science expert to use model rocketry. By discreet manipulating, the teacher can get the enthusiasm of the students to lead them into studying areas the teacher might not be able to cover in class.

In demonstrating principles of physics, model rocketry again shows considerable adaptability. Rocket propulsion may be demonstrated much more effectively and impressively by using either a model rocket engine and a simple static thrust stand or a model rocket engine in a flying rocket than by using a balloon and the blackboard. Similarly, vector forces can be demonstrated by showing the relative effect of wind and forward velocity on rocket flight. Acceleration and motion can be demonstrated in numerous ways, along with g forces, time-velocity relations, average velocity, negative acceleration, trajectory, air drag effects, and theoretical versus actual performance with no more than a model rocket, a simple tracking device, and the blackboard.

In the area of force alone, model rocketry provides for interesting and clear demonstrations of Newton's laws of motion. The effect of rocket weight on rocket velocity and altitude can demonstrate that the body at rest tends to remain at rest and the body in motion tends to remain in motion. The takeoff and flight of the model rocket show that unbalanced forces cause the body to accelerate, and the rocket engine itself, during operation, shows that for every action there is an equal and opposite reaction.

Demonstrations using model rocketry can range further afield than just the physics of motion and force. For example, in meteorology the rocket can provide for studies of wind speeds at various altitudes and studies of thermals and vertical air currents. The simple launching of a grasshopper or mouse can provide for countless studies in animal behavior and biology. In the area of mathematics the determination of a rocket's altitude provides a very effective means of introducing trigonometry, and the calculation of rocket flight characteristics can involve geometry, algebra, and even calculus.

Mathematics is highly important in model rocketry. This young man is learning to use sines and tangents to measure distances and enjoying himself while doing it. (NAR Photo)

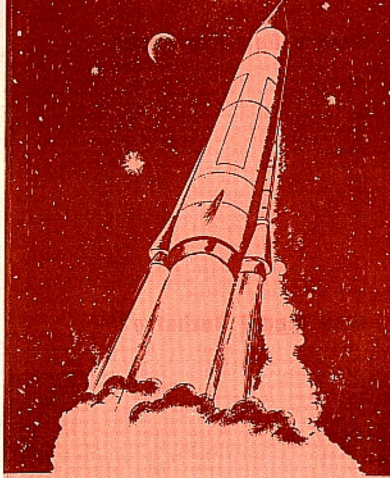
Simple static thrust stands such as this one, made from common materials like boards and paper tubes, can be used to teach much about rocket propulsion, including specific impulse, total impulse, average thrust, and mass ratio.

Optics and photography can be introduced by the design and launching of a camera rocket, leading into studies of lenses, reflection and refraction, studies of the eye, telescopes, aerial photography, mapping, and many other fields. Electricity can be covered in the design and function of launching systems, communications devices, and other accessories for model rocket operation.

It can be seen that applications of model rocketry in the classroom are numerous. By encouraging the student's interest in rocketry and space, he will also be encouraged to further efforts in language arts, history, mathematics, and the like, first as they relate to his rocketry activities, and later for their own sake. In encouraging these interests, the teacher encourages the development of the student towards the professions, and helps produce a person who will contribute to the community and the nation, since he is providing motivation for the student's learning.

If further information on projects, supplies, and literature is desired, Estes Industries will be glad to supply all possible assistance. Estes Industries recognizes the paramount importance of education in American life, and can devote their entire staff's efforts to aiding you in solving your science education problem.

A Tool for the Classroom----



Teaching for Tomorrow with Model Rocketry

A Practical Way to Channel Student Interest to Greater Achievement

Estes Industries, Inc.
BOX 227
PENROSE, COLORADO

Mathematics Physics Optics Electricity Meteorology Aerodynamics

Need a New Approach?

According to many authorities, America trails in the space race. This is no accident. It required the combined efforts of many short-sighted people--labor leaders, politicians, military personnel, and even some educators--to create this situation, and it will require all the efforts of those who are concerned with the welfare of our country to bring us through this crisis.

It can be assumed that, since you are reading this, you are not one of the short-sighted. But every teacher has problems, and the solutions are not always easy to find. We do not pretend to have the solution to every problem, but we do feel that we may be able to help find a solution to some.

Quite familiar to teachers are the cries, "I need something to get my students interested," and "I need something concrete with which to demonstrate these principles." Model rocketry can help solve both of these problems.

Why Model Rocketry?

