs.

Principles of Technology
Consortium Print and Video Order Form

Item	Unit Costs*+		Quantity	Total Costs
Student Texts Set includes: Year 1 (Units 1-7) Year 2 (Units 8-14)	Year 1 (per set)	$17.85		
	Year 2 (per set)	$17.85		
Teacher's Guides Set includes: Year 1 (Units 1-7) Year 2 (Units 8-14)	Year 1 (per set)	$122.15		
	Year 2 (per set)	$122.15		
Overview Video (One 15-minute tape)		$40.00		
Videotapes Set includes seven 60-minute tapes Year 1 (Units 1-7) Year 2 (Units 8-14)	Year 1 (per set)	$525.00		
	Year 2 (per set)	$525.00		
Decision Brochures (3-fold)	Additional quantities available at **$20.00 per 100**			

Check Tape Format

_____ 3/4"

_____ 1/2" VHS

_____ 1/2" BETA

Billing

Name ____________________

Agency ____________________

Address ____________________

____

Shipping

____

____

____

____

P.O. # ____________ Signed ____________________ Date ____________

Please return to: AIT, Box A, Bloomington, Indiana 47402

*Prices do not include actual shipping costs.
+Prices subject to change.

INFORMATION ABOUT LAB MANAGEMENT AND EQUIPMENT

INFORMATION ABOUT LAB MANAGEMENT/ FACILITIES REQUIREMENTS/EQUIPMENT LIST

Field test results show that students enjoy the lab experience in Principles of Technology. Labs offer students a chance to see things work and to make things happen. We hope that this introduction to lab management, which includes a preview of the lab facility requirements and an in-depth equipment list for Units 1-14, is helpful as you begin to teach this course. We also hope that your students will profit from this important component of Principles of Technology.

TIPS ABOUT LAB MANAGEMENT

Just as good management makes good business, good lab management makes good labs. About 40 percent of this course is spent in hands-on physics labs; therefore, we suggest that about 40 percent of your instructional preparation be spent in facilitating this aspect of the course.

Lab time fosters student learning in other course components. The lab gives students a chance for experimentation. Lab time is also a time for students to learn work habits that will benefit them on the job in their future careers. After all, technicians are responsible for maintaining, operating and servicing equipment that keeps technology moving. The lab component of this course is important to developing skills that are necessary for good technicians. Therefore, Principles of Technology labs present an introduction to the "real world of work" and serve important training functions for students who plan careers as technicians.

This doesn't mean that a clean, businesslike, bright and organized lab must also be as quiet as a study hall--to the contrary. Noise means learning is taking place. However, there are acceptable noise limits that the teacher should know. Too much noise is obviously detrimental to learning. But the right level of noise indicates activity--that something is happening, that an excitement is taking place about learning. Like Tom Sawyer painting the fence, students involved in a vibrant, exhilarating lab will attract new students who want to see what all the fun is about.

However, you'll also want to be aware of noise outside the lab--the drill team practicing, the band getting ready for a concert, etc. Outside noise is not desirable, and can be controlled with acoustics and other measures. Obviously, the lab should be properly heated, air-conditioned and ventilated.

As you already know, physical discomfort breeds behavior problems. You'll also want to be sure the lab is properly lighted, since ill lighting promotes an unsafe and inefficient place to work.

When you begin teaching Principles of Technology, you may wish to set up all the lab activities yourself. Later on, you might want to allow some of your more capable students to help you set up the labs for the other students. Once you've developed your students' ability to help you set up equipment, you'll have more time to assist students in other activities.

In fact, you may want to use this same procedure for setting up the equipment for demonstrations. In other words, you may want to allow some of your most capable students to perform the demonstrations for the class. This has the benefit of giving your students the opportunity to take responsibility for the kinds of duties they may face during their careers as technicians.

This practice in performing before their peers may also help your students develop public speaking skills and confidence in their ability. As your class begins to become accustomed to the course, you may wish to involve them further in setting up the equipment for all of the lab activities. Obviously, this will give your students a chance to try their hands at coordinating the kinds of skills that are necessary in the marketplace.

Even though Principles of Technology labs are more like physics labs than vocational shops, you may wish to initiate a check-out procedure for lab equipment so that students can check out equipment, set it up and do the activities called for in the text during a "free lab time." This time can be taken during their study hall, before school or after school--provided there is someone to supervise the lab. Nothing should go on in the lab unless there's a teacher there to supervise students.

However, students will feel more responsible for the lab if they're required to be responsible for more than lab clean-up duties--if, for example, they're allowed to help maintain the lab. Students should help you provide routine care through day-to-day inspection, doing general cleaning and making minor adjustments. As mentioned earlier, as the course progresses, students can assist in lab setup. This is sound training for future technicians.

It's also important that you know at all times what equipment is in stock, so you may also want to set up an inventory system to keep a record of equipment items. Inventory records will help you prepare budgets from year to year and plan for the purchase of additional equipment, as well as help you be aware of losses due to breakage or theft. If you have access to a computer, you may wish to keep your equipment records on a computer. This would allow to you record any discrepancies at once. Computer records also would allow you to update the list as often as you wanted to.

However, even if no computer is available, you can keep your equipment records on index cards. You may wish to ask a student to help you in this endeavor, as well. This will give the student training in computer use and/or inventory control, and will provide you with some help in maintaining your lab equipment records.

Other lab management tips you may wish to consider are:

1. Don't assume your students really know how to use a meter or any of the other instruments in the lab. You may want to give "practical" exams--to test students on their ability to use the equipment by having them operate it while you observe them.
2. In many cases, students will work together on labs. You should keep tabs to see that the distribution of work is rotated (to eliminate the possibility of one student having all the fun). You may also want to rotate partners--or make sure students take turns doing the same experiment or different experiments.
3. There are some times when students must rotate between labs. There are other times when students will all be doing the same thing at the same time. Sometimes, they'll use the same equipment, but will do different things. Be sure to point out--and emphasize--these distinctions to your students.
4. There are also labs where there will be only one lab setup for the entire class. This is a case where the lab portion is more like a detailed, highly structured demonstration. Students must still participate, however, if the lab is to be used to its best advantage. Students can take data or take turns doing some portion of the lab so that they can see what's happening first-hand.
5. The first time you teach Principles of Technology, you should do the lab yourself before you have the students do it. This way, you can find any "surprises" or variation. Some surprises may be helpful in structuring a more creative lab than you find in the text.
6. The labs in the text are written to a large general audience. Therefore, there may be times when you can add to the lab in the book by adapting labs according to available equipment at your location. As you know, these labs were written with equipment cost and availability in mind. You may have equipment that can be used to demonstrate the ideas in the lab in different ways.
7. Remember: the purpose of these labs is twofold. You don't just want your students to see the experiment. You also want your students to get practice in setting up the equipment and using it. You're trying to get your students to think with their hands as well as with their minds. This is because technicians in the workplace will need both kinds of skills and will need preemployment practice at coordinating these capabilities.

TIPS ABOUT LAB DESIGN/ FACILITIES CONSIDERATIONS

When equipment is used to teach specific principles, it's essential that some real apparatus--typical of that used in today's work places--also be used. It's not enough to demonstrate the principle alone; students must see and understand the principle as applied with the standard apparatus currently used in the technology. Students also must learn how to use the current apparatus.

Principles of Technology has been designed with a strong emphasis on lab experience. PT requires up to three times the number of laboratory hours as do the same subject courses in many traditional curricula; therefore, lab facilities must be considered carefully. PT labs are discussed here with respect to size, utility services, storage, furniture arrangements and safety considerations. Both new construction and retrofitting of existing facilities are covered in this discussion.

What are "clean" laboratories?

Principles of Technology labs are classified as "clean" labs. This means they're typified by:

- Apparatus that's portable and easily assembled, disassembled and stored.
- Light-duty tools; few power tools.
- Student work surfaces and tables that do not require hardened surfaces or heavy construction.
- Environment of room similar to that found in the traditional classroom--drop ceiling, fluorescent lighting, and linoleum floor coverings.
- Little or no use of oily or corrosive liquid substances during lab experiments.

What size should the lab be?

The major factors in the selection or construction of a clean lab facility include: (1) student load, (2) apparatus requirements, (3) experimental format, (4) single versus multiple-purpose, and (5) dedicated subject use versus multiple-subject use. Except for apparatus requirements, all of the factors listed may vary from school to school.

The optimal student load for a lock-step experimental format is between 12 and 18 students. A self-paced experimental format permits the school a greater degree of flexibility in determining the size of the lab facility. Generally, clean laboratories should have a minimum space allotment of 40 square feet per student. This allotment includes work area, storage space and access space and is stipulated for lab rooms intended as lab rooms only--

not as a combined classroom/laboratory room (multiple purpose). Multiple-purpose classroom sizes can be determined by the following formula:

$$\begin{array}{c}\text{Section capacity}\\ \text{in number}\\ \text{of students}\end{array} \times \left[\begin{array}{c}\text{Laboratory space}\\ @\ 40\ ft^2/\text{student}\end{array} + \begin{array}{c}\text{Classroom space}\\ @\ 15\ ft^2/\text{student}\end{array}\right] = \begin{array}{c}\text{Minimum}\\ \text{space}\end{array}$$

For rooms to be used as labs for more than one subject, additional storage space must be provided for experimental apparatus.

What are the utility service requirements?

When the maximum number of lab work stations has been identified and the size of the rooms determined, the requirements for utility services should be considered. Utility services include: electricity for outlets and lighting and the piped services of gas (optional), compressed air, water and drain. Related considerations are the number of connections to each required service, the arrangement of service connections, and the safety devices and precautions built into the utility service systems.

Electricity provides power for lighting and for activating many devices used in lab experiments. Most electrical service for clean labs is single-phase, 120-volt ac. The amount of light needed at bench-top surface varies with the subject and often with the type of work to be performed. A general rule of thumb is that it should never be less than 100 candle power or the amount stipulated by state/municipal regulations. Fluorescent lighting that's set diagonally to the orientation of work surfaces maximizes the amount of light reaching the work surface, regardless of the student's position. The lighting circuits should be isolated from those circuits that provide power to outlets present in the lab.

Electricity must be delivered at workbench outlets according to a unique scheme. Each workbench should have its own circuit or circuits each protected by its own circuit breaker. Ideally, a workbench with 10 lab stations should have two 20-amp circuits, with each circuit providing half the power to each lab station. This arrangement prevents the disruption of power at all lab stations when one circuit becomes overloaded. Each outlet should be color-coded as to circuit. The circuit breaker may be located remotely from the bench; however, cutoff switches for each circuit should be located at one end of the bench.

Some clean labs will require one or more of the piped utility services of gas (optional), compressed air, vacuum, water and drain. Some of these services can be provided without the permanent installation of pipes.

Compressed air and vacuum can be provided by the use of portable manual or electric pumps. Gas can be provided by portable torches or bottled compressed gas, connected by hose to a burner. The decision to use portable alternatives in place of permanent installation of pipes is usually based upon frequency and quantity of use, economic considerations and convenience.

Water service can be a particularly troublesome problem in retrofitting a room for lab use. It's little trouble to bring water in; the difficulty is in getting the water out. Traditionally, the drains need to be installed either below floor level or through a wall. If a drain is installed into the floor, cutting a trench in a cement floor can be very costly. Taking the drain through a wall results in the use of peninsula lab benches rather than the more efficient island lab benches. One innovation in retrofitting that has not been thoroughly explored is the use of a drain basin below a lab sink fitted with a sump pump; this may simplify the removal of water from a retrofitted lab.

What about ventilation?

Even clean laboratories may involve the use of--or production of--substances that can be potentially noxious or toxic. Therefore, ventilation requirements must be considered. Requirements vary from state to state, so you'll want to comply with local guidelines.

What about furniture arrangements?

Clean-lab furniture is generally found in two basic designs: low-form and standard. Low-form furniture is 28 to 30 inches from the floor to the top working surface and is intended to be used by students who are seated. Low-form furniture may or may not have drawers or cabinets; normally, this design has a composition surface. Traditional or standard furniture has a floor-to-working-surface distance of 36 to 38 inches and normally has storage space (drawers and cabinets). This lab furniture may be placed against the walls--jutting out into the room in peninsula fashion--or it may be isolated from the walls in an island style. As mentioned previously, the island style provides the greatest efficiency and maximum flexibility. Many companies manufacture lab furniture with various arrangements of storage areas and utility service outlets.

Lab furniture can provide a great deal of room for storage of materials, but it may not provide a total solution. If additional storage space is needed, tall cabinet storage along walls may help. In some instances, a separate area may be dedicated to storage. In all instances, the issues of security and safety must be given serious consideration.

What about safety?

The issue of safety--personnel safety, equipment safety, and security--is of increasing concern. Society's growing awareness of hazards and the increased willingness of many citizens to pursue damages through legal action also motivate attention to safety.

The lab is an area of increased hazard. Therefore, you should place much emphasis on safety. This emphasis can be accomplished through the installation of safety devices and the enforcement of safety procedures. We've already cited the use of circuit breakers and separate disconnect switches for each circuit of each bench. In addition, the main room lights should be isolated from any other electrical circuits. There should be an emergency electrical disconnect switch for all electrical circuits in the lab except for the main room lighting circuit. This emergency switch should be wired to deactivate all gas and water utility services and to activate an alarm. Such an arrangement is called a "scram circuit." The scram switch should be placed near the main room exit, and can be placed behind a breakable glass window in order to discourage pranksters.

Many other safety precautions should be routine: Cabinets, drawers and separate storage areas should be locked when not in use. Students should be required to memorize and practice certain basic safety procedures. Personal protective equipment such as aprons, safety glasses, gloves, etc., should be provided and required as conditions warrant. There should never be fewer than two people in an area when experiments are being performed. (The buddy rule is particularly important when high voltages are present.)

No lab work should be performed in the absence of qualified supervisory personnel. Instructors and lab assistants who are responsible for conducting lab experiments should be familiar with the various federal, state and local laws and regulations governing the use and control of toxic or explosive substances and certain hazardous equipment. Many states also have regulations governing the availability and use of safety devices in school labs. Fire blankets and extinguishers, eyewash bottles or fountains, and emergency showers may be required by law. However, the overriding concern should not be "Must a given device be present by law?" but "Should this device be present to safeguard the health and safety of students?". We must recognize that the potential for injury is greater in the lab than in the classroom--and be willing to take extra steps to protect the students for whom we're responsible.

What kind of tools will students use?

The tools required for experiments performed in the clean labs are generally light-duty and small in size. A few small power tools may be em-

employed, and hazardous electrical currents can occur with these tools. They should be double-insulated and have a proper grounding wire. Storage and control of tools can be achieved either through a central tool check-in/check-out system or by a station of lockable drawers that are inventoried when opened and closed by the lab assistant. Most tools required in clean labs will fit in a standard 5 1/2" x 6" x 18" drawer; thus, one drawer at each lab station can be outfitted and designated for this use.

TIPS ABOUT EQUIPMENT PURCHASE

Principles of Technology is a lab-intensive class. The program has been designed so that 40% of a student's time in any subunit is spent in a hands-on lab situation. At the end of this course, a student will have experienced about 90 labs. In these 90 labs, the student will have been exposed to nearly 200 individual items.

The PT teacher's responsibility includes procuring equipment items, identifying them, storing them and maintaining them. This is a large task. The attached equipment list identifies up to 98% of the items needed, based upon the labs given in the text. All major items are identified--as well as the majority of minor items. However, please remember that this equipment list should only serve as a guide. You're still responsible for getting part or catalog numbers, prices and sources of supply. To aid you in the task of constructing your order lists of equipment, we recommend the following steps:

Step 1: Order your equipment catalogs. In addition to the regular science supply catalogs from Sargent-Welch, Cenco, Fisher Scientific, etc., and normal vocational supply catalogs from Brodhead Garrett or SASCO, you need the following:
General supply--such as W. W. Grainger, Inc. (312) 928-1912
Specialized instruments--such as Omega Engineering, Inc. (203) 359-1660

Step 2: While waiting for your catalogs, review the equipment list and the labs to gain a "feel" for the lab component of Principles of Technology.

Step 3: Divide the equipment list into three categories.
Category 1: Equipment on hand and available for use in course.
Category 2: Equipment needed, nonconsumable.
Category 3: Materials of an expendable nature (that will be replaced periodically).

Step 4: If you're required to bid all items above a certain dollar figure, you could subdivide Category 2 of Step 3.

Step 5: Carefully examine the items you initially placed in Category 1 of Step 3. Will each item really work? Is it compatible with other equipment to which it must be connected in the lab?

Step 6: Select specific items. Really examine the items in Category 2 of Step 3. Naturally, you want the equipment to be rugged and flexible, yet economical. This is the tough part. One way to judge the level of flexibility and ruggedness is to look at several labs where that item is used. Buying equipment based solely on how it's used in the first experiment can present trouble down the line.

All these steps will be influenced by your experience. In many instances, you'll be faced with following one of two major paths. These two major paths are: (1) procuring materials in a disassembled kit form; or (2) getting the materials in assembled specific apparatus. The first option provides economy, flexibility and potentially greater student involvement. The second option provides convenience, time savings, and minimal student frustration. Your ability, approach and the dollars available help you select the path you should take.

Step 7: Consider your equipment suppliers. What's their track record? What service after the sale do they provide? How do they handle damaged or defective items? Do they have someone who is technically knowledgeable about the items they offer (that you can contact)? Do they offer "package" deals? Do they give discounts for quantity?

Step 8: Submit your lists--and be ready to justify each item. You might consider sitting down with your school's purchasing director and work for his/her cooperation in not allowing the order to be based only on price. Be flexible on where the equipment item comes from, but don't compromise on the capabilities of the item.

Now go back to Step 1 and begin. The time you invest now will pay big dividends to you--and to your students--during the labs in Principles of Technology.

TECHNOLOGY

COSTS OF EQUIPMENT FOR LABS AND DEMOS

- ESTIMATE FOR ONE COMPLETE SET OF EQUIPMENT TO CONDUCT ALL 90 LABS AND ALL 49 TEACHER DEMONSTRATIONS IS:
  - $7,000 to $8,000
  - 2/3 OF THIS AMOUNT IS REQUIRED FOR YEAR 1 (UNITS 1 THROUGH 7)
  - 1/3 OF THIS AMOUNT IS REQUIRED FOR YEAR 2 (UNITS 8 THROUGH 14)
- A "LAB STATION" IS A WORK SPACE AND ALL THE ITEMS NECESSARY TO CONDUCT THE 90 LAB EXERCISES IN PRINCIPLES OF TECHNOLOGY
- TYPICAL CALCULATION
  - FOR A CLASS OF 20 (TWO STUDENTS PER STATION) OR A CLASS OF 30 (THREE STUDENTS PER STATION), TEN STATIONS ARE NEEDED. IF TWO EXPERIMENTS ARE RUN CONCURRENTLY DURING EACH LAB PERIOD, ONLY FIVE SETS OF EQIPMENT WILL BE NEEDED. TOTAL COST FOR FIVE SETS OF EQUIPMENT (10 STATIONS PER LAB) WILL BE $35,000-$40,000.

PRINCIPLES OF TECHNOLOGY

FACTORS THAT CAN REDUCE LAB EQUIPMENT COSTS

- HOW MANY ITEMS NEEDED ARE ALREADY AVAILABLE IN SCHOOL SYSTEM?

- HOW MANY STUDENTS ARE ASSIGNED TO THE LAB STATION?

- HOW IS EQUIPMENT OBTAINED?
  - TOTAL PURCHASE, SINGLE-SOURCE TRADITIONAL
  - TOTAL PURCHASE, MULTISOURCE TRADITIONAL
  - TOTAL PURCHASE, MULTISOURCE TRADITIONAL/NONTRADITIONAL
  - PURCHASE/CONSTRUCTION

TECHNOLOGY

LABS, DEMOS, AND EQUIPMENT

- 90 LABORATORIES TOTAL IN PT
  - 51 IN YEAR ONE (UNITS 1 THROUGH 7)
  - 39 IN YEAR TWO (UNITS 8 THROUGH 14)

- 49 TEACHER DEMONSTRATIONS
  - 28 IN YEAR ONE
  - 21 IN YEAR TWO

- 161 MAJOR ITEMS OF EQUIPMENT
  - 40% OF ITEMS IN UNITS 1-7 ARE USED AT LEAST FIVE TIMES
  - LESS THAN 5% ARE CONSUMABLE
  - 39 ITEMS ARE CURRENTLY IN USE IN INDUSTRY
  - 42 ITEMS ARE UNIQUE, SPECIALLY DESIGNED FOR PT
  - 73 ITEMS ARE SIMILAR TO THOSE FOUND IN TRADITIONAL HIGH SCHOOL PHYSICS LABS

PRINCIPLES OF TECHNOLOGY: EQUIPMENT LIST

The following equipment list consists of three major sections. These sections are:

1. "Equipment and Vendor Lists for Principles of Technology"
   This sections contains the equipment for the hands-on labs. Each page of this section is divided into six columns. These columns identify: sequentially running "index" numbers, "item number," "item name," the number (quantity) of each item needed per lab station, specifications and descriptions of the items, and a special design column identifying an item as being specially manufactured for the Principles of Technology course.

2. "Principles of Technology: Demonstration Equipment"
   This section contains the equipment needed for the teacher demonstrations. Each page is divided into six columns. These columns identify respectively: demonstration number, number of items needed, item name, description, item number that correlates with the same item noted in the lab equipment list, and a designator that indicates the item is of special design.

3. "Design Notes on Special Equipment"
   This section contains design notes for special laboratory equipment. These pages provide information on the special items of equipment needed for the 90 hands-on labs. Rough drawings of the devices, parts lists, and source references are included in this section. (Special design items needed in the teacher demonstrations are found in the teacher's guide.)

EQUIPMENT COSTS

Based upon prices from 1984-85 catalogs, the cost for all equipment needed to conduct all 90 hands-on labs and all 49 teacher demonstrations is:

$7,000 to 8,000 per setup.

EXAMPLE:

For a class of 20 (two students per lab station) or a class of 30 (three students per lab station), ten lab stations would be needed. If two experiments are run concurrently during each lab period, only five sets of equipment will be needed. Total cost for five sets of equipment (10 stations per lab) will be:

$35,000 to $40,000.

EQUIPMENT VENDORS FOR PRINCIPLES OF TECHNOLOGY

Not Ranked

Scientific Labs, Inc.
P.O. Box 803788
Houston, TX 77280-3788
(713)464-6068

Brodhead - Garrett Co.
4560 East 71st
Cleveland, OH 44105
(216)341-0248

Sargent-Welch Scientific Company
7300 North Linder Avenue
P.O. Box 1026
Skokie, IL 60077
(312)267-5300

M.C. (Mel) Pohlkolte
AIDEX Corporation
4945 Forest Avenue
Downers Grove, IL 60515
(312)963-4270 or
(317)888-3629

H.C. Renkenberger
E.E. Equipment Co.
6850 N. Guion Rd.
P.O. Box 68143
Indianapolis, IN 46268
(317)293-5704

PRINCIPLES TECHNOLOGY: EQUIPMENT VENDORS

VENDOR COMPANY	COMPANY ADDRESS	PHONE NO.
Sargent-Welch Scientific Co.	P.O. Box 1026 Skokie, Ill. 60077	312/677-0600
Brodhead-Garrett Co.	4560 East 71st St. Cleveland, OH 44105 (OH ph #)	800/321-6730 800/362-8915
Knight Electronics	10730 Alder Road Dallas, TX 75243	214:340-0265
Midland Ross Corp. Cambion Division	One Alewife Place Cambridge, MA 02140	617/491-5400
W. W. Grainger	NAT. CO. w/gen. off. @ 5959 W. Howard St. Chicago, Ill 60648	 312/647-8900
Radio Shack	NAT. CO. w/gen. off. @ 1400 One Tandy Cntr Ft. Worth, TX 26102	
Central Sci. Co (CENCO)	11222 Melrose Ave Franklin Park, Ill 60131-1364	800/262-3625 312/451-[illegible]50
U. S. Plastics Co.	1390 Neubrecht Rd Lima, OH 45801 (OH ph #)	800/537-9724 800/821-0349

PRINCIPLES TECHNOLOGY: EQUIPMENT VENDORS

VENDOR COMPANY	COMPANY ADDRESS	PHONE NO.
Frey Sci. Co.	905 Hickory Ln Mansfield, OH 44905 (OH ph #)	800/225-3739 419/589-9905
Omega Eng. Inc.	P.O. Box 4047 Stamford, CT 06907	203/359-1660
Bellofram (A Rexnord Company)	30 Blanchard Rd Burlington, Mass. 01803	800/225-1031 617/272-2100
Edmund Sci. Co.	101 East Gloucester Pike Barrington, NJ 08007	
Dwyer Inst. Co.	P.O. Box 373 Michigan City, IN 46360	219/872-9141
Nautical Rubber Co.		
PCB Piezotronics	3425 Walden Ave Depew, NY 14043-2495	800/828-8840 716/684-0001

EQUIPMENT SOURCES

Throughout the development of Principles of Technology three equipment vendors have served the project nationwide. These vendors are:

Broadhead-Garett Company
4560 East 71st Street
Cleveland, Ohio 44105
(216) 341-0248

Sargent-Welch Scientific Co.
7300 North Linder Avenue
P.O. Box 1026
Skokie, Illinios 60077
(312) 677-0600

Scientific Labs, Inc.
P.O. Box 803788
Houston, Texas 77280-3788
(713) 464-6068

Other suppliers of equipment items used in Principles of Technology are listed in the following pages.

