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Community and School Involvement in Model Rocketry Instruction Including Suggestions for Efficient Model Rocket Construction

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COMMUNITY AND SCHOOL INVOLVEMENT IN MODEL ROCKETRY INSTRUCTION INCLUDING SUGGESTIONS FOR EFFICIENT MODEL ROCKET CONSTRUCTION

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by

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SCHOOL AND COMMUNITY INVOLVEMENT IN MODEL ROCKETRY INSTRUCTION INCLUDING SUGGESTIONS FOR EFFICIENT MODEL ROCKET CONSTRUCTION

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This paper presents the pilot-study of conducting model rocketry classes for parents and youth leaders as well as students and teachers to broaden involvement in aerospace education.

Ideas gleaned from questionnaires, surveys, observations, and the review of literature were used to compile A Handbook of Tips for the Efficient Construction and Use of Model Rockets.

A slide presentation illustrating school and community involvement in model rocketry was also developed.

Recommendations included more model rocketry classes involving students and adults be offered and suggested that an appropriate organization publish and distribute the handbook and slide presentation.

CHAPTER I

INTRODUCTION TO THE STUDY

Even though it was generally accepted that parents, youth leaders, and teachers shared a common interest in children, it was thought that the four groups could accomplish more by sharing, developing ideas, and cooperatively planning a common project. One such project could be stimulating interest and involvement in model rocketry.

Furthermore, as aerospace technological advancements affected many aspects of the daily lives of citizens, model rocketry could initiate awareness and investigation into the field of aerospace by parents, youth leaders, teachers, and students alike.

Although there were many technical materials available on model rocketry, there were few compilations of practical information available for educators and interested adults concerning tips for successful and efficient construction of model rockets.

THE PROBLEM

Statement of the Problem

It was the purpose of this study (1) to broaden involvement in aerospace education to include parents and

youth leaders as well as students and teachers; (2) to use model rocketry as a nucleus for this four way involvement; (3) to provide an opportunity for more adults to participate in a model rocketry construction and safety course in order to obtain their Washington State Model Rocket Coordinators' Licenses; (4) to compile a model rocketry handbook of tips for the efficient construction and use of model rockets; and (5) produce a color slide sequence illustrating community and school involvement in model rocketry.

Importance of the Study

Although many United States Citizens were unaware of it, aerospace technological advancements affected their daily lives. The prime responsibility for informing the citizenry lay with the news media and educators. Through a course in model rocketry, participants received introduction to an aerospace related activity. This experience could be instrumental in arousing an interest and subsequential investigation into other aspects of space science.

Many students have been introduced to, and became enthusiastic toward, model rocketry as a result of participation in, or observation of, model rocket launches at school. These children wanted to be more involved in rocketry but were unable to do so because of the limited

number of adults who possessed a model rocket coordinator's license.

To assure that the utmost safety was practiced in model rocketry, Washington State required that all adults obtain a model rocket coordinator's license before they could supervise a launch. In order to qualify for a license, adults had to participate in classes and demonstrate their competency in model rocket construction and launching.

Dr. Robert Gesell, Aerospace Education Consultant for the Washington State Aeronautics Commission, had the sole authority to grant model rocket coordinators' licenses in Washington State. Due to the large area encompassed and the increasing popularity of model rocketry, Dr. Gesell had authorized several leading aerospace educators to conduct model rocketry classes in which the participants could demonstrate their competency and obtain model rocket coordinators' licenses. Dr. Lee Dallas, Western Washington State College; Charles Carpenter, Spokane School District 81; and Dr. J. Wesley Crum and Lee Fisher, both of Central Washington State College, were four aerospace educators who had this authority.

According to Dr. Robert Gesell, Washington needed to provide more opportunities for adults to participate in model rocket courses in order that they could obtain their coordinators' licenses.

Model rocketry was a highly motivating activity that contained something of the spectacular that appealed to all ages. Rocketry generated enthusiasm and subsequent involvement for adults as well as children and therefore served as a natural nucleus for interaction between the school and community through aerospace education.

When the school and community worked closely together the learning atmosphere was enhanced and the children benefited. In this way model rocketry classes conducted for a combined group of parents, youth leaders, students and teachers provided an opportunity for a closer school and community relationship.

When community members became involved in model rocketry there was a continuance of the school activity to an extra curricula community activity. In this way the program was able to continue during the summer and other vacation periods.