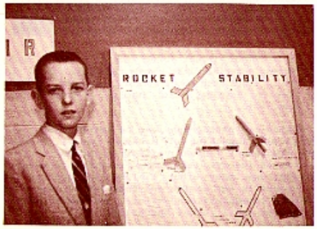
When the first Sputnik was launched in 1957, boys and young men across the country set out to try to emulate, in their back yards, the feats of the professionals. The carnage was fantastic. Match heads, gun powder, zinc and sulfur, and other mixtures were poured into gas pipes, conduit, or almost any other container to form rockets. Probably the climax of this madness came in Floydada, Texas, when seven students were injured and a chemistry teacher killed by the explosion of a "small" demonstration rocket engine built by the teacher.

It was out of this situation that model rocketry grew. Model rocketry was intended from the beginning to provide a safe, reliable means to allow America's young enthusiasts to express their desire for the stars without injuring or killing themselves. In the years since its inception in 1957, model rocketry has enjoyed one of the best safety records of any sport or active hobby.

Model rocketry's excellent safety record is largely due to the nature of the propellant means used. The model rocketeer does not build his own engine, but uses one which is commercially prepared and has been proven safe. The model rocket engine is non-metallic, highly insensitive to heat and shock, and limited in size. There are no 800 pound stove pipe missiles in model rocketry. A model rocket, by definition, weighs no more than 16 ounces, with most weighing between one and three ounces. The amount of propellant used rarely exceeds 1/4 ounce.

Classroom model rocket activities led to this sixth grade science fair project in which a small rocket sled was used in deceleration studies.

The typical model rocket engine consists of a non-metallic casing, a nozzle, propellant, a time delay charge, and an ejection charge to activate the recovery system. The rocket itself can attain altitudes of over 1000 feet single staged, and is returned by a parachute or similar device to be flown again and again by simply replacing the expended engine. While the high school senior chemistry class may, in some cases, feel they are ready to start research into fuel mixtures, generally little will be learned by such a program since the student still does not have sufficient background or safe equipment to handle thermosetting resins, binding agents, inhibitors, and the other basic elements of modern propellant technology. Rather than waste time trying to find the best mixture of zinc and sulfur, an unsatisfactory and unreliable propellant at best, teachers are finding more and more the advisability of using a model rocket engine and focusing the attention of students on the more rewarding aspects of rocketry.



Another science fair project by another sixth grade student. This young man has learned about center of mass and center of pressure while finding out the requirements for rocket stability.

It is well known that a student learns most rapidly and retains a larger part of what he learns when he can associate his learning activities with his other interests and needs, realizing that what he is studying will have a practical application at some future date. Thus the first use of model rocketry comes in arousing the student's interest and bringing home to him the practical value of learning.

There are few young people who will remain unimpressed by the sight of a small rocket soaring hundreds of feet into the air and returning suspended by a parachute. Most of them will automatically ask the question, "Can I build one too?" The teacher can encourage them to do so, secure in his knowledge of the safety factors of model rocketry. When Johnny launches his rocket to 500 feet, and breaks a balsa fin on landing because his parachute didn't open completely, Mike is going to decide that he can do better, and will set out to try.

The young rocketeer using this 3-D altitude computer is learning the elements of trigonometry as he calculates the altitudes of rockets. (NAR Photo)

Here the teacher can discreetly step in, and encourage both cooperative and competitive activities. After the student has read some of the literature supplied by the manufacturer, listened to a few simple explanations by the teacher, and discussed rocketry with his peers, he begins to understand some of the underlying principles associated with rocketry, such as propulsion by reaction, center of mass, stability, drag, acceleration, and trajectory. He has by no means mastered these fields, but he is beginning to realize their existence and recognize their value. In short, he is becoming interested in learning.

At an early stage in the pupil's acquaintance with model rocketry, the teacher may well initiate the first group activity. One teacher began his student's activity by dividing them into four groups, one to construct the rocket, another to forecast and observe the weather up to the launching, another to construct and operate the electrical launching system, and the fourth to determine, by mathematics, the altitude attained by the rocket. Each group was empowered to delay or postpone the launching for any necessary reason, and each was interested in insuring that its part of the launching went off perfectly. The result was that, with careful guiding by the teacher, each group began to learn a considerable amount about the sciences in its particular area. By rotating groups, the learning of each group was rounded.

The actual methods used by the teacher are not of prime importance, and the teacher need not be a

Motivation....A Student's Most Valuable Asset