PRINCIPLES OF TECHNOLOGY: EQUIPMENT VENDORS

VENDOR COMPANY	COMPANY ADDRESS	PHONE NO.
Sargent-Welch Scientific Co.	P.O. Box 1026 Skokie, Ill. 60077	312/677-0600
Brodhead-Garrett Co.	4560 East 71st St. Cleveland, OH 44105 (OH ph #)	800/321-6730 800/362-8915
Knight Electronics	10730 Alder Road Dallas, TX 75243	214:340-0265
Midland Ross Corp. Cambion Division	One Alewife Place Cambridge, MA 02140	617/491-5400
W. W. Grainger	NAT. CO. w/gen. off. @ 5959 W. Howard St. Chicago, Ill 60648	312/647-8900
Radio Shack	NAT. CO. w/gen. off. @ 1400 One Tandy Cntr Ft. Worth, TX 26102	:
Central Sci. Co (CENCO)	11222 Melrose Ave Franklin Park, Ill 60131-1364	800/262-3626 312/451-150
U. S. Plastics Co.	1390 Neubrecht Rd Lima, OH 45801 (OH ph #)	800/537-9724 600/821-0349

PRINCIPLES OF TECHNOLOGY: EQUIPMENT VENDORS

VENDOR COMPANY	COMPANY ADDRESS	PHONE NO.
Frey Sci. Co.	905 Hickory Ln Mansfield, OH 44905 (OH ph #)	800/225-3739 : : : 419/389-9905
Omega Eng. Inc.	P.O. Box 4047 Stamford, CT 06907	203/359-1660 : : : :
Bellofram (A Rexnord Company)	30 Blanchard Rd Burlington, Mass. 01803	800/225-1031 : : : 617/272-2100
Edmund Sci. Co.	101 East Gloucester Pike Barrington, NJ 08007	: : : : :
Dwyer Inst. Co.	P.O. Box 373 Michigan City, IN 46360	219/872-9141 : : : :
Nautical Rubber Co.		: : : : :
PCB Piezotronics	3425 Walden Ave Depew, NY 14043-2495	800/828-8840 : : : 716/684-0001

PRINCIPLES OF TECHNOLOGY: EQUIPMENT VENDORS

VENDOR COMPANY	COMPANY ADDRESS	PHONE NO.
Stock Drive Products	55 South Denton Ave New Hyde Park, NY 11040	516/328-0200
Trans Tek Inc.	Route 83, P.O. Box 338 Ellington, CT 06029	203/872-8357
ECI Energy Concepts, Inc	3254 North Kilbourn Chicago, Ill 60641	312/283-4422
Hampden Eng. Inc.	P.O. Box 563 East Longmeadow, MA 01028	413/525-3987
Scientific Labs, Inc	P.O. Box 803788 Houston, TX 77280-3788	713/464-6068
Lab Technologies	2509 Sheridan Blvd Denver Co 80214	303/449-2127
Canterburry Sales	6300 N. Central Expwy Suite 104 Dallas, Tx 75206	214/369-8434

NOTE: Equipment for Units 1 through 7 are items numbered 1-199. Item numbers 200 and greater are used in units 8 through 14. Some of the equipment used in units 1 through 7 also is used in units 8 through 14.

12/1/86

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
1.0	1	H.D. SUPPORT STAND	1	Self-supporting 6' tall x 36" wide	*
1.1	2	Force Beam		Solid wood 40"l x 6"w x 3"t with six eyebolts	
2.0	3	SPRING BALANCE	3	Large capacity 0 to 25 lb	
3.0	4	CONTAINER	1	One-gallon capacity for liquids or fine powders	
4.0	5	CHAIN	2	40-lb test, 18" length	
5.0	5.1	CORD	3	30-lb test, 24" length	
6.0	6	KEY CHAIN RING	1	One-inch diameter, steel	
7.0	7-8	BASIC MEASUREMENT SET	1		
7.1	7.1	Straightedge/ruler		One plastic or wood	
7.2	7.2	Protractor		One plastic	
7.3	8.1	Caliper, vernier		One plastic or metal	
7.4	8.2	Caliper, bow		One plastic or wood	
7.5	42	Meter stick		One wood w/brass tip, Eng/SI	
8.0	9	SPRING HOLDER JIG	1	Wood frame support w/rod drilled at one end for spring	*
8.1	9.1	Coil Spring		One coiled spring such as from clutch or brake-pedal return in car or light truck	
9.0		CLAMP SET			
9.1	13	C-type		One deep, two regular throat.	
9.2	63	Tubing type		Four polycarbonate, stepped.	
9.3		Tubing connector		six aircraft type.	
9.4	34	Thermometer type		Two hook-n-collar types.	
10.0		WEIGHT SET	1		
10.1	12	Slotted, lg cap		One set consisting of 1-5 kg, 1-2 kg, 2-1 kg, and 1-0.5 kg	
10.2	11	Weight hanger		One w/long hook of 1-kg wt	
10.3	40	Slotted, sm. cap.		One set w/1-500 gm, 5-100 gm; 1 ea 50 gm, 10 gm, 5 gm, 1 gm; 2 ea 20 gm, 2 gm; w/storage rack	
10.4	41	Weight hanger		One 50 gm hanger	

12/1/86

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
11.0	14	HYDROMETER, SCALED	1	Range 1.1 to 1.3 on scale	
12.0	15	HYDROMETER	1	Pocket type using floating colored balls	
13.0		BEAKER SET	1		
13.1	16	Small		Four 600 ml graduated type	
13.2		Large		Two 1000 ml graduated type	
14.0	17	MANOMETER	1	U-tube, water/Hg type; 1-m long; w/traps; polycarbonate	
14.1	17.1	Dye		One 4 oz bottle for water	
14.2	17.2	Mercury		One 500 gm bottle	
15.0	18	PUMP	1	Vacuum/pressure type, manual	
16.0	20	AIR CHAMBER ASSEMBLY	1		*
16.1		Tubing barbs		Two, 1/2" thread to 1/4" nip-ple, PVC or nylon	
16.2	22	Accumulator		One made of PVC w/pipe tee	
17.0	19	TUBING SET	1		
17.1	19.1	Small diam		Two, 4-ft lengths 1/4" x 1/16" tygon or plastic	
17.2	19.2	Large diam		Two, 4-ft lengths 1/2" (or 3/4") x 1/4" tygon or plastic	
17.3	19.3	Bubble type		One, 3-ft section tygon	
18.0		TUBING ADAPTER SET	1		
18.1		Small to medium		Two, 1/4" to 1/2" diam	
18.2		Small to large		Two, 1/4" to 3/4" diam	
18.3		Medium to large		Two, 1/2" to 3/4" diam	
18.4		PVC adapters		Two, 1/2" to 1/4" NPT	
19.0	21	PRESSURE GAGE	1	Compound type, 0-30 psi and 0-30" hg w/ 1/4" NPT	
20.0	23	MULTIMETER, ANALOG	1	Such as a Simpson 260 or a Triplett 310	
21.0	27	MULTIMETER, DIGITAL	1	3 1/2 digit w/full DC and AC functions; 10-Megohm input Z and must read 0.1 microamp & 0.1 mV	
22.0		BATTERY SET	1		
22.1	25	Dry cell		Two, 6-volt lantern type	
22.2	25.1	Transistor		One, 9-volt transistor type	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
22.3	26	Wet cell		One auto type PER LAB.	
23.0		ELECTRICAL WIRE SET	1		
23.1	24	Universal leads		One set, 14 to 16 AWG w/ends and probes	
23.2	84	Wire segments		One set of 18 to 24 AWG wire w/different lengths, ends stripped and tinned	
23.3	111	Magnet wire		One 1 lb spool 30 AWG coated	
24.0		SWITCH SET	1		
24.1	28	SPST, knife		Two, 4 A @ 120 V	
24.2	53	SPST, push button		One, NO-type, 4 A @ 120 V	
24.3	69	DPDT, knife		One, 4 A @ 120 V	
25.0	30	LAMP, MINIATURE	2	Type 40, miniature screw base	
26.0	29	LAMP BASE	2	For miniature lamps	
27.0		THERMOMETER SET	1		
27.1	31	l.i.g. scaled		Two, dual scale -10 to +110 C	
27.2	32	l.i.g. blank		Two, equal ranged w/item 31	
28-A	33A	HOT PLATE	1	750 watt rating, 80 cm square	
28-B	33B	GAS BURNER	1	Optional, Bunsen or Fisher; match to fuel gas available	
29.0	35	SUPPORT STAND SET	1		
29.1	35.1	Base		Two for 13-mm threaded rods	
29.2	35.2	Clamp base		One for 13-mm rods	
29.3	35.3	Threaded rods		One each 1/2" (13-mm) diam by 36" long and 24" long	
29.4	35.4	90-deg clamp		Two for 13-mm rods	
29.5	35.5	Adj. clamp		One for 13-mm rods	
29.6	35.6	Untreaded rods		Four 13-mm diam x 24" long	
29.7	35.7	Ring clamp		One needed if item 27 B used	
30.0	36	THERMOCOUPLE	1 set	Type-E, Chromel-constantan 24 AWG wire 30" long w/plugs	
31.0		CUP, STYROFOAM	3	16 to 24 ounce size	
32.0	37	PULLEY SET	1		
32.1	37.1	Single		Three single-sheave type	
32.2	37.2	Double		Two double sheave, abreast or	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
				tandem arrangement	
32.3	37.3	Triple		Two triple sheave, abreast or tandem arrangement	
32.4	37.4	Stepped		One, w/three different diam	
33.0	43	WINCH ASSEMBLY	1		*
33.1		Disk		One, wood or metal w/10" diam and 0.5" thick grooved rim	
33.2		Mount		One, wood board, 14" x 10" x (1/2" to 5/8")	
33.3		Winch		One, 1/2 ton cap manual	
33.4		Pulley		One, grooved 1" diam mounted	
34.0	38	SPRING BALANCE SET	1	Dual scale type (SI/English)	
34.1		Small		Range 0 to 2.5 N (0.5 lb)	
34.2		Medium		Range 0 to 5 N (1.0 lb)	
34.3		Large		Range 0 to 20 N (4.5 lb)	
35.0	39	MONOFILAMENT LINE	1	One roll, 25 yd of 10 lb test	
36.0		PNEUMATIC CYL. SET	1	Double-acting types	
36.1	44	Large		One, w/6" stroke & 1.125 diam	
36.2	107	Small		One, w/4" stroke & 3/4" diam	
36.3		Barbs		Four, nylon or brass threaded tubing barbs for 1/4" id tubing	
37.0	45	WEIGHT STAGE	1	Aluminum disk attached to item nos. 44 or 107	*
38.0	46	WATER PUMP SET	1		
38.1		Motor		One, DC powered rated at 12 V DC @ 10 A (or less).	
38.2		Pump		One, w/rated pumping capacity of 300 gph (or greater)	
39.0	47	POWER SUPPLY	1	Output 0 to 20 V DC @ 10 A w/ front panel V & I meters, AC output optional	
40.0	50	CONTAINER, LG FLUID	1	5-gal plastic w/lid	
41.0	52	ELECTRIC MOTOR ASSEMBLY	1		*
41.1		Motor		Permanent magnet type, rated at 12V DC @ 6 to 10 A	
41.2		Mount		Wood construction, adjustable	
41.3		Accessories		1 ea drive pulley, drum, &	

12/1/86

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
				shaft coupler	
42.0	51	STOPWATCH	1	Digital readout to 0.1 sec, w/2 functions (reg. & lap)	
43.0	54	SOLENOID ASSEMBLY	1		*
43.1		Solenoid		One, 12 V DC type w/1" pull	
43.2		Mount		One, wood construction w/ three 5-way binding posts	
44.0	55	CONVEYOR ASSEMBLY	1	Wood construction	*
45.0	56	BALANCE, TRIPLE-BEAM	1 needed per 3 stations	Similar to OHAUS model 2610	
46.0	57	STROBOSCOPE	1	Adjustable flash rate 180 fpm to 10,000 fpm	
47.0	58	WATER CHANNEL ASSEMBLY	1	Vinyl or metal rain gutter w/ V-notched obstruction (weir)	*
48.0	59	AIR STORAGE TANK	1	Six gal w/pressure gage, brass manifold, shutoff valve, and 6-ft hose w/a quick-connect-disconnect female coupler	
49.0	60	PRESSURE REGULATOR	1	0-30 psi w/quick connect male connector on input and brass output barb for 1/4" id tubing	
50.0		GAS ORIFICE ASSEMBLY	1		*
50.1	62	Orifice body		One machined acrylic w/4 barbs (for 1/4" id tubing)	
50.2	61	Collection column		One, Plexiglass or acrylic tube w/2" id & 13"-24" long	
50.3	61.1	Water bath		One, tray 4"-5"d x 6" x 9"l	
51.0	65	OSCILLOSCOPE	1	Dual channel, 0 to 10 MHz	
51.1		Probes		Two, X1/X10 type w/clip	
52.0	66	FUNCTION GENERATOR	1	0 to 10 MHz, 10 V (p-to-p) output into 600-ohms w/3 waveforms (sine, square, sawtooth)	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see below
53-A	67A	DEWAR FLASK	1	1.9 l. capacity w/12 cm id	
53-B	67B	INSULATED CONTAINER	1	3 lb coffee can wrapped w/2" styrofoam insulation	
54.0		HEAT TRANSFER ASSEMBLY SET	1		*
54.1	68A	Conductor tester		One insul board w/Al slug	
54.2	68B	Insulation tester		Two Al plates	
54.3	64	Lamp socket		One porcelain, standard	
54.4	64.1	Heater		One light bulb, 100 W	
55.0	70	CONTAINER SET	1	For fluids, made of metal	
55.1		Small		Three, 1-lb coffee can	
55.2		Large		Two, 3-lb coffee can	
56.0		FRICTION PLATE ASSEMBLY	1		*
56.1	71	Fixed		One Al, 6" x 18" x 3/16"	
56.2	72	Movable		One Al, 4" x 6" x 1/4" w/all edges smoothed & rounded	
57.0		AIR-FLOW ASSEMBLY	1		*
57.1	73	Tube		Plexiglass or acrylic 24" x 2" id w/flow-control holes	
57.2	74	Objects		Three different shapes w/ cross-sectional area 70-80% of air-flow tube	
58.0	75	AIR-FLOW SYSTEM	1		
58.1	75.1	Vacuum		One 5-gal, 1.1 hp dry type	
58.2	75.2	Hose		One, 6-ft x 2.5" wire reinforced plastic type	
58.3	75.3	Adapter		One, 2.5" down to 2" id	
58.4	76	Duct tape		One 20-yd roll canvas adhesive, 2.5" to 3" wide	
59.0	78	GARDEN HOSE SET	1		
59.1	78.1	Large		One 25′ length of 5/8" to 3/4" diam w/male & female conn	
59.2	78.2	Small		Two 25′ lengths of 3/8" to 1/2" diam w/male & female conn	
60.0	97	PRESSURE GAGE TAP	2	PVC threaded tee, w/outputs male/female/male, 3/4 diam	
60.1		Gage adapter		One male 3/4" thread to 1/4"	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see below
				female NPT	
60.2		Teflon tape		One roll teflon pipe seal	
61.0		PLATFORM SCALE	1	Household "bathroom" type	
62.0		FLOW RESTRICTOR SET	1	Each to be 4" X 4" size	*
62.1	79	Plates		Seven metal w/different sizes of flow holes	
62.2	80	Filters		Two sections, fiber type	
63.0	opt.	MANOMETER, SLANT TUBE	1	Slant tube w/0" to 3" water range. Option: use U-tube	
64.0	81	SOLDERLESS BREADBOARD	1	Plastic, 6.5" x 2.25" w/128 terminals and 5 tie points/term	
65.0		RESISTORS SET	1		
65.1	82	Fixed assortment		1/2 watt, 5% tolerance of: 1-10 ohm, 2-100 ohm, 2-560 ohm, 1-1 kohm, 2-1.5 kohm, 2-2.5 kohm 1-50 kohm, 1-1 Mohm, & 4-10 Mohm	
65.2	82.1	Power type		One each 10 watt 50 & 100 ohm	
65.3	83	Variable		Two each, 2 watt 30% tol. 0-10 kohm & 0-100 kohm. Make 1 audio taper & other linear	
66.0	85	THERMAL PIPE ASSEMBLY	1	Two copper pipe sections, 1 insulated and 1 uninsulated	*
66.1	85.1	Stoppers		Three rubber stoppers per tube w/one being a 1-hole type	
66.2	86	Funnel		One plastic type	
67.0	87	SPRING TEST ASSEMBLY	1	Wood construction w/ spring Option of two designs.	*
68.0	91	HYDRAULIC FLOW & SHOCK ASSEMBLY	1	PVC construction 1/2" & 3/4" pipe w/tee's & flexible tube section	*
68.1	77	Valves		One each ball & gate, PVC	
69.0	89	AIR MOTOR	1	Rated at 1/20 hp min w/ 1/4" input air lines and a 3/8" diam output shaft	
69.1	89.1	Gage accessory		One PVC 1/2" diam tee w/3 fe-	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAMF	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be- low
				male ends and 2 tubing barb adapters for 1/4" id tubing	
69.2	90	Stirring attach.		One, w/sleeve coupler	
70.0	88	FLYWHEEL ASSEMBLY	1	Wood construction w/cast iron wheel 8"-10" diam of 3-6 lb of weight mounted on 1/2" diam shaft w/roller bearing support	*
70.1	88.1	Drive belt		One, flat belt (from sewing machine or carpet sweeper)	
70.2	88.2	Friction brake		One leather strap attached	
71.0	92	STRIP-CHART RECORDER	1 for class	Servo type w/4" wide chart and 1 Mohm input Z. Variable ranges and speeds	
72.0	93	ROTAMETER	1	Air-flow meter w/range of 180-1800 SCFH (cu ft/hr)	
73.0	94	SPECIFIC HEAT SAMPLE SET	1	5-metal cyl, each of same mass but different volume	
73.1	95	Tongs		One set w/insulated handles	
74.0	98	WATT-HOUR METER ASSEMBLY	2 per class		*
74.1	98.1	Watt-hour meter		One domestic type	
74.2	98.2	Line volt monitor		One panel voltmeter w/range of 10% to either side of AC line	
74.3	98.3	Circuit breaker		One 30 A rated w/switch	
74.4	98.4	Mult outlet strip		One w/5 or 6 outlets	
75.0	99	MOTOR-GENERATOR SET	1	Two identical assemblies w/ fixed and rotating coils whose configuration can be set via external connections	
76.0	100	WINCH,"COME-A-LONG"	1	1 ton to 1 1/2 ton capacity	
77.0	101	PIPE CLAMP ASSEMBLY	1	3-ft long w/disk replacing handle	*
78.0		GEAR SET	1		
78.1	102	Spur type		A collection of 5 or 6 spur gears w/shafts and frame to be mounted on as per lab 7M3	
78.2	103	Worm type		One worm screw driving a	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see below
				wheel gear	
79.0	104	BELT DRIVE ASSEMBLY	1	Wood construction w/2 stepped drive pulleys at adj distances	*
79.1	104.1	Belt		One V-belt for stepped pulley	
79.2	104.2	Drive belt		One timing belt w/3mm pitch 300 mm length, 9 mm wide	
79.3	104.3	Drive pulleys		Double flange w/1-8.3 cm diam & 1-14 cm diam or greater	
80.0	105	HYDRAULIC JACK	1	1 1/2 ton cap w/high pressure gage, 0 to 5000 psi	*
81.0	106	PRESSURE STAGE	1	Steel construction w/springs	*
82.0	108	TRANSFORMER ASSEMBLY	1	Soft steel construction	*
82.1	108.1	Coil forms		Four plastic or cardboard tubes, just large enough to fit over bolts in assembly	
83.0	110	TRANSFORMER	1	One step-down center tapped w/115 V AC primary & 12.5 V AC @ 1 A secondary	

END OF FIRST YEAR EQUIPMENT REQUIREMENTS

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see below
84.0	200	IMPULSE MEASUREMENT ASSEMBLY	1	Consists of frame, impact plate, spring, rod, and guide	*
85.0	201	MOMENT OF INERTIA ASSEMBLY	1	Rotating rod w/movable weights	*
86.0	202	FLUID MOMENTUM ASSEMBLY	1	Two flexible hose sections w/90-degree PVC elbow	*
87.0	205	deleted			*
88.0	206	MECHANICAL SHOCK ASSEMBLY	1	Wood construction	*
89.0	207	VIBRATION TRANSDUCERS	2	Piezoelectric w/frequency range of 1 Hz to 5 kHz & sens of 10 mV/g, linearity 1%, and excit of 18-28 V DC @ 2-20 mA	
89.1	208	Battery		One per transducer, such as	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
89.2	207.1	BNC cables		Burgess type K15 Two 4-ft long w/connectors at both ends minimum	
90.0	209	SPEAKER	1	3" wide freq range speaker w/1000-ohm CT transformer	
91.0	210	MICROPHONE	1	Omnidirectional 30 Hz to 15 kHz range w/4-10 V DC pwr	
92.0	211	RESONANCE TUBE	1	2" id x 2' long	
93.0	213	CAPACITORS	1		
93.1	213.1	Small set		Three 47 pF nonelectrolytic	
93.2	213.2	Large set		One 10 mmF electrolytic	
94.0	219	REFLECTOR	1	Parabolic, 18" diam metal	
95.0	218	PHOTOMETER	1	Laser power meter type w/ range 0.003 mW to 10.0 mW	
96.0	217	FLOOD LAMP ASSEMBLY	1	Fixture w/reflector and lamp rated at 300 W	
97.0	214	WIND GENERATOR ASSEMBLY	1		*
97.1		Duct fan		1-10" diam w/300 cfm min flow	
97.2		Flow tube		7'-8' length w/10" to 8" diam	
97.3		Output fan		One, 7" diam w/5 blades	
97.4		Output assembly		With 1.5 V DC motor, shaft, & cradle to hold items aligned	
98.0	215	ANEMOMETER	1	Slant-tube manometer cali-brated in wind speed (mph) w/ pitot tube	
99.0	216	SOLAR CELL PANEL	2	Each rated [illegible] V DC @ 50 mA	
100.0	225	FLUORESCENT FIXTURE	1	8 W to 15 W miniature can be battery powered	
101.0	227	WATTMETER, AC	1	1000 W range, or optional design of POWER MEAS MODULE	*
102.0	226	STEAM ENGINE	1	Electrically heated w/output	

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
				flywheel	
103.0	234	BIMETALLIC STRIP ASSEMBLY	1	Linear strip w/ electrical contacts, adjustable	
104.0	221	THERMOELECTRIC MODULE ASSEMBLY	1	Two Al blocks drilled for temp chambers; insulated by styrofoam blocks; sandwiching a thermo[illegible]ric module	*
105.0	228	LOAD CELL ASSEMBLY	1		*
105.1		Strain gage		Two unbonded foil type	
105.2		Output board		One PC board w/bridge circuit	
105.3		Load member		One PVC 2" slip-type coupler	
105.4		Connecting cable		One 3-ft long 4-conductor wire	
106.0	231	PRESSURE MANIFOLD ASSEMBLY	1	Wood and PVC construction	*
107.0	232	D/P CELL	1	One electrical output w/0 to 15 psi range	
108.0	233	LIQUID FLOW ORIFICE ASSEMBLY	1	PVC construction w/inserts	*
109.0	229	LVDT	1	DC-to-DC type w/1" min. range	
109.1		Accessory set		One set as per lab 11E2	
110.0	237	SOLID-STATE TEMPERATURE SENSOR	1	Probe w/temp to mV convertor and battery. Reads 1 mV/degree C, at ice pt=0 mV out	
111.0	236	PRT(Platinum Resistance Thermometer)	1	Probe element w/100-ohm nominal resistance	
112.0	235	THERMISTER	1	Probe element 3" long x 0.095" diam w/ nominal resistance of 2252 ohms at 25 degrees Celcius.	
113.0	238	SPECTROSCOPE	1	Student type, hand-held w/ diffraction grating and built-in wavelength scale	