As model rocketry was a relatively new activity, school directors, educators, parents, and community leaders often were not aware of its existence. Furthermore, they did not realize the motivational and educational role it could play in an aerospace education program. Finally, they may have been unaware of (1) state requirements for

licensing; (2) efficient construction techniques; and (3) proper launching and safety procedures.

A well organized slide presentation with descriptive narrative emphasizing these features and illustrating the school and community involvement in a model rocketry program, in addition to model rocketry education classes and a handbook containing tips for efficient construction, could be instrumental in improving school and community relationships and participation in model rocketry.

LIMITATIONS OF THE STUDY

Experimental classes for children in Maywood Hills Elementary School were limited to a fourth and fifth grade combination class, children who signed up for model rocketry as part of the school's activity program, and children who participated as team members with adults in after school classes.

The after school classes were limited to team enrollees. The two member teams consisted of a teacher, a parent, or a youth leader, with a child as a partner. These teams worked together the entire duration of the class.

Model rocketry was taught in correlation with aerospace education in the fourth and fifth grade combination class. The course was designed to stress the learning of model rocket parts, safety, principles of flight, propulsion,

and individual construction and launching of model rockets. Other topics were either not covered or covered only indirectly.

Coordinators' licenses were issued only to adults who demonstrated competency in model rocketry.

The slides used in the color slide sequence were taken of the classes conducted during this study, slides taken during the 1970 United States Air Tour offered by Central Washington State College, and from the slide collection of Dr. Robert Gesell.

The suggestions for efficient construction of model rocketry were compiled from information gained in a survey of available literature, experiences gained in the rocketry classes, and from responses to a questionnaire sent to the rocket coordinators in the State of Washington.

DEFINITIONS OF TERMS USED

Activity Program

An activity program consisted of high interest courses offered as electives to elementary students. It differed from the self-contained classroom in that the children (1) met in different classrooms; (2) did not necessarily remain with their homeroom classmates; (3) had various instructors; and (4) selected the subject in which they would participate. At Maywood Hills the Activity Program was a ten week program consisting of ten one hour

classes. All intermediate children selected their interest areas (i.e. bowling, cooking, model rocketry, etc.) in order to develop a leisure time skill. Parents and teachers guided the students in developing skills in the activity of their choice. The groups were limited to about ten students in order to allow for maximum attention.

Aerospace Education

Bruno (2:1) defined aerospace education as

> . . . a curricular recognition of the general interest in aviation and space achievements, and it reflects an awareness of the fact that aerospace endeavors are having a dramatic effect upon our whole way of life. "Aerospace" is not an isolated educational discipline. Like conservation education, family life education, human relations education and citizenship education, it is an emphasis that permeates the curriculum of all subjects at all grade levels.

This definition was selected for use in this study.

Construction Components

Construction components were lightweight materials such as cardboard, plastic and balsa wood that were used to build model rockets.

Engines

The engines used in model rockets were nonmetallic self-contained, solid propellant engines that were prepared by professionals and were sold commercially. Model rocket engines could be imported into the state of Washington by

model rocket coordinators who were licensed by the Washington State Fire Marshal. They were also available for licensed coordinators from wholesale or retail outlets in Washington.

Model Rocketry Handbook

The model rocketry handbook is a compilation of tips for efficient construction and use of model rockets. It was developed as a result of this study. It also includes aerospace related studies that can be correlated with model rocketry.

Slide Presentation

The 35 millimeter slide presentation is a slide program on model rocketry that was developed as a result of this study. The slides were primarily photographed in the Maywood Hills' model rocketry classes and taken during the 1970 United States Air Tour offered by Central Washington State College. Dr. Robert Gesell also contributed slides to help complete the presentation.

DEVELOPMENT OF THE STUDY

The developmental model for this study proceeded from the formulation of an initial idea involving the school and community in model rocketry instruction, to the formulation

and filming of the classes and, finally, to organizing the materials into a slide presentation.

Methods Employed

Three types of classes in model rocketry were conducted to stimulate school and community involvement in model rocketry and to provide a laboratory for the collection of data.

Dr. Robert Gesell served as a consultant to the study. Conferences were held with him concerning subject matter to be covered in the classes and the type of handbook and slide presentation that would be most beneficial to educators.

Model rocket manufacturers were contacted for advice, materials and permission to include materials applicable to the study.

Materials Developed

A 35 mm slide presentation and narrative illustrating school and community involvement in model rocketry and a handbook of tips for efficient rocket construction were developed as a result of this study.