12/1/86

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
114.0	223	HV POWER SUPPLY	1	Spectrum tube power supply w/spectrum tube holder	
115.0	224	SPECTRUM TUBE SET	1		
115.1	224.1	Hydrogen		One	
115.2	224.2	Helium		One	
115.3	224.3	Nitrogen		One	
115.4	224.4	Neon		One	
115.5	224.5	Mercury vapor		One	
116.0	222	LASER	1	Helium-Neon w/output power of 0.48 to 0.7 mW.	
117.0	239	Radioactivity Demo Set	1	two or three radioactive samples with a raditation dector NOTE: this set is used for both the the demo and student lab	
118.0	240	LAZY SUSAN OPTICS TABLE	1		*
118.1		Bearing		One 3" diam "lazy susan" type	
118.2		Base		One wood, 1' x 1' x 5/8"	
118.3		Disk		One heavy poster board, 17.5" diam w/white matte finish	
119.0	242	LENS SET	1	NOTE: FL MEANS FOCAL LENGTH	
119.1		Positive long FL		One, plano-convex lens 33-mm diam w/233-mm FL	
119.2		Positive short FL		One, plano-convex lens 32-mm diam w/58-mm FL	
119.3		Negative		One, plano-concave lens 35-mm diam w/-53 mm FL	
119.4		Cylindrical		One, glass rod 2"-3" long x 3 to 4 mm diam	
120.0		FILTER SET	1		
120.1	241	Color set		One set of 8 mounted 2" x 2" solid color slides	
120.2	246	Polcrized		Two, mounted 2" x 2" filters	
121.0	242.1	MIRROR SET	1	Flat, front-surface type	
121.1		Lg flat		One 22mm x 22 mm x 5 mm	
121.3		Convex (radius)		One 26 mm diam w/62 mm FL	
121.4		Concave (radius)		One 25 mm diam w/-25 mm FL	

12/1/86

PRINCIPLES OF TECHNOLOGY LAB EQUIPMENT

INDEX	ITEM NO.	ITEM NAME	NUMBER per LAB STATION	SPECIFICATIONS & DISCRIPTIONS	see be-low
122.0	242.2	BEAM SPLITTER SET	1		
122.2		Glass type		One microscope slide	
123.0	242.3	PRISM SET	1		
123.1		Right angle (PORO)		One 19 mm x 19 mm x 25 mm, unaluminized	
123.2		Equilateral		One, 25 mm x 25 mm size	
123.3		Dove		One, 76 mm x 25 mm x 18 mm	
	242.4	GLASS SLAB	1	0.25" to 0.5" thick w/2 parallel edge surfaces.	
124.0	244	DIFFRACTION GRATING	1	One, 2" x 2" mounted w/ 13,400 grooves/inch	
125.0	243	SCREEN	1	One 3" x 5" index card, white unlined, will suffice.	
126.0	250	FIBER OPTICS SET	1		
126.1		Cable		One 5-meter length of fiber optics cable	
126.2	251	LED/photo diode		One pair of LED and photo diode detectors, IR type	
		Couplers		One each, input and output	

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Special
1DM	1	Sponge			
	1	Meter stick		42	
	2	Spring balance scale	Dual scale type w/5-lb range	38	
	2	Suction cups	Rubber, 2"-3" diam		
	2	Cord	12"-18" length, 40-lb test	5	
	1	Paint can	Gallon size filled w/sand		
	1	SOCKET FIXTURE			*
	2	C-clamps		13	
	1	Torque wrench			
	2	Connector clamp	Aircraft type w/1.25" max expanded od for hose		
	1	Masking tape	One roll, 5/8" wide		
1DF	1	Flow indicator			
	2	Fluid containers	5-gal cap, 1 w/outlet at bottom and 1 w/o outlet		
	2	Tubing sections	Tygon bubble type, 2 ft	19	
	2 to 4	Connector clamp	Aircraft type w/0.7" max expanded od for tubing		
	1	Tubing clamp	Polycarbonate pinch-off	63	
	1	Lab jack	Heavy-duty type		
	2	Beakers	One liter cap Pyrex		
	1	Stopwatch		51	
1DE	2	Batteries	Lantern type, 1.5 volt		
	2	VOM	Analog volt-ohm-milliammeter	23	
	3	Hook-up wire	18-24 AWG wire segments 4" & 6" long, 1-red, 1-black, & 1-yellow insulation		
	2	Alligator clip	Miniature type		
	1	SPST switch	Knife type	28	
1DT	1	CONDUCTION BAR	14" x 1" x 1/2" w/5 holes made of copper		*
	1	Hot plate	750 watt, 80 cm square	33A	
	1	Lab jack	Heavy-duty type		
	5	Nails	"16-penny"		
	1	Paraffin	Two ounce amount		
	1	Thermo crayon			
	1	INSULATOR SHIELD			*
2DM	1	Basketball			
	1	Spring balance scale	Dual scale type w/5-lb range	38	
	1	Block, wood or brick			

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Special
	1	Meter stick		42	
	1	Cord	1-ft length, 40-lb test	5	
2DF	2	Fluid container	5-gal cap (bucket)	50	
	1	Water pump	Electric motor driven	46	
	1	Power supply	AC/DC type	47	
	2	Hoses	For connection to pump	19	
2DE	1	Slotted weight set	Small cap	40	
	2	C-clamps		13	
	2	VOM	Analog volt-ohm-milliammeter	23	
	1	Support stand		35	
	1	Pulley	For support stand	37	
	1	Power supply	AC/DC type	47	
	1	DC motor		52	
	1	Stopwatch		51	
3DM	1	Toy car	Windup or electric type		
	1	Stroboscope		57	
	1	Stopwatch		51	
	1	Meter stick		42	
	1	DC Motor		52	
	1	6" diam disk	For connection to motor		
	1	Power supply	AC/DC type	47	
	1	C-clamp		13	
	1	Masking tape	One roll, 5/8" wide		
3DF	1	Fluid container	5-gal cap, 1 w/outlet at bottom		
	1	Fluid container	5-gal cap (bucket)	50	
	1	Triple-beam balance		56	
	2	Beakers, large	1-liter size		
	1	Stopwatch		51	
	1	Tubing clamp	Polycarbonate pinch-off	63	
3DE	2	Batteries	Lantern-type, 6 volt	25	
	1	Lamp w/base	6-volt		
	1	SPST switch	Knife type	28	
	1	VOM	Analog volt-ohm-milliammeter	23	
	1	Oscilloscope		65	
	1	Function generator		66	
3DT	3	CONDUCTION BAR	14" x 1" x 1/2" w/5 holes 1 made of steel, 2 of copper		*
	2	Hot plates	700 watt		
	2	Lab jacks	Heavy-duty type		

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Spe-cial
	8	Nails	"16-penny"		
	2	Paraffin	Two ounce amount		
	2	Stopwatches		51	
4DM	1	Plate	Al or steel, 18" x 6" x 1/4"		
	2	Weights	1-lb lead bricks		
	1	Oil	1 oz of lubricating oil		
	2	Cup-hook screws			
	1	Spring balance scale	Dual scale type w/5-lb range	34	
4DF	1	FLOW SHROUD	w/mylar ribbon strips		*
	1	Auto air-filter			
	1	Vacuum			
	1	Manometer	Slant-tube type		
	1	Confetti	Approximately 1 cup measure		
4DE	1	DEMONSTRATION BOARD	Board mounted w/4 different wires, each w/ diff resistance		*
	1	Power supply	AC/DC type	47	
	2	DMM	Digital multimeters	27	
4DT	1	CHIMNEY ASSEMBLY	Uses Cu pipe, insulation, & aluminum foil		*
	1	Support stand		35	
	1	Bunsen/Fisher burner	Butane torch optional		
	1	Temp indicator strip	Reversible type		
	1	Thermo crayon set	70 to 100 degree C range		
5DM	1	Plexiglass tube	2-ft long x 2" id	73	
	1	Weight hanger	50-gm for slotted weight set	41	
	1	Slotted weight set	Small capacity set	40	
	3	Nails	Roofing type		
	1	Styrofoam board	2" x 4" x 14", dense type		
	1	Cord	18" length, 40-lb test	5	
	1	Masking tape	One roll, 5/8" wide		
5DF	1	Air tank	6-gal size	59	
	1	Pressure regulator	0 to 30 psi	60	
	1	Air motor	Fractional horsepower type	89	
	1	DC motor	Permanent magnet type	52	
	1	Miniature lamp w/base	1.5 volt bulb		
	1	Support stand		35	
5DE	1	SPST switch	Knife type	28	
	1	Battery	6-V dry cell	25	

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Spe- cial
	1	Resistor, variable	0 to 20 ohms		
	1	Resistor, fixed		82	
	1	Capacitor	Nonelectrolytic, w/value of 5-10 microfarads		
	1	Power supply	AC/DC type	47	
	1	Strip-chart recorder	Servo type	92	
	1	ADJ VOLT-DIVIDER CKT	As described in Demo 5DE		*
5DT	1	PIPE ASSEMBLY	As described in Demo 5DT		*
	1	Power supply	AC/DC type	47	
	1	Strip-chart recorder	Servo type	92	
	1	Pump	Electric motor driven	46	
	1	Thermocouple	Type E w/ice pt ref junction	36	
	1	Fluid container	5-gal cap (bucket)	50	
6DM	1	H.D. support stand		1	
	1	Slotted weight set	Large capacity	12	
	1	Weight hanger	1-kg size	11	
	1	Cord	8-ft, 60-lb test		
	1	Pulley		37	
	1	Meter Stick		42	
	1	Masking tape			
	1	Stopwatch		51	
6DF	1	H.D. support stand		1	
	1	Slotted weight set	Small capacity	40	
	1	Weight hanger	50-gm size	41	
	1	Cord	8-ft, 60-lb test		
	1	Pulley		37	
	1	Air tank	6-gal size	59	
	1	Pressure regulator	0 to 30 psi	60	
	1	Air motor	Fractional horsepower type	89	
	1	Rotameter			
	1	Masking tape			
	1	Stopwatch		51	
6DE	1	Power supply	AC/DC type	47	
	1	Miniature lamp w/base	6-volt bulb	29 & 30	
	1	SPST switch	Knife type	28	
	1	VOM or voltmeter		23	
	1	DMM or ammeter		27	
	1	Transparency	Of a kilowatt-hour meter		
	1	Resistor, variable	0 to 20 ohms		
7DML		VARIOUS COMMON DEVICES THAT INCORPORATE LEVERS			

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Special
7DMR	1	Power supply	AC/DC type	47	
	1	DC motor	Permanent magnet type	52	
	1	Drive pulley	1.25" diam		
	1	Stroboscope		46	
	1	Multi-step pulley		37.4	
	3	Rubber bands	Broad heavy-duty type, short		
	1	Support stand		35	
7DF	1	Hydraulic jack		105	
7DE	1	Transformer	25-V ct step-down type		
	1	Autotransformer			
	4	DMMs		27	
	1	Resistor	Power type 50 ohm, 30 watt		
	1	"Pigtail" power cord			

END OF FIRST YEAR DEMONSTRATIONS

8DMF1	5	Marbles, glass	Should be of equal size and weight.		
	2	V-track, Aluminum	Two sections, one 3' to 4' long; the other 8"-10" long.		
	1	Fresh raw egg			
	1	Hot water bottle			
	1	Meter Stick		42	
	1	Clay, modeling	8 to 10 ounces		
8DMF2	1	Stool, rotating			
	2	Slotted weights	2-kg size		
	1	Stopwatch		51	
9DM1	1	Support rod base	Table-edge clamp type	35.2	
	2	Support rods	Both 13-mm diam, one 40 cm long and threaded, the other 120 cm long and unthreaded.	35.3 not listed	
	1	Support rod clamp	90 degree V-block type	35.4	
	1	Steel hacksaw blade			
	1	Wood dowel	1" long x 1/2" diam.		*
	1	"Slinky"			
	1	Stopwatch		51	
	1	Meter Stick		42	
9DM2	1	H.D. support stand		1	
	1	Cord	1.5 meters		

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Special
	1	Stopwatch		51	
	2	Tuning forks w/boxes	Key of E tuning forks mounted on resonator boxes. (such as CENCO cat. #84565-002)		
10DM	1	Electric hand drill	3/8" variable speed		
	2	Board, wood	one 2" X 4" X 4", the other 1" X 1.5" X 3"		*
	2	Dowels, wood	Both 3/8" diam. one 4" long, the other 6" long.		*
	1	Coil forms w/wire	FROM LAB 7E1/E2	108	
	1	Oscilloscope	Dual trace type, 10 MHz min. bandwidth.	65	
	1	Bar magnet			
	1	Fan blades	w/ 1/4" shaft		*
10DF	1	Air tank	Charged to 180 psi	59	
	1	Pressure regulator	0 to 30 psi	60	
	1	Pheumatic cyl., lg	w/6" stroke, 1.125" diam.	44	
	1	Pressure gage	Compound type, 30 psi/30"Hg	21	
	1	Weight stage	Al disk	45	
	1	Air motor	Min 1/20 hp w/ 1/4" air input and a 3/8" diam output shaft.	89	
	1 set	Support stand & rods		35	
	1 set	Tygon tubing		19	
10DE		Misc. equip.	Use equip avail. in room		
10DT	1	Steam Engine		226	
		Motor-Generator Set		99	
		Lamp, minature		30	
		Lamp base, minature		29	
		Hook-up wire		24	
11DM	1	Slotted wt. set, lg		12	
	1	Slotted wt. set, sm		40	
	1	Spring balance scales		38	
	1 set	Support stand set		35	
	1	Pivot block	A wood block 4"/side w/a 1/4" threaded bolt extending 1" beyond a surface. Block can be mounted on standard 13-mm support rod and clamped in place.		*
	1	Lever Rod	1/2" diam to 3/4" diam. wood		*

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Special
			dowel. 1/4" diam hole drilled perpendicular to length at center. Hook-n-eye bolts at each end.		
11DF	1	Air tank	Charged to 180 psi	59	
	1	Pressure regulator	0 to 30 psi	60	
	1	Pressure gage	Compound type, 30 psi/30"Hg	21	
	1	Pressure manifold		231	
	1	U-tube manometer	w/Mercury	17 &17.2	
	1	D/P cell	0-15 psi input for a 0 to 100 millivolt output.	232	
	1	Strip chart recorder		92	
	1	Power Supply	AC/DC type	47	
	1 set	Hook-up wire		24	
	1 set	Tubing		19	
11DE	1	Power supply	AC/DC type	47	
	1	VOM or voltmeter		23	
	1	DMM or ammeter		27	
	1	Solderless breadboard		81	
	3	Resistors, fixed	All 1/2-watt or better; one 5 kohm, the other two 10 kohm		
12D1	1	Spectrum Chart	Wall type		
	1 set	Color Filters		241	
	1	Projector	35 mm slide type		
	1	Laser	HeNe	222	
	1	Radiometer			
12D2	1 set	Radiation Demo Set (Partical Radiation)	A demonstrator set containing detection instrument, samples, and detailed information. Such as CENCO's cat. #71201-003.	239.1	
13D•1	1	"Lazy Susan" optics table		240	
	1	Laser	HeNe	222	
	1	Microscope slide		242.2	
	1	Screen	3" X 5" Index card, blank & unlined	243	
	1	Partical or smoke generator	Chalk board erasers w/ chalk dust in them.		
13D•2	1	"Lazy Susan" optics table		240	

PRINCIPLES OF TECHNOLGY: DEMONSTRATION EQUIPMENT

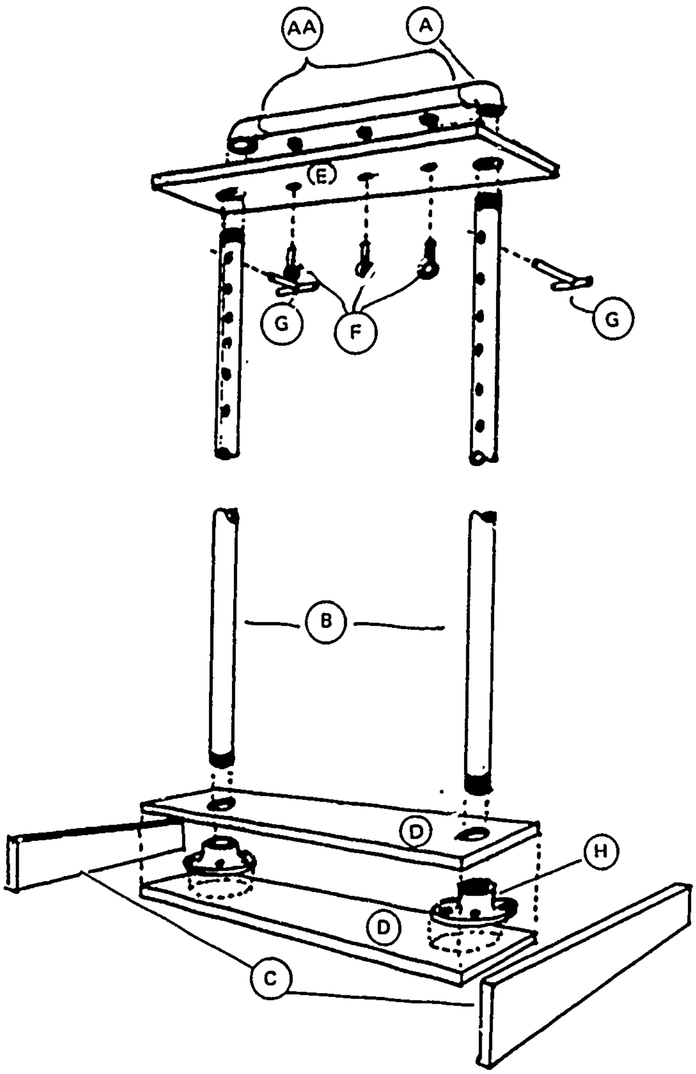
DEMO NO.	NUMBER ITEMS NEEDED	ITEM NAME		ITEM NO. in EQUIP. LIST	Special
	1	Laser	HeNe	222	
	1	Microscope slide		242.2	
	1	Screen	3" X 5" Index card, blank & unlined	243	
	1	Partical or smoke generator	Chalk board erasers w/ chalk dust in them.		
	1	Projector	35 mm slide type		
	1	Collimator	As per design in T.G.		*
	1	Glass Slab		242.4	
	2	Prisms	One equilateral and one porro	242.3	
13D*3	1	Laser	HeNe	222	
	1	Diffraction Grating		244	
	1	Steel rule			
	1	Phonograph record			
	1	Projection screen	A flat white piece of poster is sufficent.		
	1	Filter holder	From lab 13*7		
	1	Laboratory Jack			
13D*4	1	Laser	HeNe	222	
	1	Projection screen	A flat white piece of poster is sufficent.		
	1	Filter holder	From lab 13*7		
	1	Lens, plano-concave	w/3 cm focal length and 1.6 cm diam. Such as Edmunds Sci cat. #F95430.		
14D*1	1	Meter Stick		42	
14D*2	2	DMM		27	
	1	Power supply	AC/DC type	47	
	1	Solid state temp. sensor		237	
	1	VOM		23	
	2	Stopwatch		51	
	1 set	Radiation App. set		239	
	1	D-cell batt.	Rechargeable type completely discharged.		
	1	Beaker	1 liter size	16	

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Heavy-Duty Support Stand Item No. 1

MATERIALS

1 - 5/8 dia pipe 29" in length with npt threads both ends (AA)
2 - 90 degree elbows for 5/8" diameter pipe (A)
2 - 6 ft long pipes (5/8" diameter) (B)
2 - 1/2" t x 3" w x 24" long boards (C)
2 - 5/8" t x 4" w x 36" long boards (D)
1 - 1" t x 4" w x 36" long board (item No. 1.1) (E)
3 - Eye bolts F
2 - Adjustment pins . (G)
2 - mounting flange for 5/8 dia pipe (H)



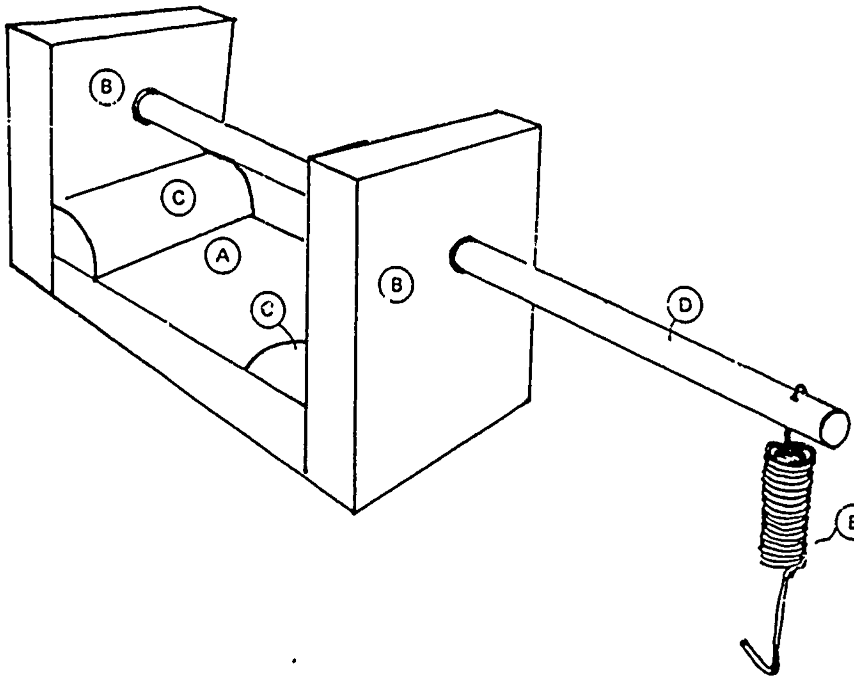
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Spring Holder Jig   Item No. 9

MATERIALS

1 - 3 3/4" w x 5/8" t x 5" long plywood board Ⓐ
2 - 3 3/4" w x 5/8" t x 5 1/4" long plywood boards Ⓑ
2 - 3 3/4" long x 5/8" radius quarter-round boards Ⓒ
1 - Aluminum rod 1/2" diam x 12-14" long Ⓓ
1 - Coiled spring (- automobile or truck clutch pedal return spring) Ⓔ



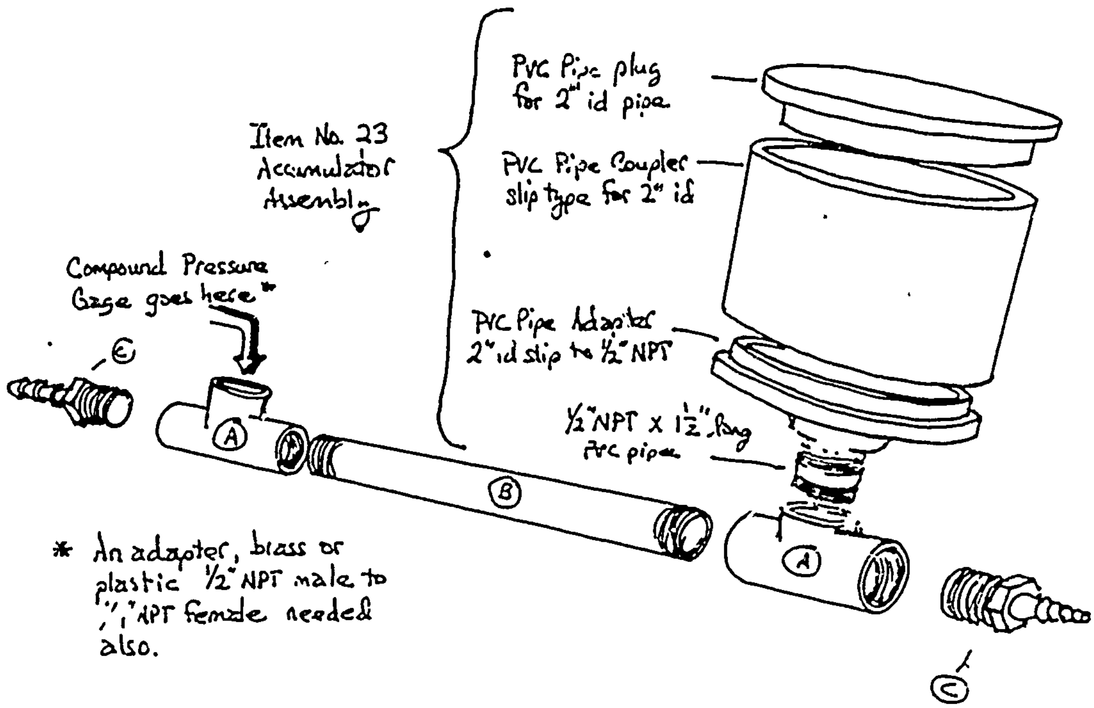
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Air Chamber Assembly — Item No. 20

MATERIALS

2 - PVC, 1/2" diam pipe tees with threaded ports Ⓐ
1 - PVC, 1/2" diam pipe 3" lon' Ⓑ
2 - Tubing barbs, 1/2" NPT to 1/4" tubing Ⓒ
2 - Tubing/hose clamps Ⓓ



12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

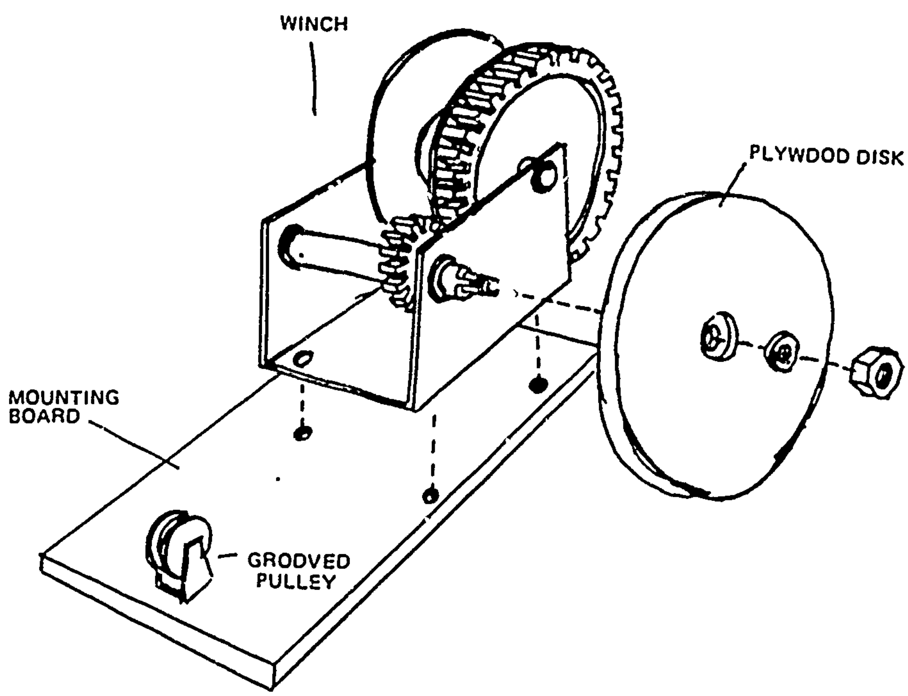
Item Name: Winch Assembly Item No. 43

MATERIALS

1 - Wood board, 10" w x (1/2" - 5/8") t x 14" long
1 - Winch, similar to W.W. Grainger, type 2Z601
3 - Wooden disk, 10" daimeter x 1/2" thick
1 - 1" diam grooved pulley

NOTE: It is important that the winch be able to free-wheel both in and out and that input handle can be removed easily. The handle will be removed to allow the attachment of the disk.