Groups Surveyed

Licensed model rocket coordinators in Washington were surveyed to obtain suggestions for efficient rocket construction and aerospace related units to teach with model rocketry.

All class participants were surveyed to learn the source of their initial interest in model rocketry, their previous rocketry experience, the reasons for their present involvement, and their future plans in model rocketry.

Groups Used

Twelve fourth and twelve fifth graders from a self-contained combination classroom constructed model rockets in conjunction with their study of aerospace.

Eleven fifth grade boys constructed model rockets as part of the Maywood Hills' Activity Program.

The evening classes consisted of teams of adults and children who had signed up for the course as partners. The adults were either teachers, parents, or youth leaders and the children were students of Maywood Hills Elementary School.

ORGANIZATION OF THE REMAINDER OF THE THESIS

Chapter II is a review of the literature. Chapter III contains information gained from the classes through the collection and recording of data. Chapter IV consists of the results of the questionnaire sent to model rocket coordinators. Chapter V is the narrative script for the 35 mm slide presentation. Chapter VI is composed of the

summary, conclusion and recommendations. Appendix F is a handbook for model rocketry. The handbook was designed for publication and subsequently stands independent with the remainder of the thesis. A general appendix and bibliography for the study follow Chapter VI.

CHAPTER II

REVIEW OF LITERATURE

The review of literature was limited to areas related to (1) school and community involvement in education in general including aerospace education; (2) the use of model rocketry as a nucleus for parent, teacher, youth leader, and student involvement in aerospace education; and (3) sources of instructional techniques for the efficient construction of model rockets.

LITERATURE ON SCHOOL AND COMMUNITY INVOLVEMENT IN EDUCATION

A child's education was generally considered primarily dependent upon state directives, home and school environment, and district and community goals. Conant (16:foreword) said,

> The nature of the community largely determines what goes on in the school. Therefore, to attempt to divorce the school from the community is to engage in unrealistic thinking, which might lead to policies that could wreak havoc with the school and the lives of children. The community and the school are inseparable.

Olson (12:10) echoed this thought when he wrote:

> American educators are generally well aware that the educational isolation of the school from its community is as indefensible and as truly impractical as is political isolationism for the nation. . . .

An example of these philosophies was found in the Puget Sound Area. For many years the lives of the citizens of Seattle and its suburbs had been directly related to the growth and development or layoffs of the area aerospace industries. "When Boeing sneezes the entire area catches pneumonia." This was a fairly accurate description of the influence aerospace industries had on the area.

Under such circumstances, it was easy to understand why the children in these communities needed aerospace education. In addition to its scientific principles, the social and economic influences of the aerospace industries needed to be included in the curriculum. Many districts either added aerospace education or broadened their existing programs. The Renton Flying Classroom Project and a space-oriented Seattle Center, which has been widely used by school groups, were two results of communities influencing their educational facilities.

Many educators have agreed that isolationism was not desirable. Furthermore, the school and the community should not merely coexist. They should communicate and interact. Sumption (16:xi) maintained, ". . . there must be a clear and effective two-way system of communication between school and community."

Wilson (17:141) stated that in order to improve communication and public relations, ". . . the school

system should make a deliberate and conscientious effort to disseminate more information about schools to the citizens of the county."

The forestated philosophies of Conant, Olson, Sumption and Wilson became even more significant in light of the recommendations made to educators as a result of the National Aeronautic and Space Administration's work in the space program. In a NASA presentation delivered at Camp Murray, June, 1969, Bill Horvath stated that there were four basic skills, attitudes, or characteristics that educators should strive to instill in their students. They were: (1) teach children to get along with one another; (2) teach them to communicate verbally and orally; (3) teach them to be adaptable to change; and (4) let them use their imaginations. Time, space and money are the only true limitations of man's imagination.

In order to accomplish these goals the school and the community had to be adaptable to change. One area that had undergone change was the curriculum. Sumption (16:1) illustrated this when he said, "The expanded role of the school is apparent in broader curricula which include driver training, space science, and electronics as well as many other subjects."

Another area that has undergone change and has contributed to better school and community relationships was

a more flexible utilization of school plants. Olson (12:13) saw the school plant as a community center for people of all ages. He said:

> Now as never before, doors must be opened between school and community--two-way doors, so that students and adults alike may study and serve the community by bringing the community into the school and by taking the school into the community.

Furthermore, the school and the community should serve as educational resources to each other. In this way they both served as learning laboratories. This idea was synonymous with the view that space itself was a gigantic learning laboratory. Viewed as such, aerospace science provided involvement, interaction, and communication between parents, teachers, youth leaders, and students.