The plywood disk should be grooved to receive the mono-filament line.



12/01/86

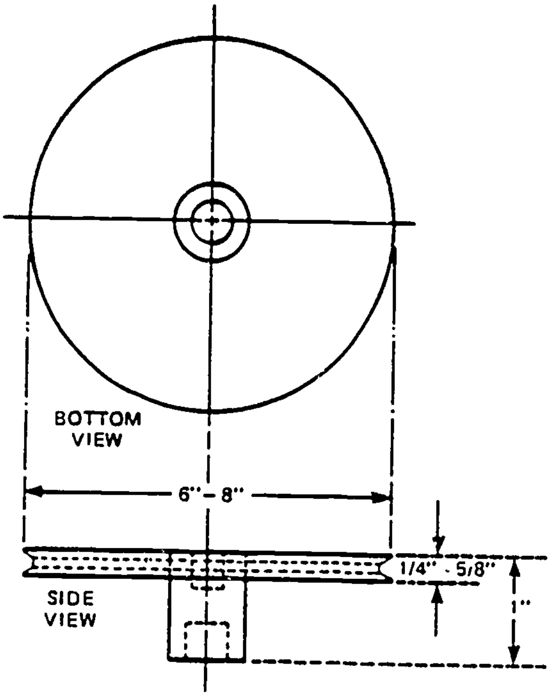
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Weight Stage

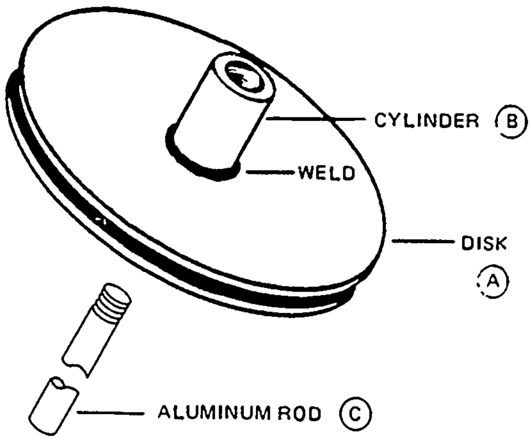
Item No. 45

MATERIALS

1 - 6" to 8" diam aluminum disk, 1/4" to 5/8" thick Ⓐ
1 - Aluminum cylinder, 1" diam x 1" long Ⓑ
1 - Aluminum rod, 8" to 10" long x 3/16" diam, threaded at one end Ⓒ



DRAWING NOT TO SCALE



Note: The aluminum rod is to help the slotted weights stay centered on the stage.

137

12/01/86

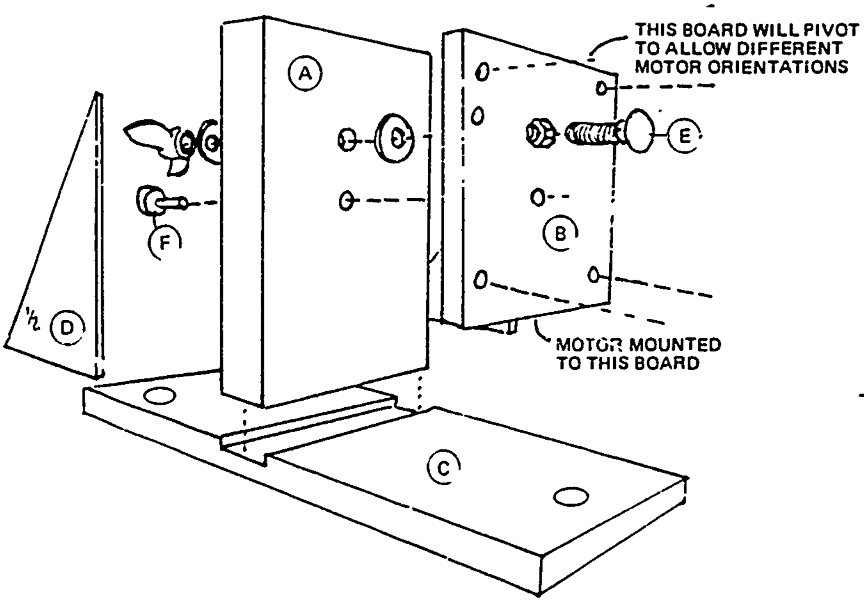
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Electric Motor Assembly Item No. 52

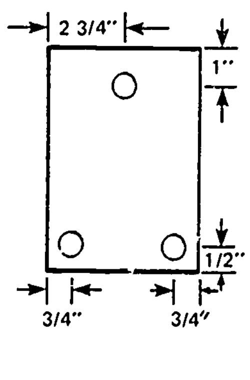
MATERIALS

1 - 5 1/2" w x 3/4" t x 6 3/4" long solid wood board Ⓐ
1 - 4 1/4" w x 5/8" t x 4 1/2" long plywood board Ⓑ
1 - 5 1/2" w x 3/4" t x 8" long solid wood board Ⓒ
1 - 3 1/2" w x 3/16" t x 5" long wood board
(cut diagonally in half) Ⓓ
1 - Permanent magnet DC - 1/16 hp (or less) electric motor
Motor should not exceed 8 amps at 12 V DC max
4 - Screw, washer, nut assemblies to fasted motor to board.
1 - 1/2" diam carriage bolt with washers and wing nut Ⓔ
1 - index pin Ⓕ

Additional materials to be available
1 - 2" o.d. drive pulley for motor shaft (to accept 1/8" diam round belts)
1 - 1" to 2" diam x 1" width drum for motor shaft
1 - 3/4" long piece of rubber tubing slightly smaller than shaft diam to act as a shaft coupler.



DRILL 3–9/32" DIA HOLES THROUGH BASE AS SHOWN



138

12/01/86

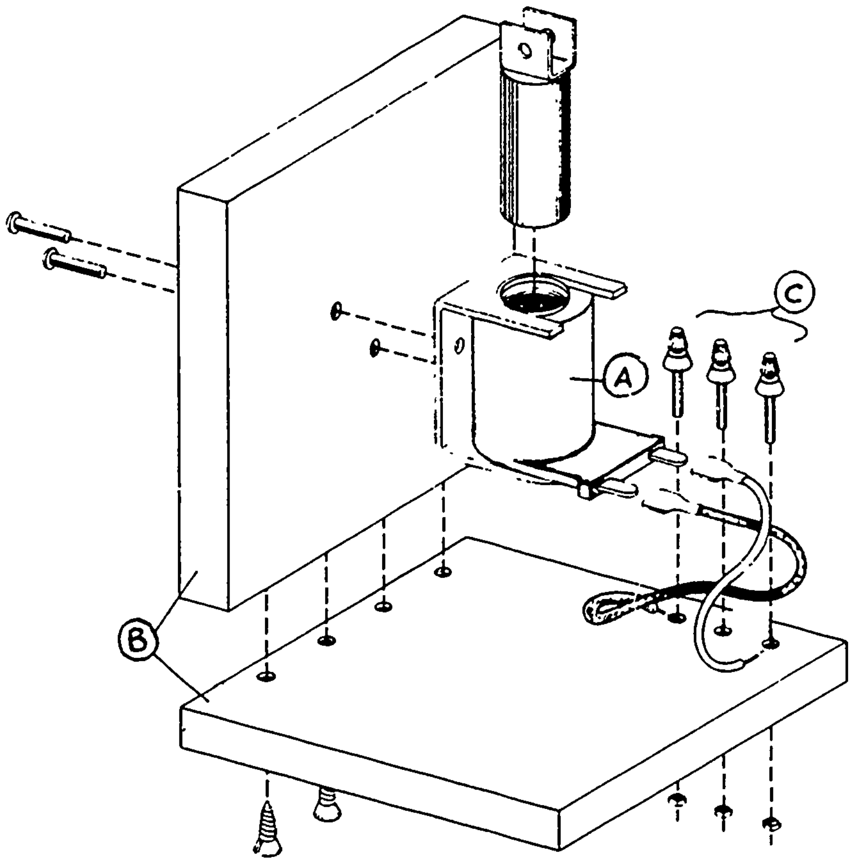
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Solenoid Assembly Item No. 54

MATERIALS

1 - 12 V DC solenoid with 3/4" pull Ⓐ
4 - Wood screws
1 - Mounting frame of 2 - 6" x 4" x 5/8" thick plywood Ⓑ
3 - 5-way binding posts (1 red and 2 black) Ⓒ

Construction:
Cut 2 plywood rectangles and mount together with solenoid and binding posts as shown in figure below.



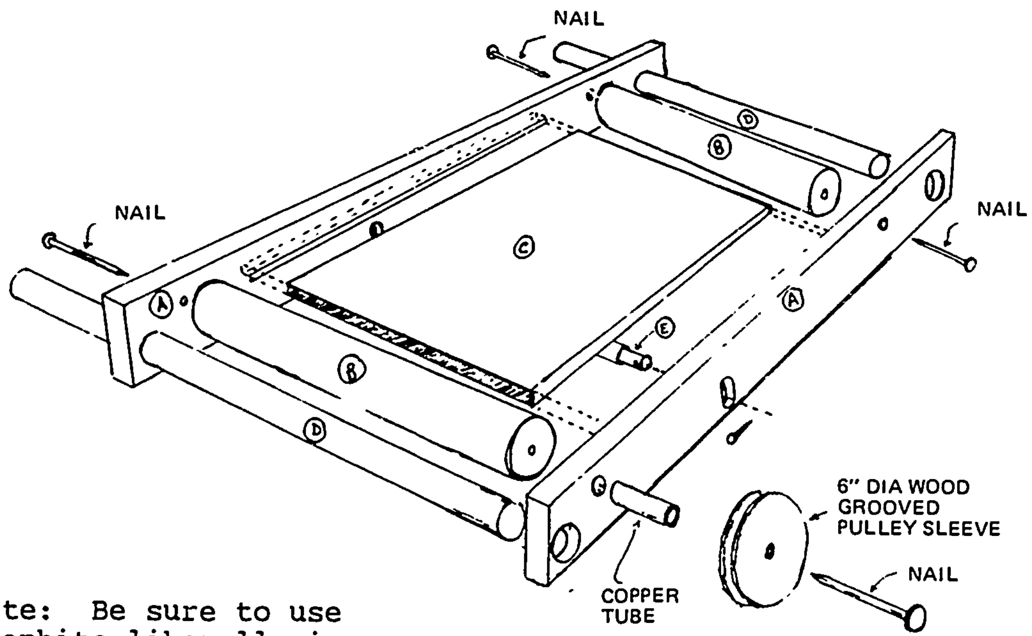
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Conveyor Assembly   Item No. 55

MATERIALS

2 - Wood boards 2" w x 1/2" - 5/8" t x 18" long Ⓐ
2 - Wood dowels 1" diam x 2 1/2" long Ⓑ
1 - Wood board - top surface covered with aluminum foil Ⓒ
1/4" t x 2 5/8" w x 10" long
2 - Wood dowels 3/4" diam x 6" long Ⓓ
1 - Wood dowel with plastic straw (2 1/2" long)
1/8" diam x 4" long (Optional) Ⓔ
1 - 2" to 2 1/4" wide belt
NOTE: This belt can be a sanding belt or a section cut out of an automobile tire innertube.
1 - Continuous round drive belt with 1/8" diam



Note: Be sure to use graphite liberally in each nail hole in boards marked "A".

Also, the copper pipe 3/4" long x 3/16" id. acts as spacer and bearing. It keeps the grooved pulley from dragging on the wood board.

12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

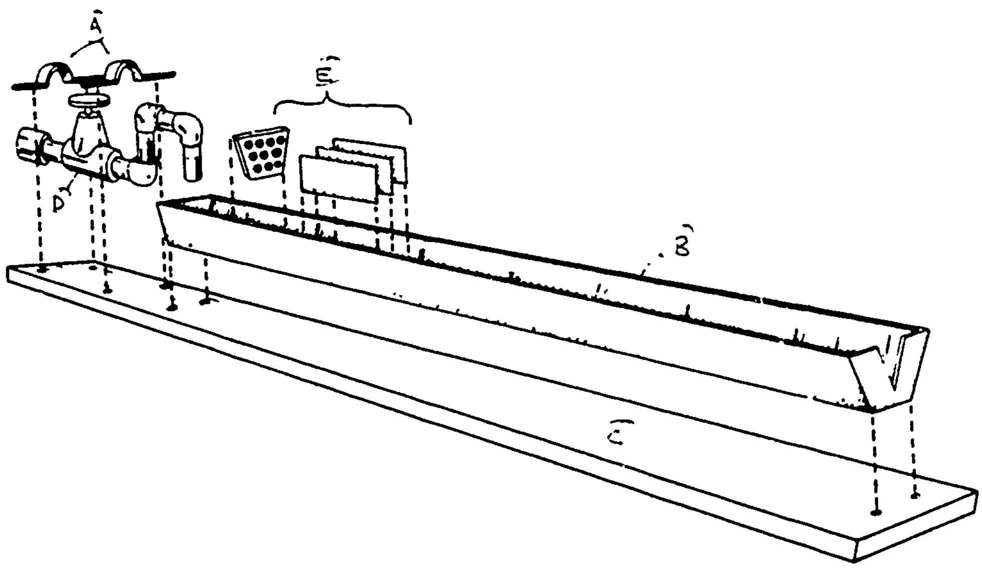
Item Name: Water Channel Assembly   Item No. 58

MATERIALS

2 - Pipe clamps Ⓐ
1 - Vinyl plastic or rain gutter, 37" to 42" long x 4 1/2" wide x 2 3/4" high. Ⓑ
1 - Wood board, 46" long x 5" wide x 5/8" thick Ⓒ
3 - PVC 90 elbows
3 - PVC pipe sections
1 - PVC control valve Ⓓ
1 - Baffle and flow straighteners Ⓔ
1 - PVC pipe to hose coupling/connector (female hose connector --male pipe connector)

Assembly:

The flow straighteners should be no less than 4" long x 2" tall x 1/16" thick to no more than 10" long x 2" tall x 1/16" thick. These should be glued across the bottom of the gutter and attached to run exactly parallel to the length.



12/01/86

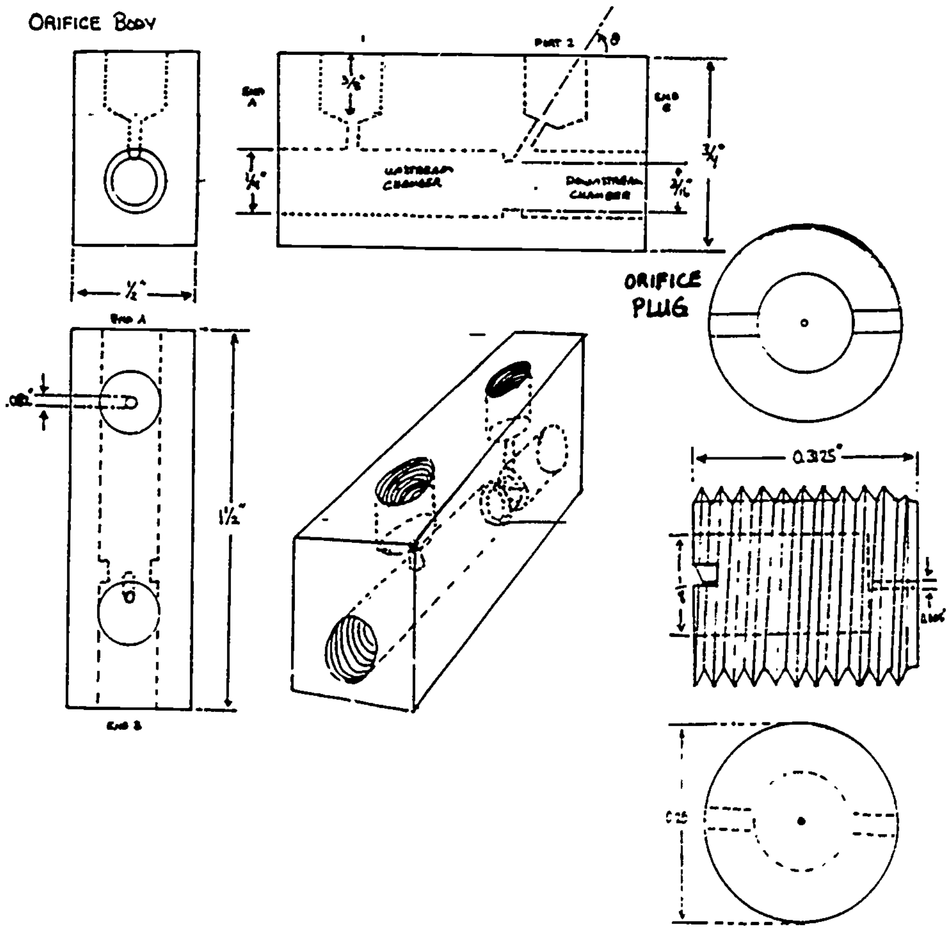
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Gas Orifice Assembly

Item No. 62

MATERIALS

1 - Orifice plug, preferably brass
4 - 1/4" NPT brass adaptors
1 - Orifice body, plexiglass or acrylic plastic
1 - Plexiglass tube 2" ID x 24" - 1/8" wall thickness recommended. Tube should be drilled and tapped within 2" of the bottom to receive a 1/4" NPT tubing barb.
1 - 3" square glued to top of tube--drilled and taped for 1/4" NPT
2 - 1/4" NPT tubing barb
1 - Plastic tray or pan 4" - 5" deep with 6" wide x 9" long dimensions



ADDITIONAL DATA AND INSTRUCTIONS ON BACK OF PAGE.

PREPARATION OF ORIFICE BODY

Need 1 rectangular plexiglass rod 1/2" w x 3/4" h x 1 1/2"

1. Drill a pilot hole 1/8" diam through the length (1.5")of the block. The hole is not to be centered. This hole should be located 1/4" from 3 sides of the face and 1/2" from the remaining side.
2. Counterbore with 3/16" diam completely through length.
3. Drill and tap for 1/4" - 28 SAE from one end (End A) to a depth of 9/10".
4. Drill and tap for 1/4" - NPT from other end (End B) to a depth of 2/5".
5. Drill 2 pilot holes on the top 1/2" x 1 1/2" face with a 1/8" diam bit to a depth of 3/8". Port 1 should be 0.375" from End A and centered on the 1/2" width. Port 2 should be 0.300" from End B and centered on the 1/2" width.
6. Drill and tap for 1/4" - NPT to a depth of 1/4" for each port.
7. Use a #45 drill (0.082" diam) to drill a hole on center of Port 1 to intersect upstream chamber.
8. Use a #45 drill to drill a 63 degree angle to intersect downstream chamber near orifice plug.

NOTE: Tubing barbs for 1/4" holes come with NPT thread, not with SAE thread. Three of your ports have NPT, one has SAE. Once the orifice plug is installed you may find it necessary to insert an adaptor that would have male 1/4" 28-SAE on one end and female 1/4" NPT on the other.

PREPARATION OF ORIFICE PLUG

Need brass rod 0.25" diam.

1. Run rod through die to thread for 28 turns per inch for a depth of 0.35".
2. Bore from end on center 1/8" diam x 0.25" deep.
3. Counterbore with #97 drill (0.005" diam) to a depth of 3/32".
4. Cut off rod to length of 0.3125".
5. Clean 0.005" diam hole.

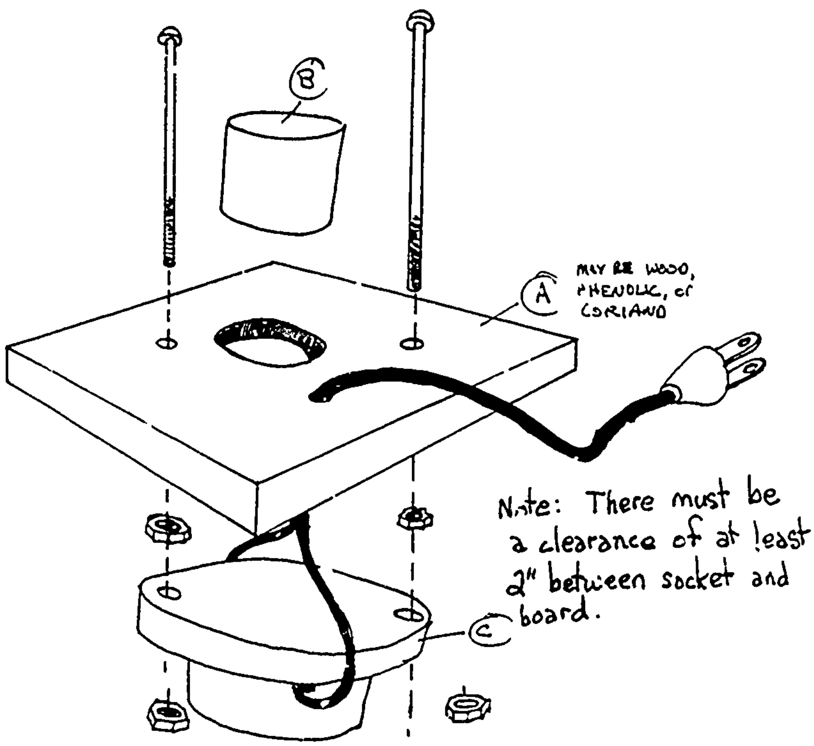
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Heat Transfer Assembly Set — Item No. 68

MATERIALS

For 68A (Used in Lab 3T1)

1 - 7 1/2" to 9" square x 1/2" - 5/8" thick plate (A)
1 - 1" to 1 1/2" diam x 1" long aluminum cylinder (B)
2 - 1" x 3/4" strip of metal tape (aluminum)
1 - Lamp socket subassembly (C)
1 - Standard base 100 W light bulb (D)
1 - AC patch cord wired to the lamp socket subassembly



NOTE:

For lab 3T1, you should run the lamp at full voltage, from the power supply, for no more than 4 minutes. After 4 minutes readjust the power supply AC output to approx. 20% of full setting. Note also that we now recommend the use of a 100 watt lamp instead of the 600 watt heater.

MAKE NOTE OF THESE RECOMMENDATIONS IN YOUR TEACHER GUIDE

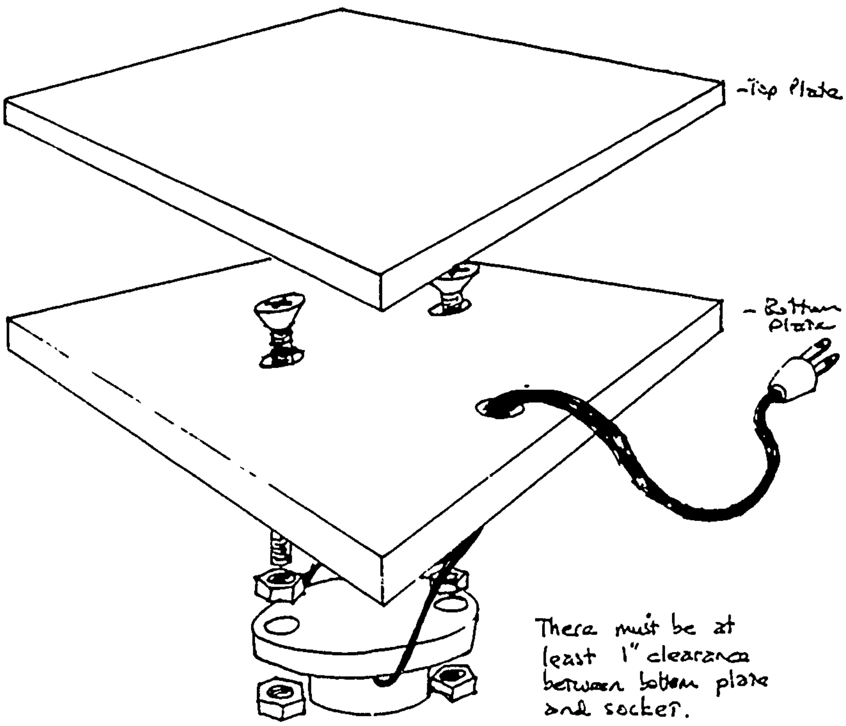
INFORMATION ON 68B ON BACK OF PAGE

MATERIALS

For item 68B (used in Lab 4T1)

2 - Aluminum plates, 3/16" thick x 8" wide x 8" long
  - items from 68A C , D , and F
2 - bolts, 3 1/2" long x 10-32 thread

NOTE: The upper aluminum plate will be untouched except for the edges being deburred and rounded to remove any sharp edges. The bottom aluminum plate will be prepared as shown below.



NOTE:

Once more, for this lab (4T1) we recommend:

1. Replace the 660 watt resistance heater with a 100 watt light bulb.
2. Allow full voltage (110 V AC) to be applied for no more than 4 minutes.
3. After 4 minutes reduce the input voltage to 40% of full.

MAKE NOTE OF THESE RECOMMENDATIONS IN YOUR TEACHERS GUIDE.

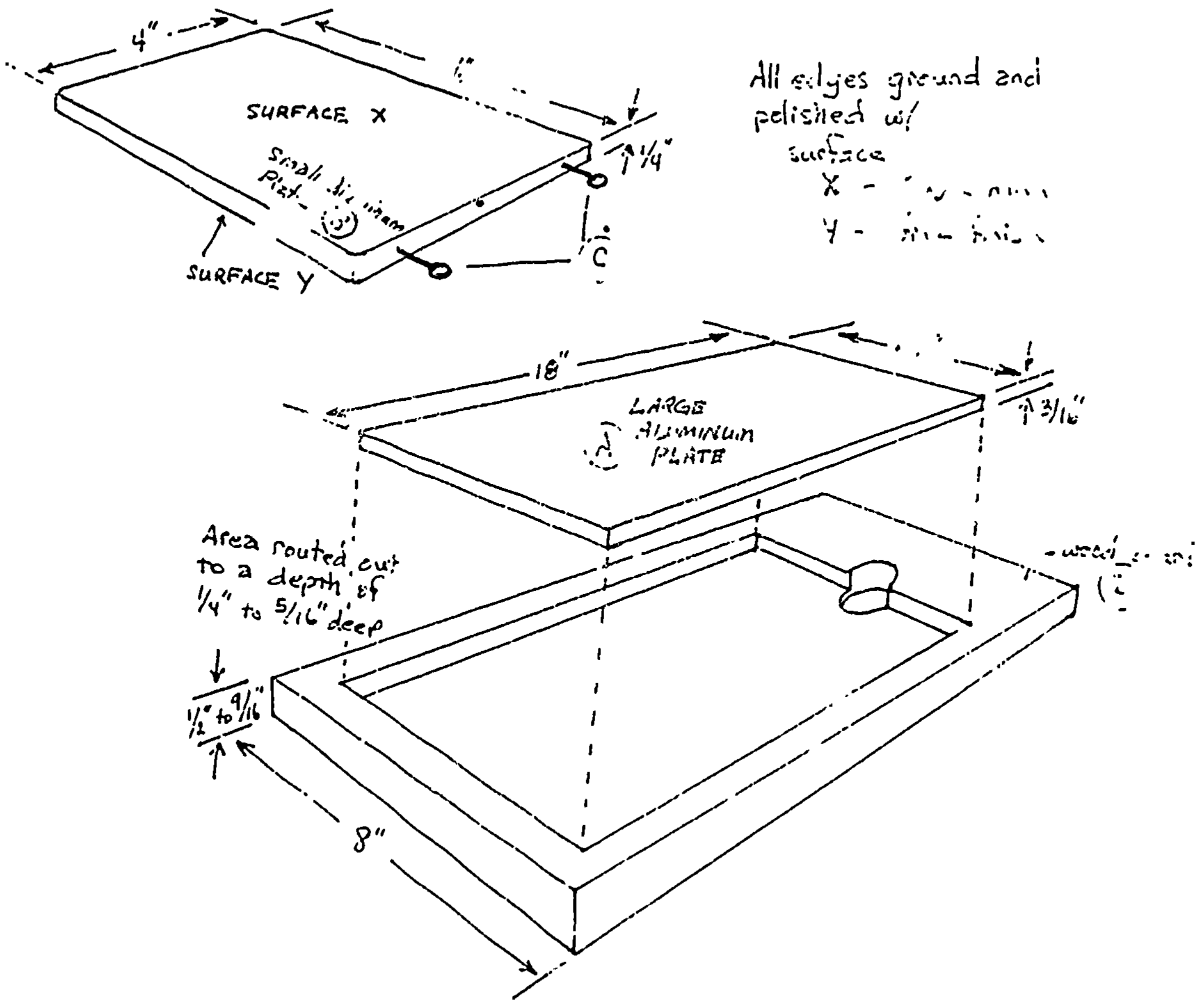
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Friction Plate Assembly   Item No. 71 & 72

MATERIALS

1 - Lg. aluminum plate, 6" x 18" x 3/16", (A)
1 - Sm. aluminum plate, 4" x 6" x 1/4", (B)
2 - Minature eye screws (C)
1 - Wood board, 8" x 24" x 1/2" to 9/16" (D)



12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

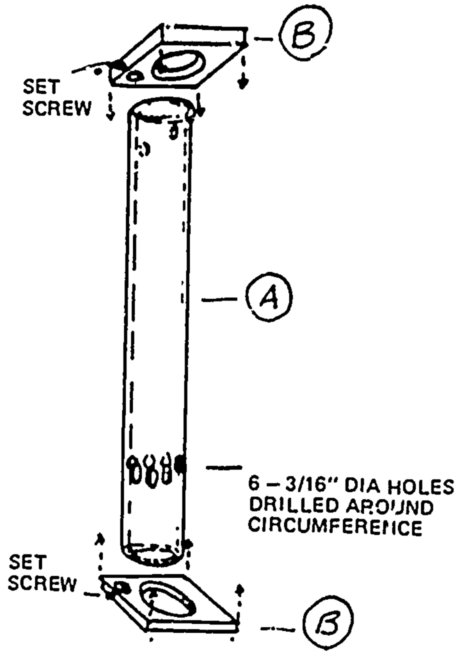
Item Name: Air Flow Assembly Item No. 73

MATERIALS

1 - 36" long x 2" id tube, plexiglas Ⓐ
2 - 4" x 4" squares, plexiglas with 1-2" diam hole drilled on center in each, 1/4" thick. Ⓑ
3 - Flow objects (item no. 74)
These objects are to be made of wood or plastic, 3-shapes. Each shape w/ the same cross-sectional diam (d).
NOTE: The value (d) must be between 70% and 80% of the value of the cross-sectional diam of the unrestricted flow tube. Thus d = 1.4" to 1.6"

CONSTRUCTION

Glue squares at each end of the tube so that holes in squares coincide with that of the tube.
Squares should have 3/8" diam hole drilled in one corner of each square and aligned to the same side. These holes should be drilled and tapped for set screws.



USE NOTE:

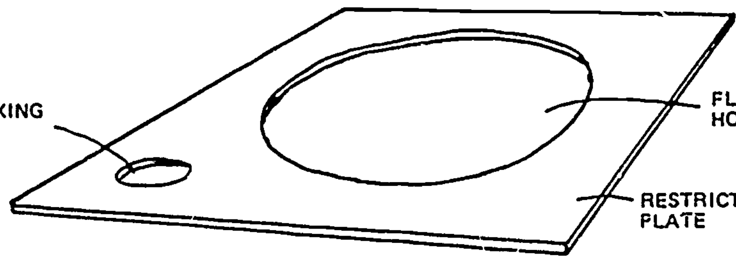
Use a spring balance (0-5 N range). Suspended it above air flow apparatus. The with a length of monofilament line connect the spring balance and drag objects.

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Flow Restrictor Set Item No. 79

MATERIALS

8 - 4" x 4" x 1/32" aluminum plates



CONSTRUCTION

[illegible]ach of the 8 plates is identical except for the size of t[illegible] flow hole. The diam of the flow hole in each plate is calculated to be a percent of the cross-sectional area of the unrestricted air flow device. The relationship of diam to the percent of cross-sectional area is shown by the following chart.

% of OPEN AREA	DIAMETER MULTIPLIER
100%	D
90	[illegible]95 D
80	[illegible] D
70	[illegible] D
60	[illegible] D
50	[illegible]
40	[illegible].63 D
30	[illegible].55 D
20	[illegible].45 D

NOTE: The diam multiplier has been rounded off to only 2 places, thus the true percent of open area resulting is in error by 0.6% at worst.

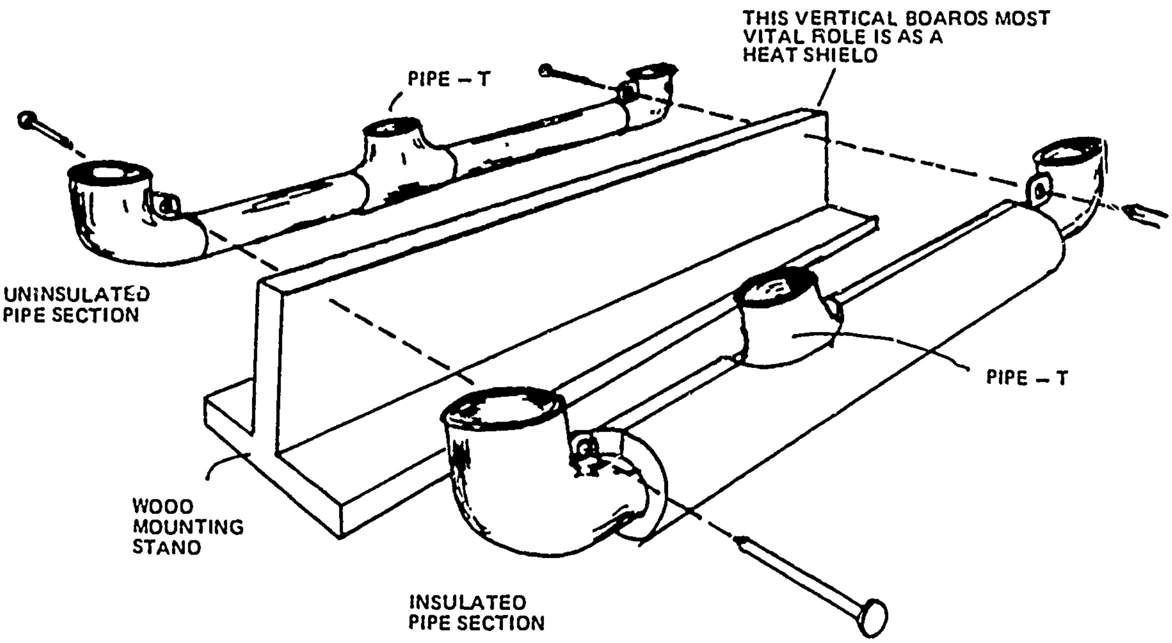
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Thermal Pipe Assembly Item No. 85

MATERIALS

4 - tubes, copper, 16" long x 1" diam
2 - pipe tees, copper
4 - pipe elbows, copper
1 - thermal insulation 34" long tube for 1" diam pipes
1 - wood mounting stand



12/01/86

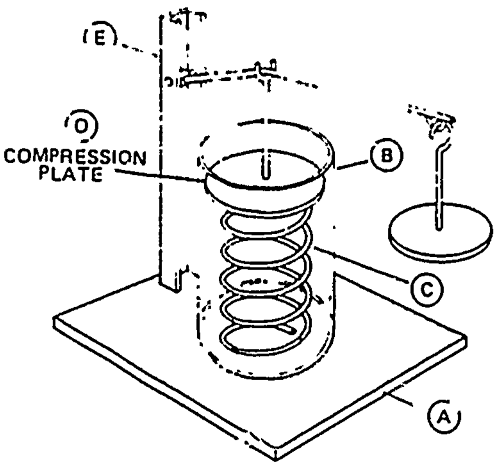
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Spring Test Assembly Item No. 87

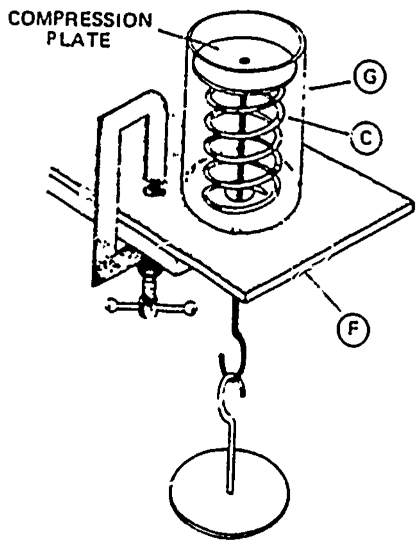
MATERIALS

For Design A
- 1 - Base, 4" x 4" x 3/4" wood Ⓐ
- 1 - Tube, 2" diam x 5" tall Ⓑ
- 1 - Spring, coil type, 1 7/8" diam x 3 1/2" long Ⓒ
- 1 - Compression plate, circular disk 1 15/16" diam x 1/4" aluminum with vertical 3" long rod mounted on center (rod diam 1/4") Ⓓ
- 1 - Vertical support rod with lever arm Ⓔ

For Design B
- 1 - Base, 6" x 4" x 3/4" wood Ⓕ
- 1 - Tube, 2" diam x 5" tall Ⓖ
- 1 - Spring, coil type (same as "C" above)
- 1 - Compression plate (same specs as "D" above except vertical rod must be 5" to 6" long).



DESIGN A



OES.GN B

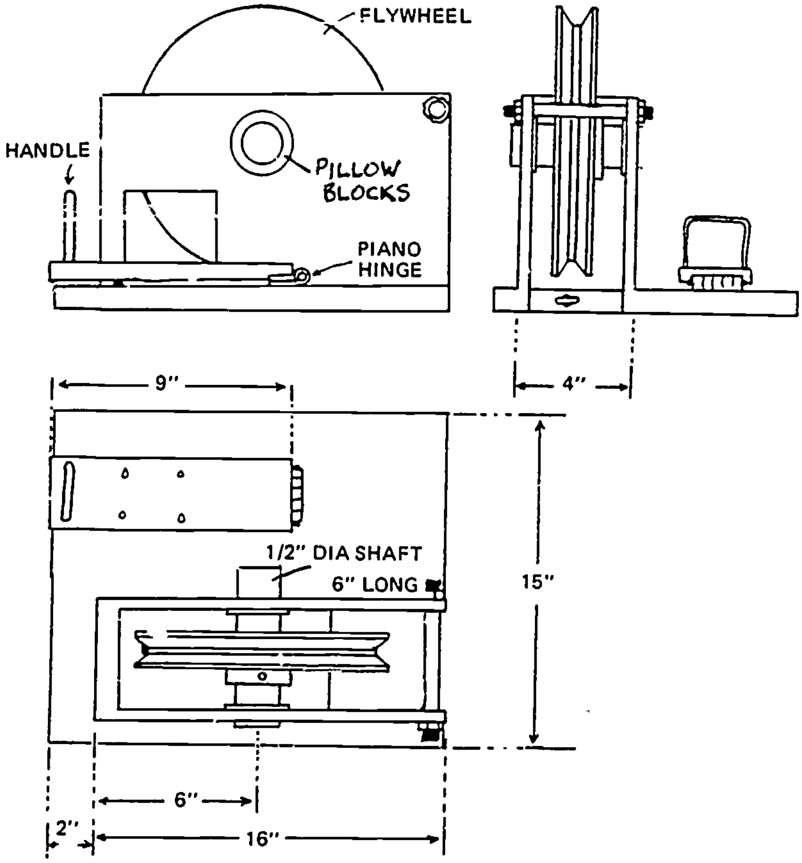
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Flywheel Assembly Item No. 88

MATERIALS

Base 5/8" t x 15" x 18" plywood
Sides - 1/2" t x 16" x 12" plywood
Lever - 1/2" t x 9" x 4" plywood
Piano hinge 3" wide
Flywheel - cast iron pulley sheave 8-10" diam x 3/4" wide with weight of 4 to 5 lb
Shaft - 1/2" diam x 6" long
Threaded bolt 5" long x 1/4" diam
2 - Pillow block with bearings for 1/2" diam shaft
Eye screw 3/4" long - wood screw



ADDITIONAL INFORMATION ON BACK OF THIS PAGE.

12/01/86

All materials listed below are referenced to W.W. Grainger, Inc., cat. #367

Pulley sleeve, 8 1/4" diam	stk # 3X598	$19.73 ea
Bushing set, for 1/2" diam shaft malleable split type	stk # 3X884	6.64 set
Pillow block set Ball bearing for 1/2" diam shaft	stk # 1A396	16.94 set
Shaft collars	stk # 2X568	.59 ea

12/01/96

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Hydraulic Flow and Shock Assembly   Item No. 91

MATERIALS COST OF ACCUMULATOR DEVICE

Item-Description	Cost Each	Number Needed	Total Price
Adaptor, garden hose to 1/2" pipe thread	1.80	2	3.60
Adaptor, 1/2" pipe thread to 1/2" pipe slip	0.33	12	3.96
Adaptor, 1/2" pipe thread male to 1/4" NPT female	0.99	2	1.98
Valve, gate type with 2 female 1/2" pipe thread	7.90	1	7.90
Valve, ball type with 2 slip PVC	2.99	1	2.99
Tee, PVC with 3 female 1/2" pipe thread	0.59	3	1.67
Pipe nipple 1/2" male to male PVC	0.80	1	0.80
1/2" PVC schedule 40 x 24" long	0.80	1	0.80
1/2" vinyl tubing	0.8t/ft	1/3 ft	0.29

TOTAL MATERIALS COST $31.99

The prices lsited are retail prices in Waco, Texas. Prices for Teflon pipe tape and PVC pipe cement are not included--nor the cost of assembly in labor.

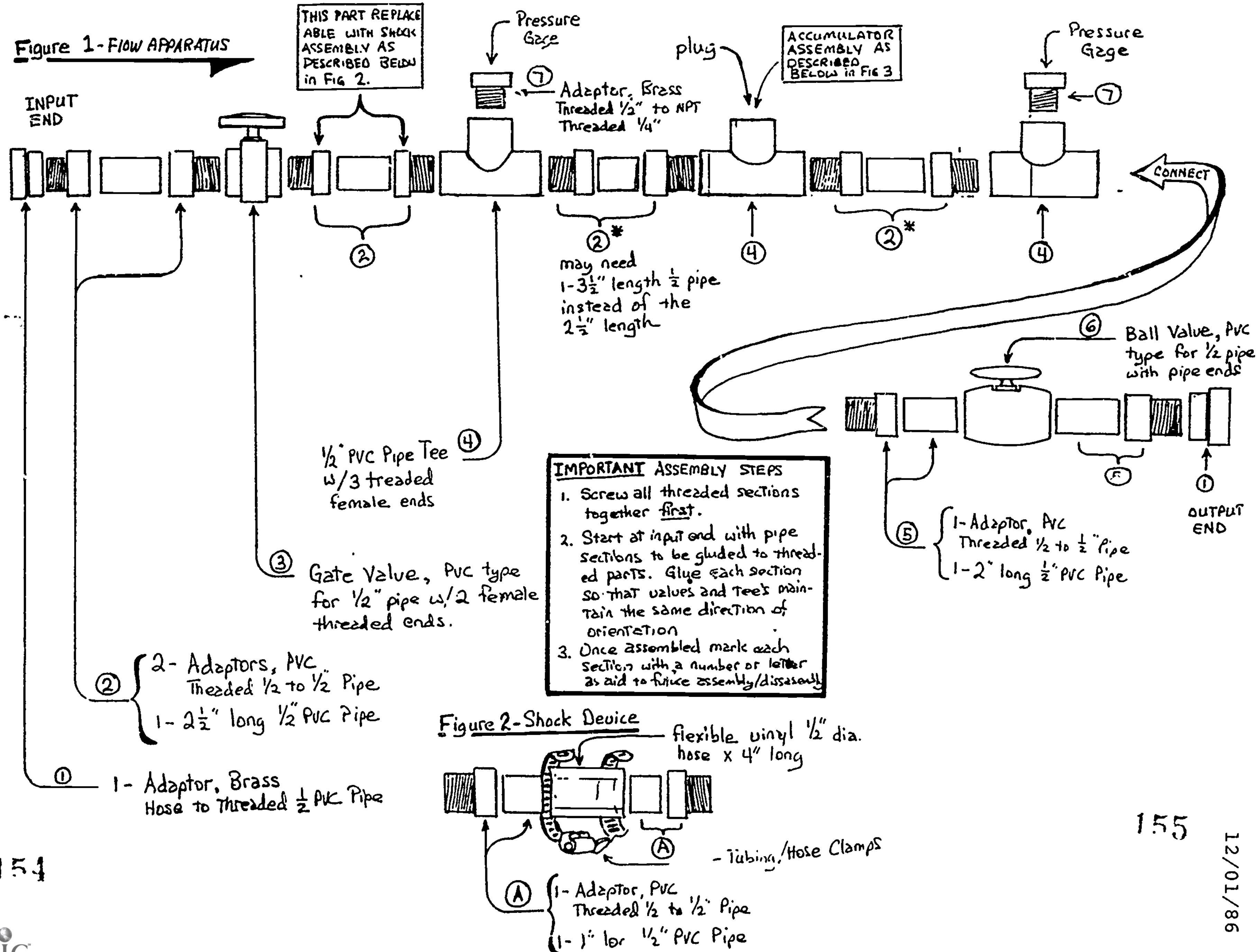


Figure 1 - FLOW APPARATUS
INPUT END
THIS PART REPLACEABLE WITH SHOCK ASSEMBLY AS DESCRIBED BELOW in FIG 2.
Pressure Gage
7 Adaptor, Brass Threaded 1/2" to NPT Threaded 1/4"
plug
ACCUMULATOR ASSEMBLY AS DESCRIBED BELOW in FIG 3
Pressure Gage
CONNECT
2* may need 1-3½" length ½ pipe instead of the 2½" length
6 Ball Value, PVC type for 1/2 pipe with pipe ends
1/2" PVC Pipe Tee w/3 treaded female ends
IMPORTANT ASSEMBLY STEPS
1. Screw all threaded sections together first.
2. Start at input end with pipe sections to be gluded to threaded parts. Glue each section so that values and Tee's maintain the same direction of orientation
3. Once assembled mark each section with a number or letter as aid to future assembly/dissasembly
5 1-Adaptor, PVC Threaded 1/2 to ½ Pipe; 1-2" long ½" PVC Pipe
1 OUTPUT END
3 Gate Valve, PVC type for 1/2" pipe w/2 female threaded ends.
2 2- Adaptors, PVC Theaded 1/2 to 1/2 Pipe; 1- 2½" long 1/2" PVC Pipe
1 1- Adaptor, Brass Hose to Threaded ½ PVC Pipe
Figure 2 - Shock Device
flexible vinyl 1/2" dia. hose x 4" long
- Tubing/Hose Clamps
A 1- Adaptor, PVC Threaded 1/2 to 1/2" Pipe; 1- 1" lon 1/2" PVC Pipe

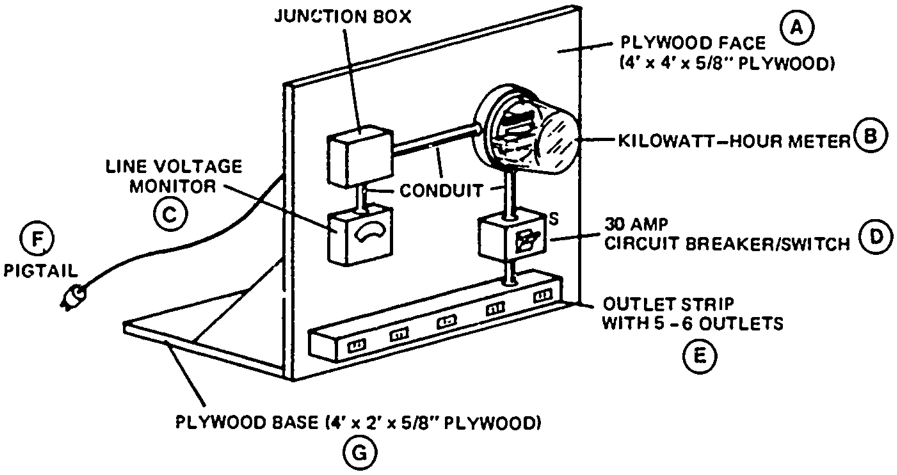
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Kilowatt-hour Meter Assembly Item No. 98

MATERIALS

2 - 4'w x 5/8" x 4' long plywood (A) & (G)
1 - Kilowatt-hour meter base socket
1 - Kilowatt-hour meter (B)
1 - Line voltage monitor (C)
1 - 30-A circuit breaker/switch (D)
1 - multiple outlet strip (with 5 or 6 outlets) (E)
1 - Pig tail connector (3-wire) (F)
- Conduit and junction boxes



156

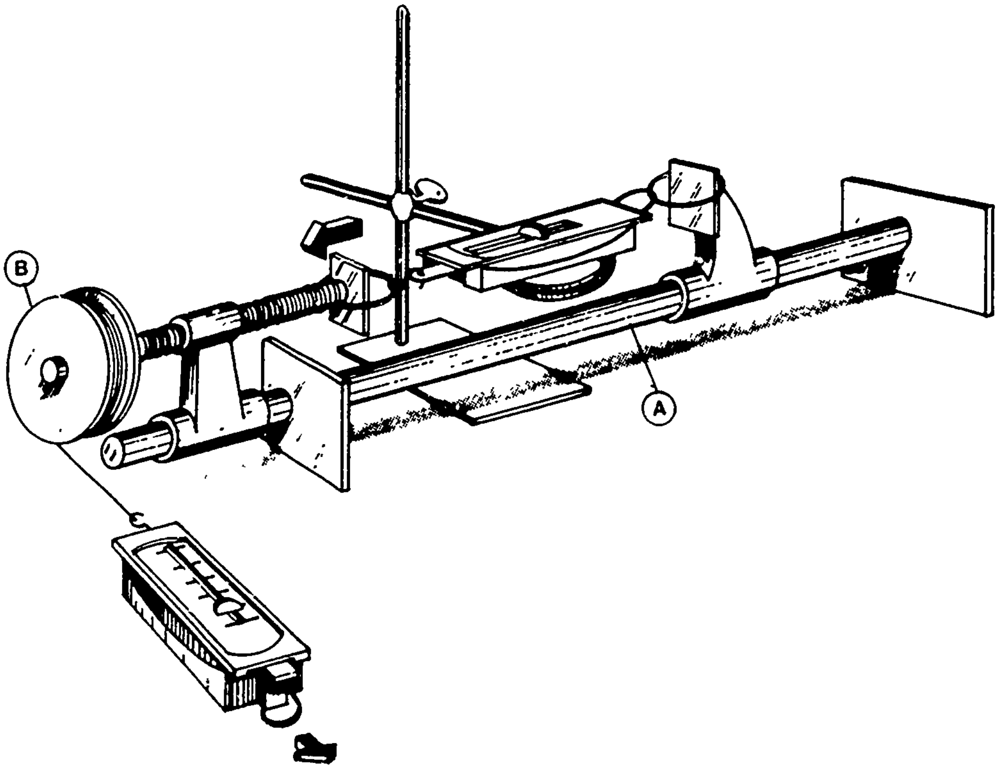
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Pipe-Clamp Assembly   Item No. 101

MATERIALS

1 - 1" diam x 4' long iron or steel pipe (A)
1 - set of bar clamps, one end with adjustable screw mechanism
1 - 8" diam disk (B)



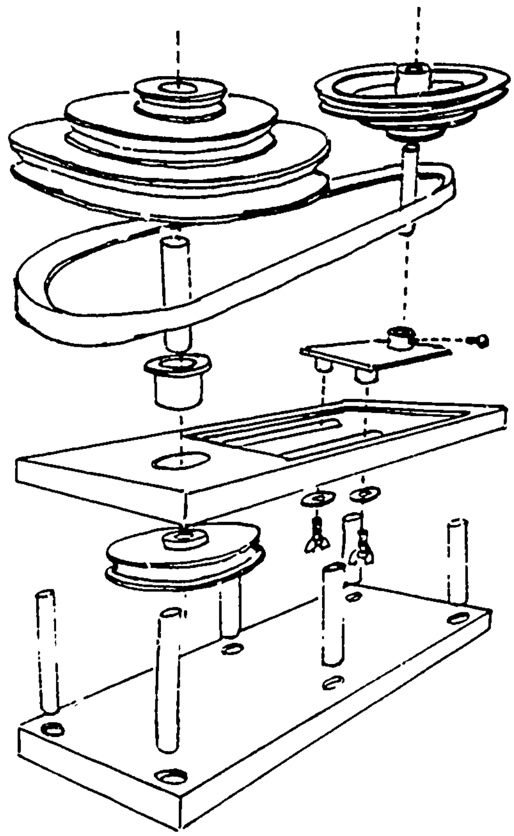
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Belt Drive Trainer   Item No. 104

MATERIALS

2 - Multiple step pulleys, V-belt type
2 - Shafts - 12 mm diam
2 - Plywood Boards 6" w x (1/2" - 5/8") t x 22" long
6 - 1" diam x 4" long wood dowels
1 - V-belt to fit
1 - Fixed bearing assembly
1 - Movable bearing assembly
2 - Timing belt pulleys
1 - Timing belt



The two multiple-level pulleys can be removed along with the V-belt and the cogged wheels with cogged belt replace these on the same shaft.

Specifications for the timming belt and the timming belt pulley are from Stock Drive Products. SEE ITEM NO. 201 for information on these.

3 mm pitch	3 mm pitch
300 mm length	Double flange
100 grooves	8.3 cm diameter flange
9 mm width	12 mm bore
	80 grooves
	22 mm width

12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

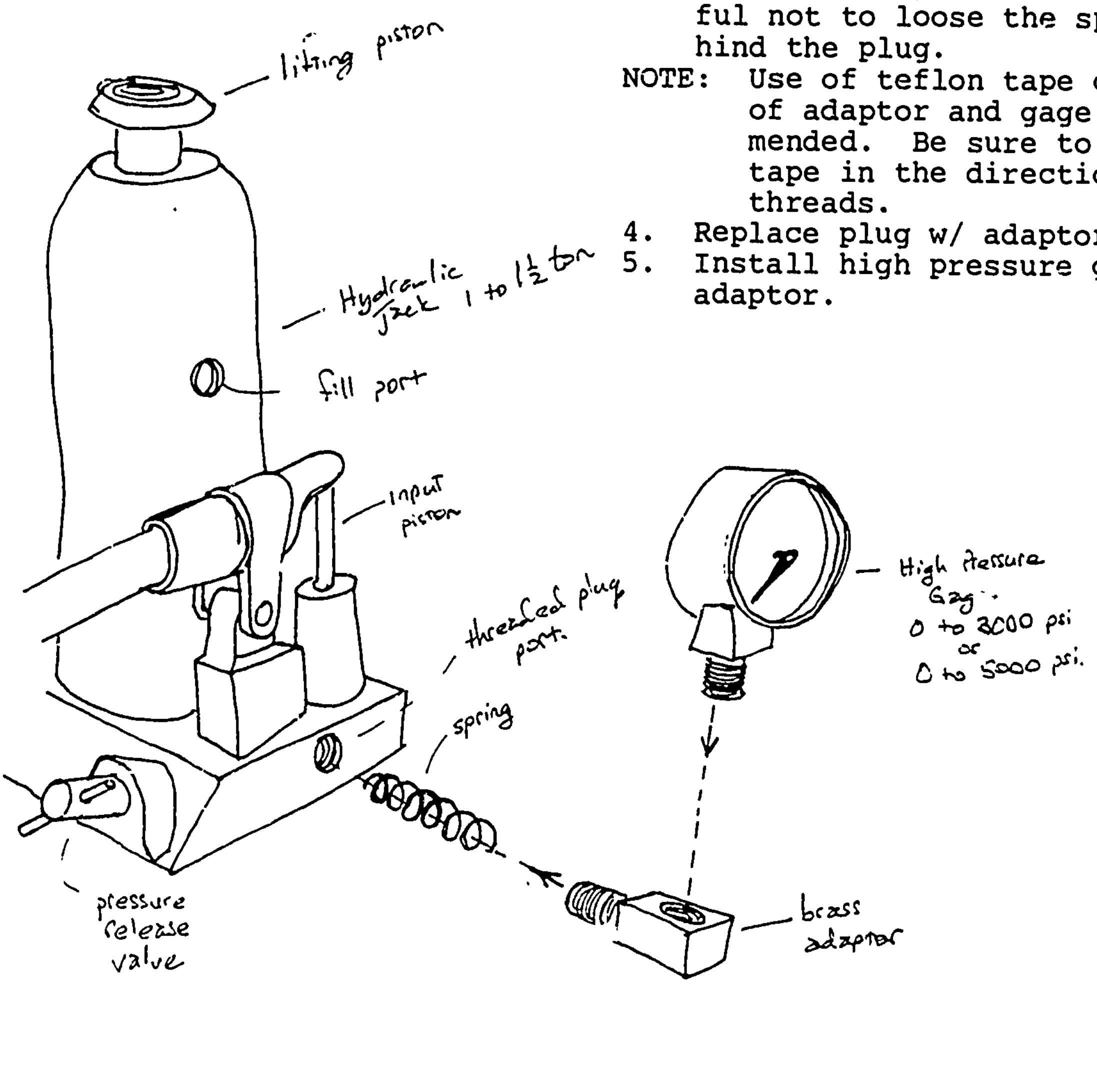
Item Name: Hydraulic Jack   Item No. 105

INSTRUCTIONS FOR MODIFICATION

1. Open pressure release valve.
2. Lay jack on side w/ plug port up.
3. Remove threaded plug in the base of the jack. Be very careful not to loose the spring behind the plug.

NOTE: Use of teflon tape on threads of adaptor and gage is recommended. Be sure to wrap tape in the direction of the threads.

4. Replace plug w/ adaptor.
5. Install high pressure gage on adaptor.



NOTE: On some hydraulic jacks there is a rubber or plastic seal behind the threaded base plug. This must also be removed, but do so with care.

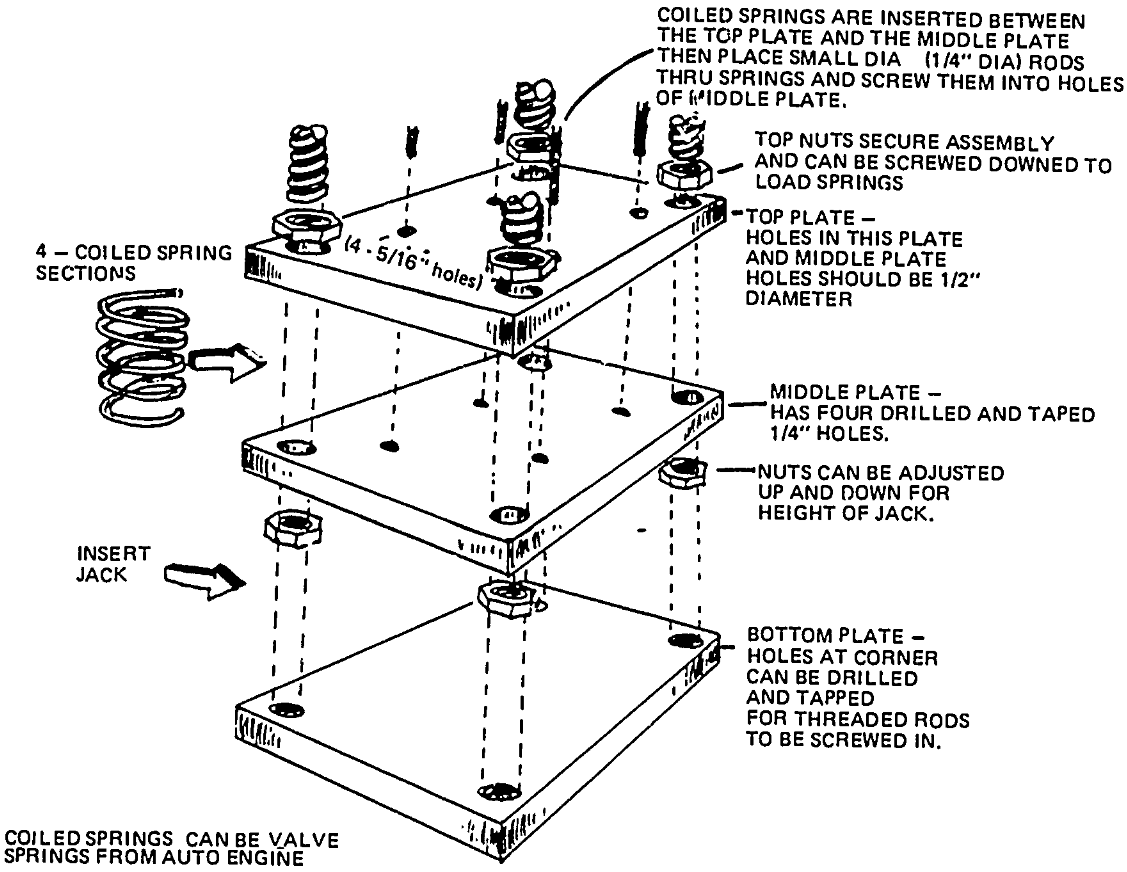
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Pressure Stage — Item No. 106

MATERIALS

3 - 1/2" t x 3" d x 4" long (minimum)
4 - 3/8: diam x 16" long threaded rods
16 - Heavy-duty nuts
2 - Strong coiled springs
4 - 1/4" diam x 8" long threaded bolts



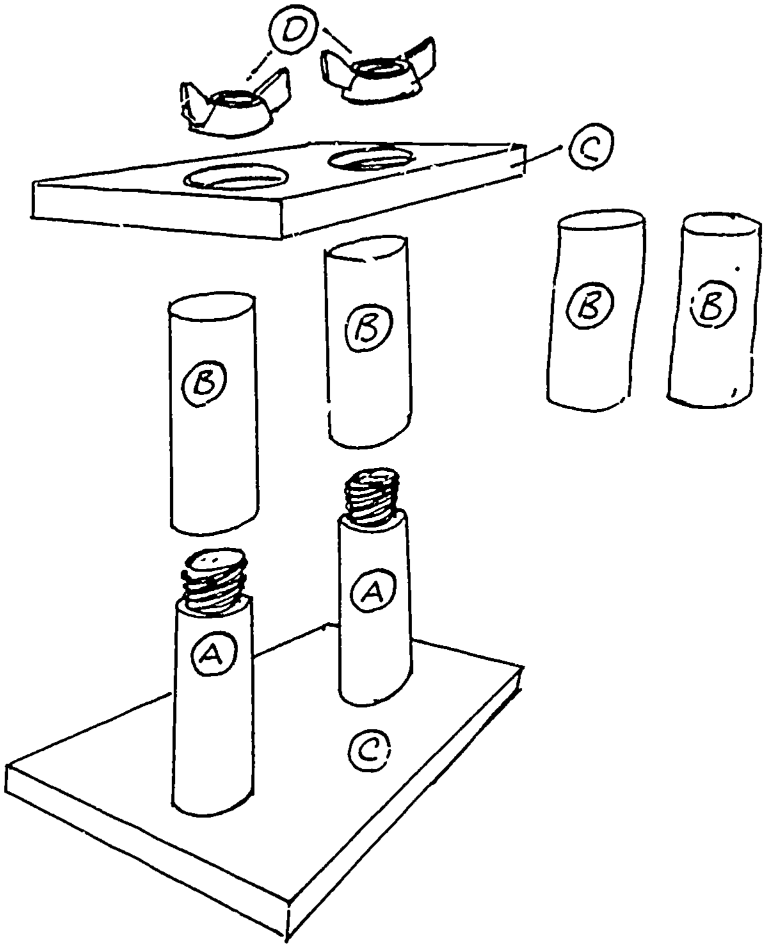
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Transformer Assembly Item No. 108

MATERIALS

2 - 4" long x 1/2" diam steel bolts Ⓐ
4 - 3" long x 1/2" diam plastic tubes Ⓑ
2 - 3/16" t x 4" long x 3" w soft iron plates Ⓒ
2 - Wing nuts Ⓓ



NOTE: Weld bolts to bottom plate
with centers 2 1/2" apart.

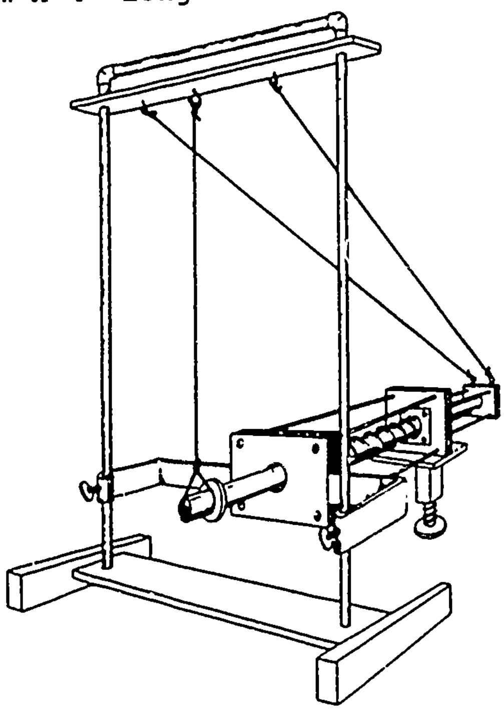
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Impulse Measurement Assembly Item No. 200

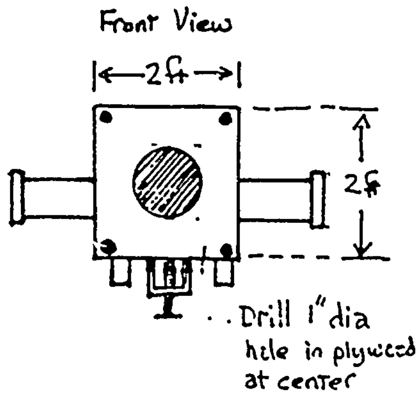
MATERIALS

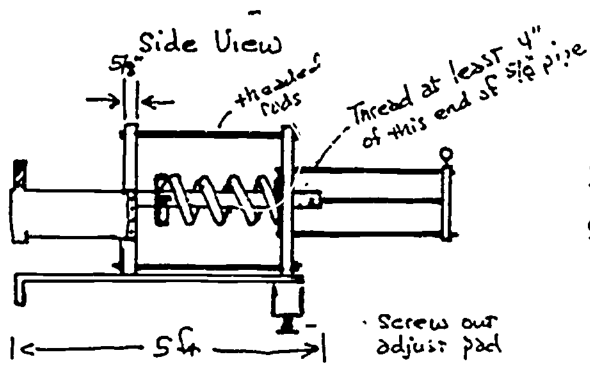
2 - 2' x 2' x 5/8" t plywood board
1 - 7/8" id steel pipe x 5' long
1 - Impact plate, 6" diameter steel x 3/8" t
1 - 1' x 1' x 5/8" t plywood board
Coil Spring - 3" to 5" diam x 12" x 18" long must be able to withstand 185 to 220 ft-lb energy
8 - 7/16" diam threaded rods 3 ft long
32 - steel washers 1" diam with 7/16" hole
48 - nuts 7/16" diam hole
1 - steel plate 3/16" x 1' square
2 - eyebolts 3/16" diam
2 - threaded collars for od of 5/8" diam pipe
1 - smooth steel pipe 1/2" diam x 4' long
2 - steel support arms
2 - steel support legs
1 - adjustable height leg
6 - 1/4" balls, steel



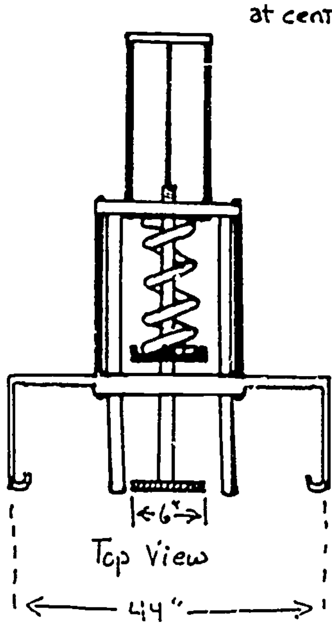
NOTE: This assembly is intended as an accessory to the heavy-duty support stand (item no. 1). Dimensions and configuration may need to be different due to support and coil spring actually on hand.

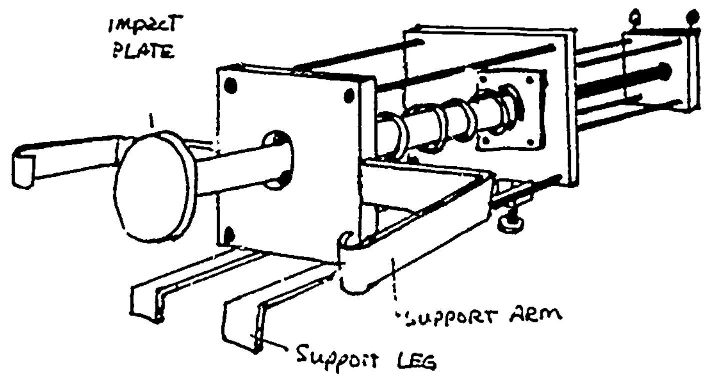
FIGURES AND ADDITIONAL DATA ON THE BACK OF THIS PAGE.





FIGURES
ARE NOT
DRAWN TO
SCALE





12/01/86

Information on materials for preparing your own spring.

Use #312 wire
OD of spring 3.2"
ID of spring 2.7"
Length of spring 15" to 18"
Number of coils = 20 to 25
Ground and squar ends.
k = 33 lb/in

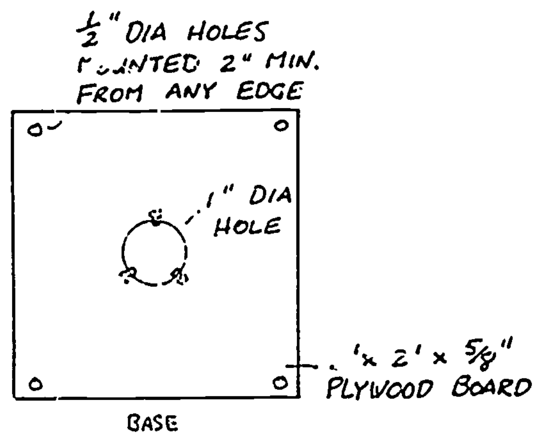
Impact Head Assembly

Weld impact head to one end of 7/8" pipe and thread the last 6"-8" of other end.

For each board: mounting the impact head assembly

* Drill 3 holes 120 apart with a diam of 5/16" and a depth of 3/16".
* Place a number of layers of felt in each hole to reach a thickness of 5/32".
* Liberally coat top layer of felt with graphite.
* Place 1/4" steel balls in holes and hold in place with 6" long strip of tape.
* Insert 7/8" diameter pipe, then remove strips of tape.

The result is that the pipe is suspended and guided by only three points of contact at each board. And these points of suspension are lubricated.



164

12/01/86

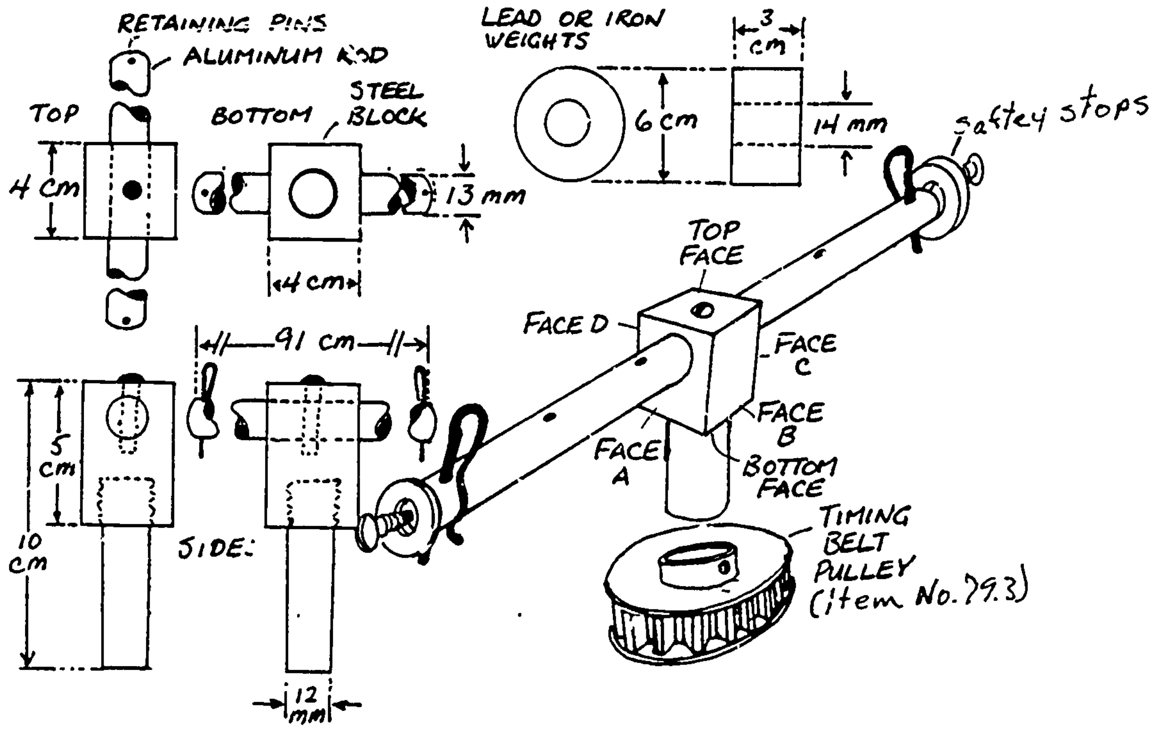
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Moment of Inertia Assembly — Item No. 201

MATERIALS

Steel block, 4 cm x 4 cm x 5 cm
Aluminum rod, 13 mm diam x 91 cm
Steel rod 7 1/2 cm x 12 mm diam
2 - iron (or lead) disk-shpaed weights
4 - retaining pins
2 - Saftey stops

NOTE: DRAWINGS ARE NOT DONE TO SCALE



FABRICATION STEPS AND ADDITIONAL DATA ON BACK OF PAGE.

12/01/86

This assembly is intended as an accessory to the Belt Drive trainer (item 104)

VENDOR REFERENCE SOURCE

Timing Belt Pulleys - double flange

sdp* cat. no. 6Z23M080DF091

flange diam = 8.3 cm	Bore = 12 mm	Width = 22 mm
OD = 7.56 cm	Hub diam = 22 mm	
# of grooves = 80	3 mm pitch	

Lexan reinforced fiberglass with Al insert (knurled)

Timing Belt

sdp cat. no. 6R23M100090
3 mm pitch
300 mm long
Nylon covered, fiberglass reinforced neoprene

Aluminum Rod

Standard support rod from Sargent-Welch
91 cm long x 13 mm diam
cat. no. S-78454-D

*sdp - Stock Drive Products
55 South Denton Ave
New Hyde Park, New York 10040
(516) 328/0200

FABRICATION STEPS

Steel Block

1. Drill a 13-mm diam hole from FACE A to FACE C. Center of hole should be 2 cm from TOP FACE and FACES B and D.
2. Drill and tap a 5-mm diam hole 25 mm deep at center of top face.
3. Drill and tap a 10-mm diam hole 20 mm deep in bottom face at center.

Aluminum Rod

1. Measure to exact center of length of rod and drill an oversized 5 mm hole completely through rod.
2. From edge of hole measure 44 cm down length (in both directions) and drill a 3-mm hole completely through rod.
3. From edge of center hole measure 21 5 cm down length (in both directions) and drill a 3 mm hole completely through rod.

Steel Rod - 10 mm diam

1. Mark one end of rod 2 1/2 cm from the end.
2. Thread rod to this depth.

12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Fluid Momentum Assembly   Item No.: 202

MATERIALS:

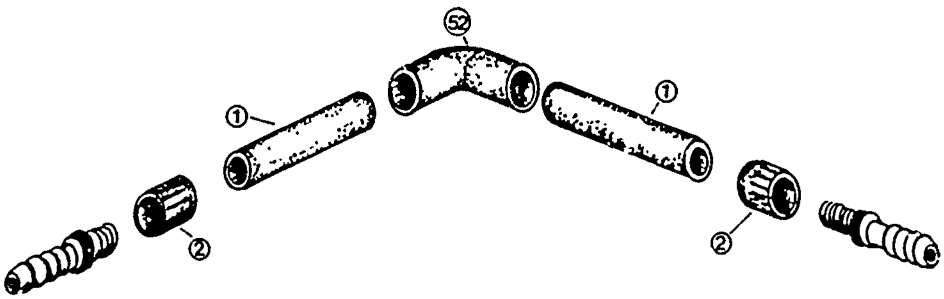
PVC Components; all 1/2" diameter size, all schedule 20
- 4 - Straight pipe sections, 6" long
- 8 - Pipe adaptors, slip to NPT female
- 9 - Tubing barbs, NPT male to barb
- 1 - Air chamber assembly (Item no.20)
- 2 - Elbows: 2-90 , 1-slip type, 1-slip type to NPT male

- 2 - Flexible plastic tubing-accordian pleated 10" long and 1/2" diam
- 8 - Hose clamps; adjustable 7/16" diameter to 1 1/16" diameter
- 4 - Pipe hold-down bracket
- 1 - Compound pressure gage (Item no. 21)
- 1 - Accumulator assembly (Item no. 22)
- \- Assorted wood screws and 1 eye-bolt screw

Wood Components:
- 1 - Mounting base; plywood, 3/8" - 1/2" t x 4' x 2' w
- 2 - Wood dowels; 1/4" diameter x 12-14" long
- 2 - Wood blocks; both 1" tall x 3/4" thick, 1 - 3" , 1 - 6"

CONSTRUCTION DETAILS:

I. Reaction Components



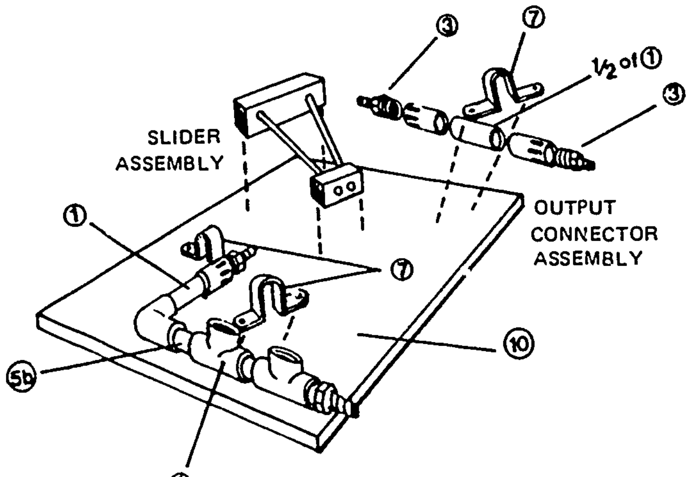
a. 90° degree bend types

ADDITIONAL FIGURES ON BACK OF PAGE.

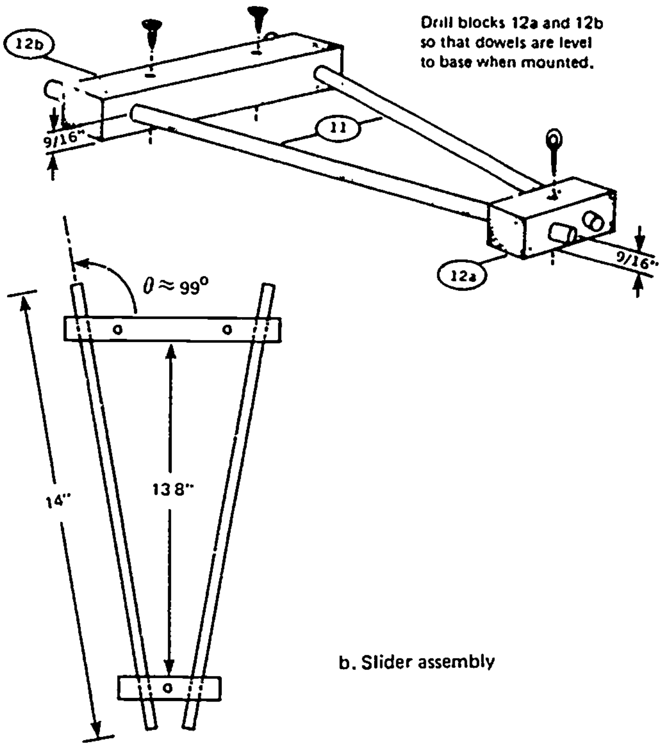
167

II. Work Base

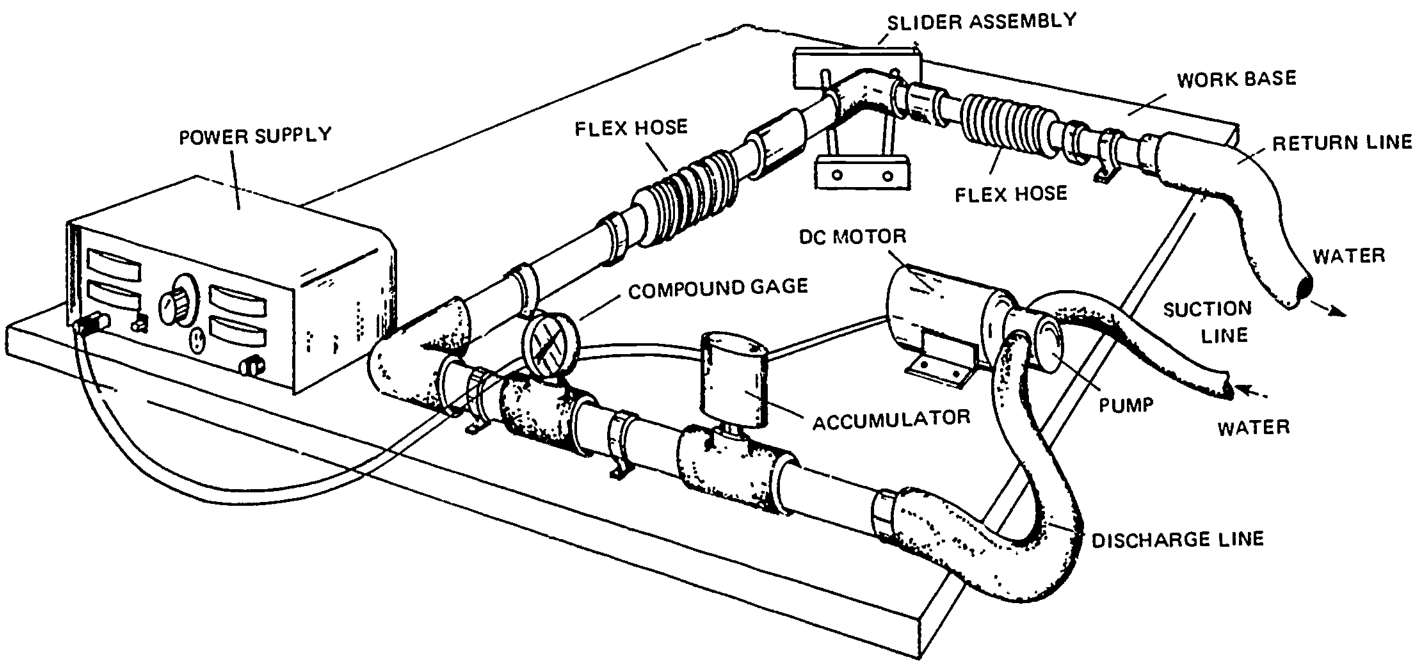
The flex hose is available from:
Nautical Rubber Corp.
Okland Center
8980 Route 108
Columbia, MD 21045
at a cost of $0.89 per foot of 3/4" o.d. "bilge hose".



a. Composite



b. Slider assembly



168

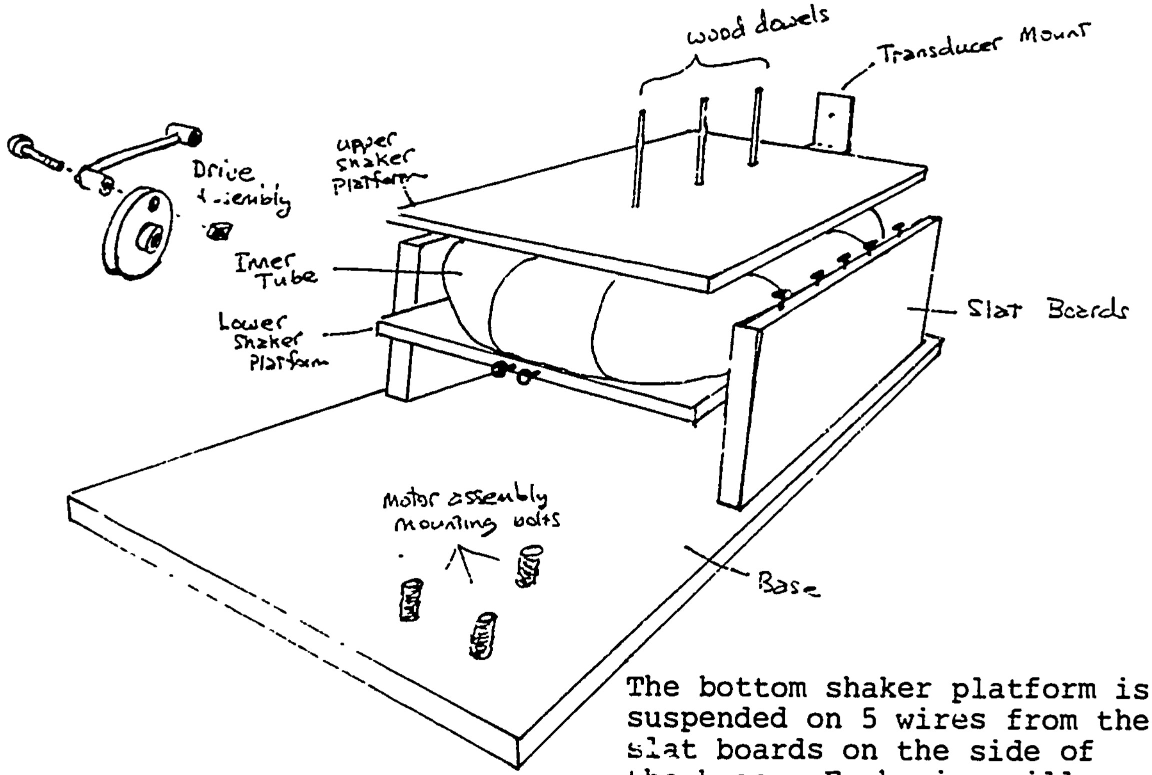
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Mechanical Shock Assembly   Item No. 206

MATERIALS

Wood base, 24" x 18" x 5/8" plywood
2 - shaker platforms 12" x 12" x 1" plywood
Air inner tube (12" od max)
Steel wire, high tensile - 1 mm diam
2 - transducer mounts
Motor connector assembly
Mounting hardware
Wood dowel 5/16" diam x 14"
2 - wood slat boards 8" x 10" x 1"
Aluminum disk 2" diam x 3/16" thick with 3/4" x 9/16" diam hub
Brass tubes 3/16" id x 1/2" long
Brass rod 1/8" diam x 4 5/8" long



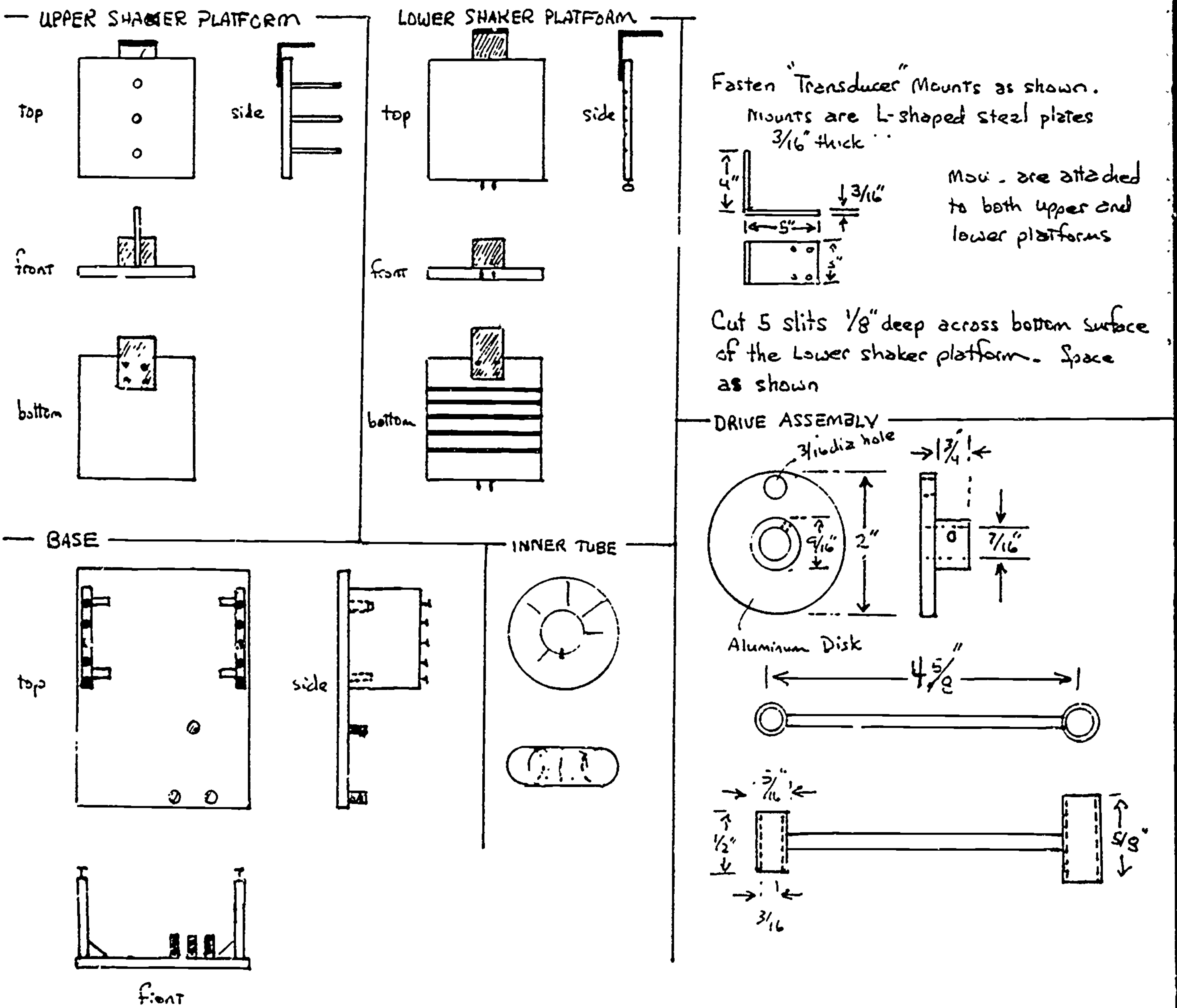
The bottom shaker platform is suspended on 5 wires from the slat boards on the side of the base. Each wire will need to be 25" long.

ADDITIONAL FABRICATION AND ASSEMBLY INFORMATION ON BACK OF PAGE

NOTE: An alternative way to induce vibrations is to use a cam drive.

The 2" diam x 3/16" thick disk can act as the cam. The 3/4" x 9/16" diam hub can be mounted off-center. This hub should be mounted no more than 1/4" off-center. When the slug is mounted to the motor shaft and placed so that only the circumference of the disk is in contact with the bottom shaker platform a cam action occurs.

Be sure that the cam (off-center disk) contacts the bottom shaker platform where the axis of rotation (the motor shaft) and the circumference (the edge of the disk) are in closest approch.



12/01/86

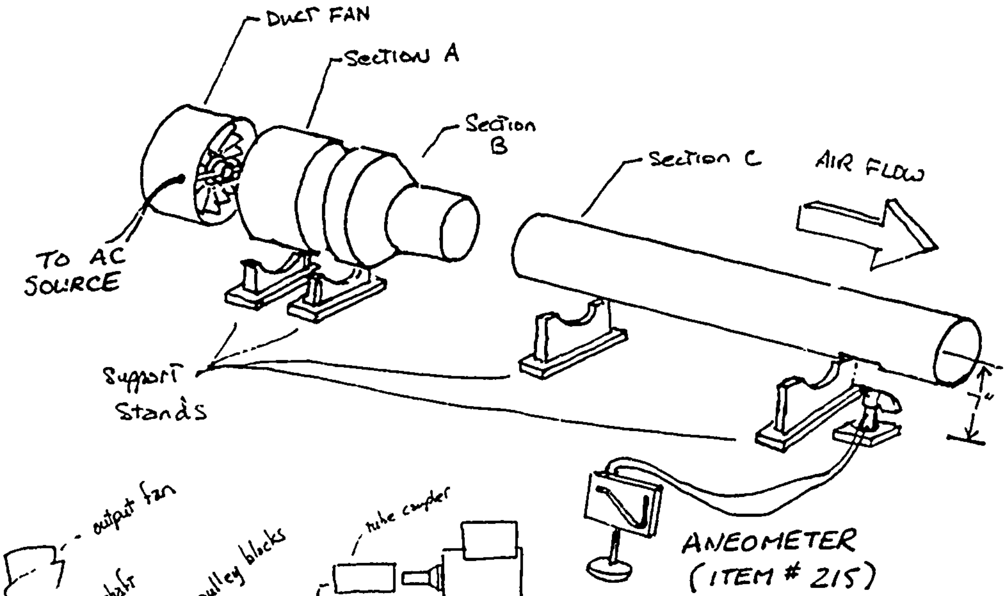
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

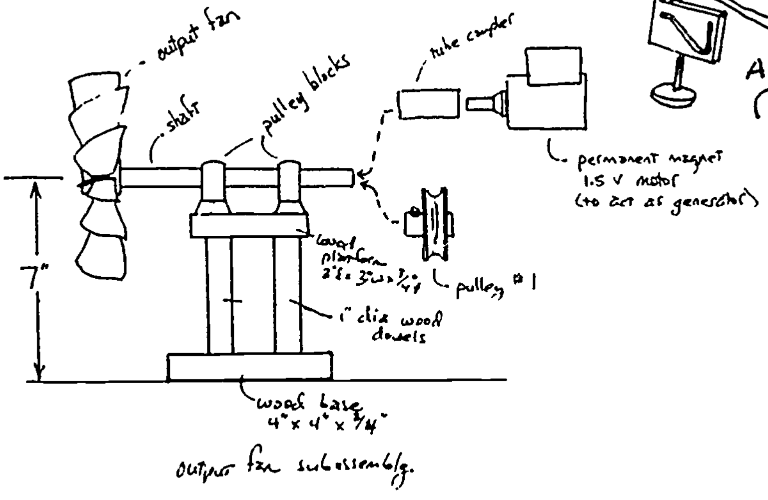
Item Name: Wind Generator Assembly | Item No. 214

MATERIALS

Duct fan - 10" diam
Duct section A - 10" diam x 2' long
Duct section C - 8" diam x 5' long
Duct reducer (section B) - 10" to 8" diam
Duct tape
Support stands - made of wood
Bands
Output fan subassembly

Optional
38' x 1" id PVC pipe
PVC pipe cement





Apparatus must be built so center of flow is 7" above table top.

Output fan subassembly is constructed so axis of fan rotation is also 7" above table top.

12/01/86

Duct Fan and Output Fan Referenced
from W.W. Graingers, Inc.

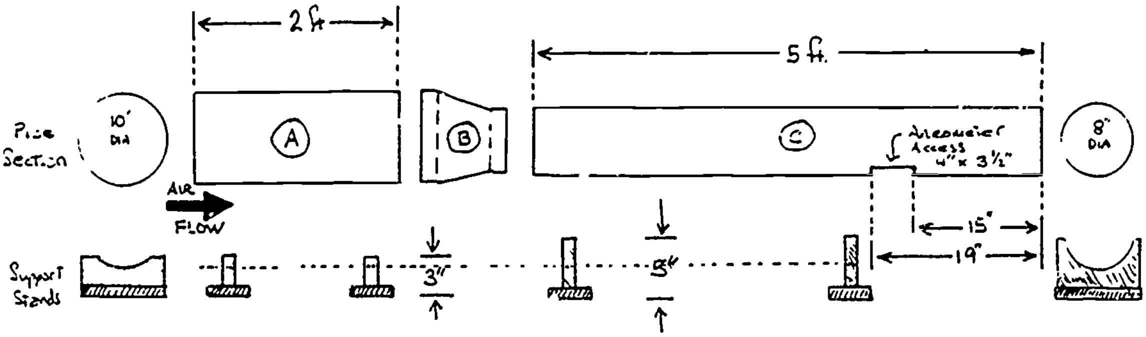
Duct fan - 10" diam with 1/100 hp motor 300 CFM at 0.73 A draw
Stock no. 2C222
Output fan - 7" diam with 5 wings of Al Stock no. 4C473

Output fan connecting shaft and pillow block referenced
from Stock Drive Products

1/4" diam shaft (0.2497" diam) 12" length, cat. no. 7X1-08120
Pulleys for round belts
#1 - 1/4" bore, 1" od with 5/8" hub diam,
cat. no. 6T10-1241008
#2 - 3/16" bore, 1" od with 5/8" hub diam,
cat. no. 6T10-1241006
Round belt
1/8" diam x 8" loop diam, cat. no. 6R11-04080
Two pulley blocks
1/4" bore with mounting holes 1 1/2" apart,
cat. no. 7Z6-F2208
Shaft collar
1/4" bore, 1/2" od, 9/32" wide with #10-24 x 1/8" set screw,
cat. n. 7C2-11608

Output generator
Small 1.5 VDC permanent magnet motor or a bicycle generator
coupled to output fan shaft.

NOTE: The 10" & 8" diam ducting is the most difficult thing to find and presents a hazard because of the sharpness of the edges. It would be possible to use PVC sewer pipe.



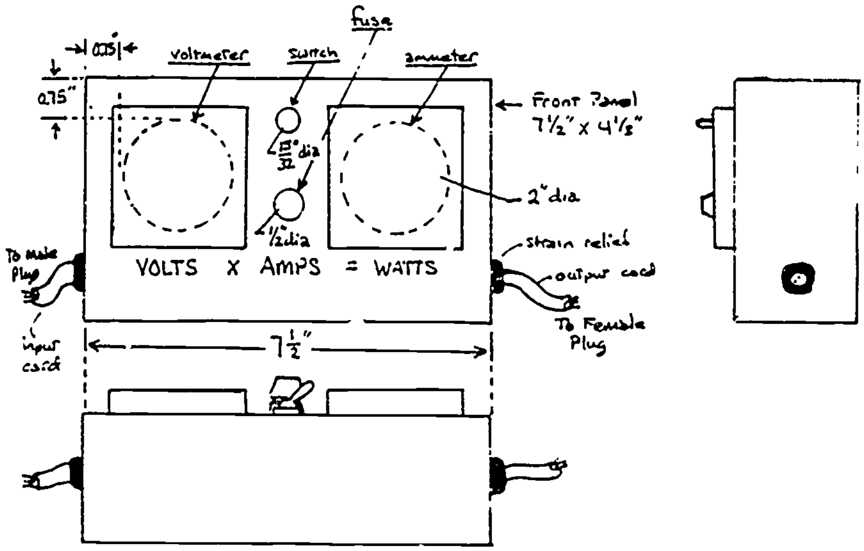
12/01/86

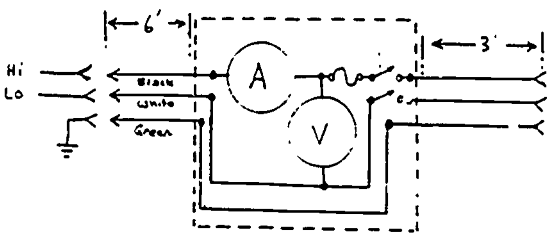
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: AC Power Measurement Module   Item No. 227-ALT

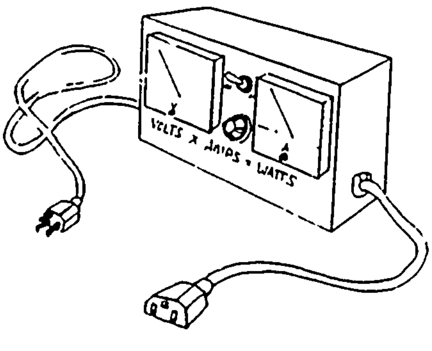
MATERIALS

- Panel meters
  - AC Ammeter 0-15 V AC
  - AC Voltmeter
- Fuse holder with fuse
- DPDT switch
- Cabinet
- Wire
- Power cord





SCHEMATIC



PARTS AND ESTIMATED COSTS OF MATERIALS ON BACK

12/01/86

All parts referenced to Allied Electronics Catalog #834

	Stock No.	Single Item Cost
* Ammeter, AC 0-15 A ±5%	701-8508	$10.92
* Voltmeter, AC 0-150 V ±5%	701-8406	13.95
Switch, DPDT ON-OFF 15 A @ 125 V AC rating	757-4500 (mfr's type 7560KS)	4.60
Fuseholder	740R2006 (mfr's type HTA)	2.20
Fuse (311015/AGC)	603R0202	1.40/5
Cabient (7 1/2" x 4 1/3" x 2 1/4")	806-1599 (mfr's type 11591EOR)	7.90
Power cord 9" x 14 AWG, Type SJ	663-7086 (Delden #17629)	10.40
Strain reliefs - 2		

Total Materials Cost Estimate= $52.00

*model 850Z, 2 1/2" rectangular

12/01/86

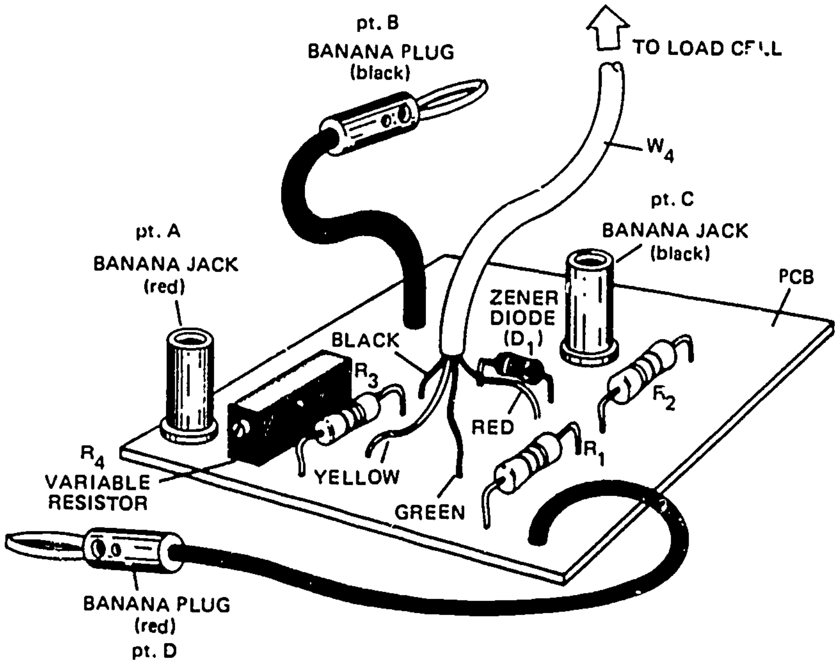
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

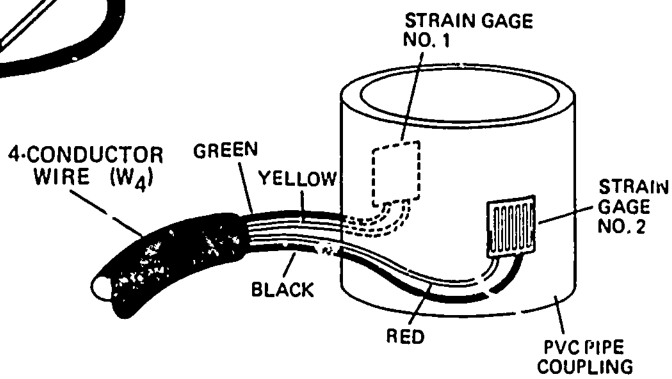
Item Name: Load Cell Assembly

Item No. 228

MATERIALS

PVC slip-type pipe coupler, 2 3/8" long x 2" i.d.
Unbonded strain gages
Strain gage adhesive (cold cure)
Strain gage protective coating
Hook-up wire
Bridge output board
9-V battery connector





BRIDGE OUTPUT BOARD

R_1 = 330 ohms, 1/4 watt
R_2 = 15 ohms, 1/2 watt
R_3 = 1500 ohms, 1/2 watt
R_4 = 0 to 500 ohms, 3/4 watt
D_1 = Zener Diode 1n4739 (9.1 V)

ADDITIONAL INFORMATION AND DATA ON BACK OF PAGE

12/01/86

All strain gage materials are referenced to Omega Engineering, Inc. "Pressure and Strain Measurement Handbook and Encyclopedia" for 1985

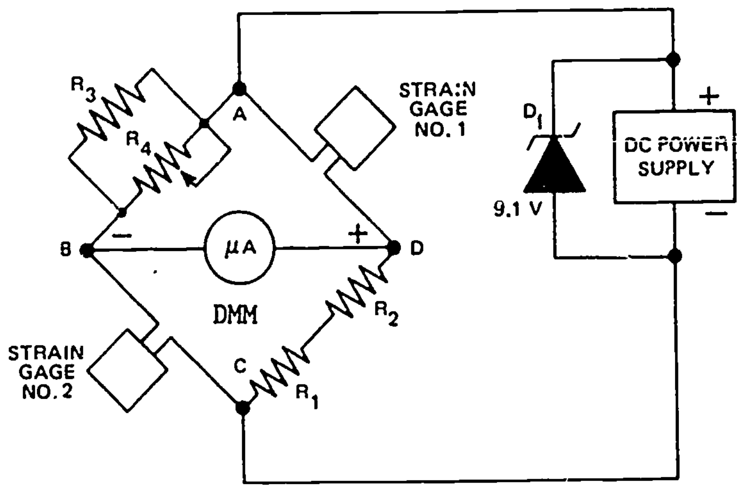
Strain gages, HBM 6/360 LY 11 10 for \$46.00
Nominal Resistance = 350 ohms
Energizing Voltage = 15 VDC
GF = 2

Cold cure rapid adhesive, Z70 10 cc for \$9.50
(enough for 250 gages)
Protective coat foil, ABM 75 11-205 x 100 mm pieces for \$17.00
(enough for 200 gages)
Hook-up wire, TFCP-0 5-50 \$11.00
(50 ft of 0.015" diam wire teflon coated)

NOTE:
Extensive educational materials on stress measurement technology is available from:

Measurements Group, Inc.
P.O. Box 27777
Raleigh, NC 27611

Student strain gages are also available--comparable to those listed above,
Model # EA-06-240LZ-120 for \$10.00 per package of 10.
Nominal Resistance = 120 ohms, intended for mount to steel.



12/01/86

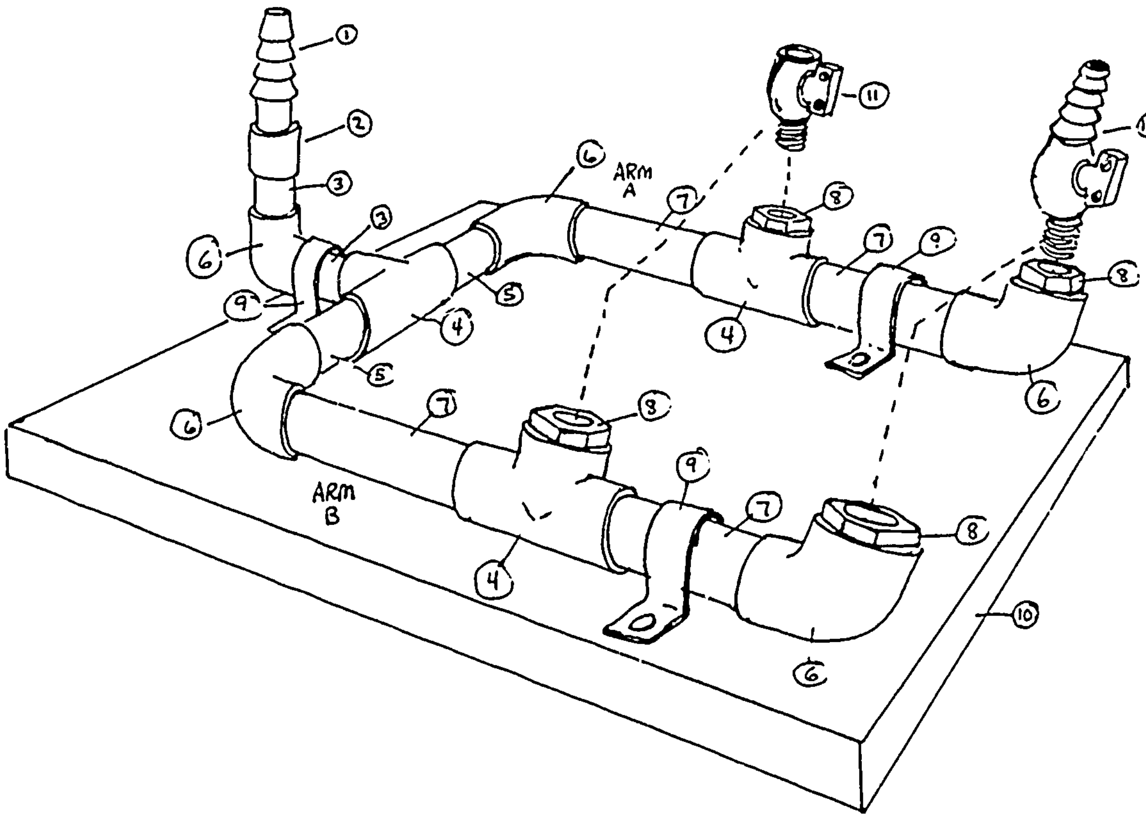
Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Pressure Manifold Assembly Item No. 231

MATERIALS:

1 - Plywood board (10) 18" x 8" x 5/8"
1 - PVC adaptor (1) Tubing to 1/4" id pipe to NPT
1 - PVC adaptor (2) 1/4" female NPT to slip
3 - PVC pipe tees, 1/4" id, slip type (4)
3 - PVC elbows, 90 , 1/4" id, slip type (6)
4 - PVC adaptors, 1/4" id slip to female NPT (8)
3 - Pipe hold-down clamps 9
2 - Brass cutoff valves 11
2 - Brass cutoff valves with nipple (12)

PVC pipe sections - 1/4" id
2 - (3) 2"
2 - (5) 3"
4 - (7) 4"



177

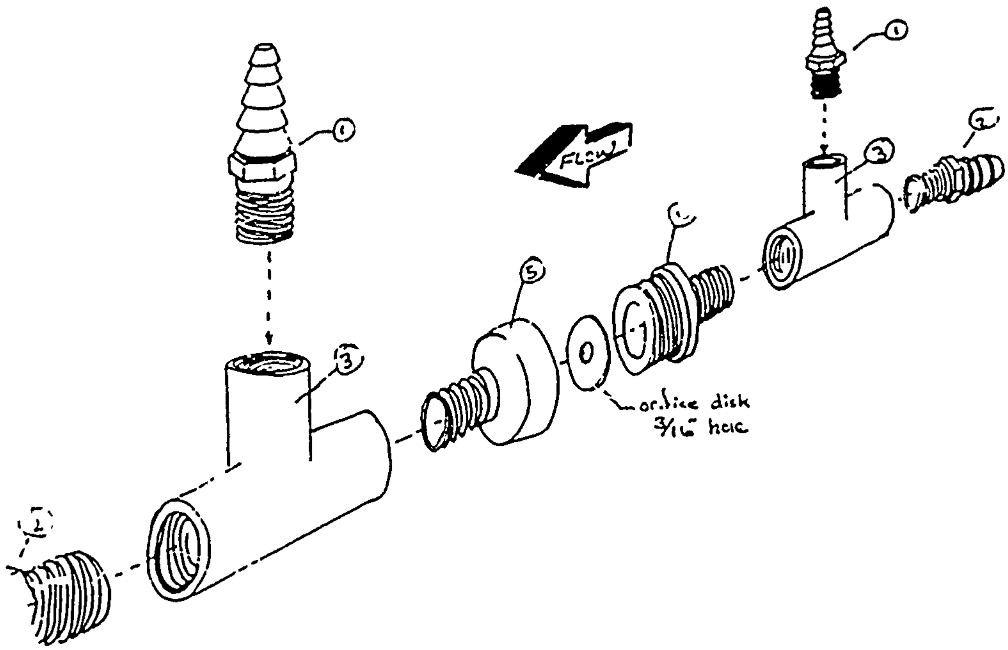
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Liquid Flow Orifice Item No. 233

MATERIALS

Adaptors NPT to nipple for tubing (1)
Adaptors NPt to nipple for hoses (2)
PVC tees NPT type 3/8" - 1/2" id (3)
Orifice disk, copper 1 1/4" od x 1/16" t with 3/16" id hole
Male-female threaded coupler (5)
Male-male threaded coupler (6)



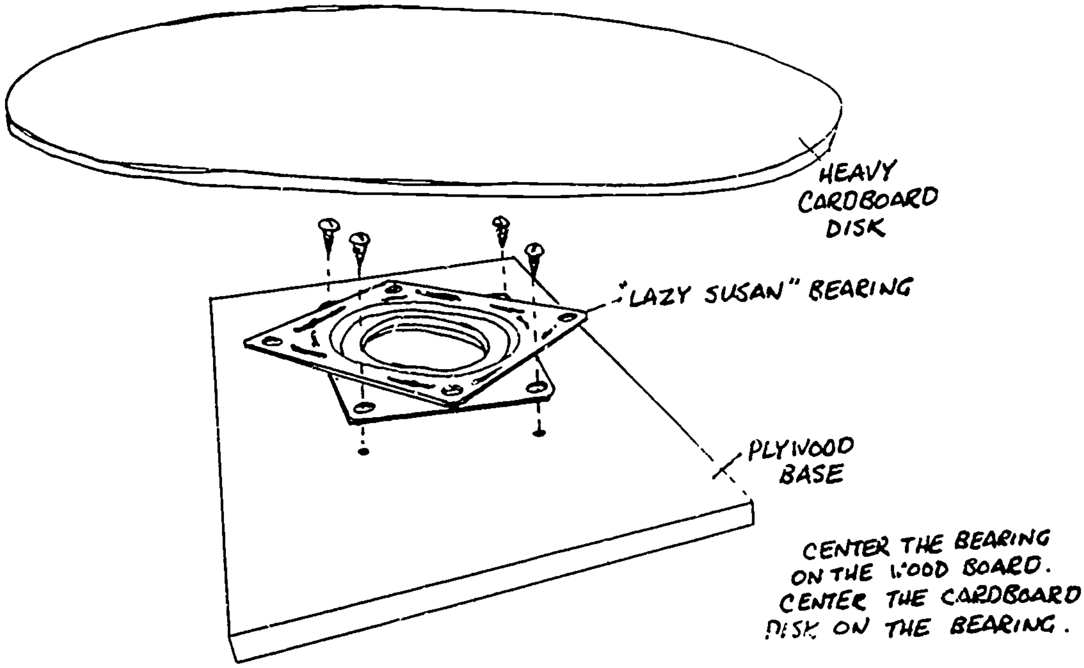
12/01/86

Principles of Technology
DESIGN NOTES ON SPECIAL EQUIPMENT

Item Name: Lazy Susan Optics Table Item No. 240

MATERIALS

"Lazy Susan" 3" diam bearing
Wood base - plywood 1" x 1" x 5/8"
Heavy cardboard disk 17 1/2" diam with white matte finish
4 - wood screws
Adhesive



Center the bearing on the wood board. Center the cardboard disk on the bearing.

"Lazy Susan" is available in 3", 4", 6 1/8", and 12" sizes from Edmund Scientific Co with part no. H40,600 (3" size)

PRINCIPLES OF TECHNOLOGY: COST COMPARISON WORKSHEET

ITEM NO.	QUANTITY	VENDOR ____			VENDOR ____			NOTES OR COMMENTS
		CAT. NO.	UNIT PRICE	TOTAL PRICE	CAT. NO.	UNIT PRICE	TOTAL PRICE	

Useful Physics Software

Here is a list of some computer software that may be used to supplement instruction and in-depth discussions about various *Principles of Technology* topics. George Taliadouros of Minuteman Regional Vocational Technical School District in Lexington, Massachusetts, is currently using these materials in his *PT* and physics classes.

The author has volunteered to try to update this list as often as possible. In addition, R. G. Dunn and Jim Everett of Platte County Area VoTech School in Missouri would like to know of any mathematics or other software that *PT* instructors are successfully using. Send any information to the *PT Newsletter*.

Methods and Measurements

Title	Type*	Computer	Status*	Publisher
1. Mass Spring	S	Apple	P	CDL
2. Math for Science Series	T	Apple; PET	P	Merian
3. Measurements: Length, Mass & Volume	T	Apple; Commodore 64	P	Focus Media
4. Discovering the Scientific Method	S	Apple; TRS 80	P	Focus Media
5. The Metric System	T	Apple	P	COMpress
6. Isaac Newton & F.G. Newton	S	Apple; TRS 80; Atari; PET	P	Krell

Force, Motion and Energy

Title	Type*	Computer	Status*	Publisher
7. Vectors & Graphing	T	Apple	U	Cross
8. Flight Vector	S	Apple	P	EduSoft
9. Vector	S	Apple	P	EduTech
10. Vector Addition	D	Apple	U	Vernier
11. Kinematics	D	Apple	U	Vernier
12. Motion	T	Apple; IBM	U	Cross
13. Projectile Motion Workshop	D	Apple	P	High Technology
14. Target	S	Apple	P	EduTech
15. Mechanics	D	Apple	P	EduToch
16. Projectiles	D	Apple	U	Vernier
17. Gravity Simulation	S	IBM	U	Cross
18. Circular Motion	T	Apple; IBM	U	Cross

Force, Motion and Energy (continued)

Title	Type*	Computer	Status*	Publisher
19. Statics	T	Apple; IBM	U	Cross
20. Rendezvous	S	Apple	P	Peachtree
21. Space Station	S	Apple	P	EduTech
22. Orbits	D	Apple	U	Vernier
23. Harmonic Motion Workshop	D	Apple	P	High Technology
24. Air Track Simulator	S	Apple	P	CDL
25. Conservation Laws	T	Apple; IBM	U	Cross
26. Yellow Light Problem	S	Apple	P	CDL
27. Saturn Navigator	S	Apple	P	SubLogic
28. Law of Motion	D	Apple; IBM; TRS 80	P	EME

Heat and the Structure of Matter

Title	Type*	Computer	Status*	Publisher
29. Energy House	S	Apple	P	MECC
30. Ideal Gas Law	[illegible]	Apple	P	High Technology
31. Gas Law Simulator	S	Apple	P	CDL
32. Three Mile Island	S	Apple	P	Muse

*Type: S (simulation); T (tutorial); or D (demonstration)

*Status: P (copy protected) or U (unprotected)

Wave Motion: Sound and Light

Title	Type*	Computer	Status*	Publisher
33. Waves & Vibrations Series	T	Apple; PET	P	Merlan
34. Wave Addition	D	Apple	U	Vernier
35. Harmonic Motion Workshop	D	Apple	P	High Technology
36. Standing Wave Workshop	D	Apple	P	High Technology
37. Optics: Mirrors & Beams	D	Apple	P	HRM Software
38. Ray Tracer	D	Apple	U	Vernier
39. Optics/Light Waves	S	Apple; IBM; TRS 80	P	EME
40. ChemDemos	D	Apple	P	CDL
41. Optics	T	Apple	U	Cross

Electricity

Title	Type*	Computer	Status*	Publisher
42. Electric Field	D	Apple	P	EduTech
43. Basic Concepts of Electricity	T	Apple; PET	P	Merlan
44. Oil Drop	S	Apple	P	EduTech
45. Charged Particles	D	Apple	U	Vernier
46. Atomic Physics - 2	S	Apple	U	Programs for Learning

Electromagnetism

Title	Type*	Computer	Status*	Publisher
47. Charged Particle Workshop	D	Apple	P	High Technology
48. Electricity & Magnetism	T	Apple	U	Cross

Modern Physics

Title	Type*	Computer	Status*	Publisher
49. Atomic Physics	T	Apple	U	Cross
50. Atomic Physics - 2	S	Apple	U	Programs for Learning

Publishers' Addresses

Cambridge Development Laboratory (CDL)
100 Fifth Avenue
Waltham, MA 02154

COMpress
P.O. Box 102
Wentworth, NH 03282

Cross Educational Software
1802 N. Trenton Street
P.O. Box 1536
Ruston, LA 71270

Educational Materials and Equipment (EME)
P.O. Box 17
Pelham, NY 10803

EduSoft
P.O. Box 2560
Berkeley, CA 94702

EduTech
303 Lamartine Street
Jamaica Plain, MA 0.130

Focus Media
839 Stewart Avenue
P.O. Box 865
Garden City, NY 11530

High Technology Software
1611 NW 23rd Street
Oklahoma City, OK 73106

HRM Software
175 Tompkins Avenue
Pleasantville, NY 10570

Krell Software
1320 Stony Brook Road
Stony Brook, NY 11790

Merlan Scientific
247 Armstrong Avenue
Georgetown, Ontario
CANADA L7G 4X6

Minnesota Educational Computing Consortium (MECC)
2520 Broadway Drive
Lauderdale, MN 55113

Muse Software
347 N. Charles Street
Baltimore, MD 21201

Peachtree Software
3445 Peachtree Road
Atlanta, CA 30326

Programs for Learning
P.O. Box 954
New Milford, CT 06776

SubLogic Corporation
210 W. Springfield
Champaign, IL 61820

Vernier Software
2920 SW 98th Street
Portland, OR 97225

*Type: S (simulation); T (tutorial); or D (demonstration)

*Status: P (copy protected) or U (unprotected)