LITERATURE ON THE USE OF MODEL ROCKETRY AS A NUCLEUS FOR PARENT, TEACHER, YOUTH LEADER, AND STUDENT INVOLVEMENT IN AEROSPACE EDUCATION

Schools were often responsible for introducing children to model rocketry. One reason schools used model rocketry was because it was a real "hands on" experience for students. Saltrick and Kubota (14:3) stated that model rocketry's appeal lies in the fact that students like having ". . . an opportunity to build and fly a model rocket, not a wind-up or a toy that is already put together, not a toy that flies on a string, but a real, safe, miniature rocket. . . ."

The Education Department of Estes Industries (3:1) made the following statement concerning model rocketry and the schools:

> The excitement felt by many thousands of youngsters as they practice safe model rocketry as a scientific hobby has reached the classroom. Rockets inspire a high degree of interest in youth. The great amount of both mental and physical involvement experienced in model rocketry activities helps make model rocketry an excellent teaching tool. The thrills the youngsters experience as they build and fly their model rockets may be channeled into valuable teaching-learning experiences in a wide variety of subject fields.

Model rocketry has grown rapidly in Washington State. This growth has primarily been attributed to the efforts of Dr. Robert Gesell, Aerospace Consultant to the Washington State Aeronautics Commission, leading aerospace educators, and the model rocket coordinators in Washington.

Ron Pretti (13:16, 17) summarized the development and growth in Washington when he said:

> Washington State's prominence as a national pacesetter in the aerospace industry and in space technology has more recently embraced the field of aerospace education. Our state now leads the nation in the relatively new and sophisticated program of model rocketry.
>
> From the seeds of an idea first conceived in 1958 by William Gebernini former WSAC director, and Dr. Robert Gesell, a retired physician and former consultant to Boeing, the Commission's educational rocketry program has grown by leaps and bounds over the past ten years.
>
> Today the program involves over 400 licensed graduate rocket study coordinators, 90 percent of whom are teachers--an estimated 30 percent of the teachers are women. Activity wise, more than 1,000 rocket models are fired each weekend in Washington State.

> . . . The Commission has been complimented many times for its efforts to motivate, educate and safeguard the scientifically inclined youth of the state through the program.
>
> The letter reproduced below is one of the many which attest to the benefits and excellence of the model rocketry program which the Commission continues to foster as a major component of its aerospace educational activities. . . .

The aforementioned letter (Ibid.) from J. Wesley Crum, Department of Education at Central Washington State College, has been included below to illustrate the favorable position that model rocketry has attained among top educators in Washington.

> I wish to take this means of commending the members of the Washington State Aeronautics Commission for providing leadership in the area of model rocketry. My experience in aerospace (aviation and space) education, education in general, teacher education, and youth organizations leads me to the conclusion that model rocketry is a safe activity for children and youth, generates and maintains a high level of interest and involvement, provides learning experiences parallel to school programs, and develops internal motivation for other academic pursuits.

Stine (15:1) not only saw model rocketry as an educational tool, but as a wholesome hobby activity that provided an opportunity for involvement by many people. He said:

> Model rocketry is one of the finest and most meaningful educational tools available for teaching physical science and mathematics to our young people and it is being used with increasing frequency and great success in grade schools, secondary schools, college and undergraduate studies, summer camp programs, Scout programs and YMCA youth activities. Several park and recreation departments have also established model rocket programs and made available large flying areas in public parks.

Model rocketry appeals to many people and has great potential for clubs as well as for families and schools. Boles (1:8-9) suggested activities that lend themselves to group involvement. These activities included:

> . . . sport flying, launches, various types of contests, research and development projects, and aerospace workshops. Field trips, conferences, films, guest speakers, educational activities, demonstrations, and exhibits are also available to organized clubs.
>
> . . . In addition to schools and recreation departments, youth organizations such as the YMCA, Boy Scouts, 4-H, CAP, Boys Club, and service organizations such as Lions, Kiwanis, Rotary, and Optimists can be extremely successful in the development of a youth model rocket program. Clubs started by these types of groups have the additional advantage of instant sponsorship and the opportunity to gain an adult advisor almost immediately.
>
> . . . An advisor can be a parent, recreation leader, teacher, coach, scientist, Scout leader, merchant, or any adult who is willing to assume the responsibility of club advisor and who is acceptable to the members. He does not need to be an expert on rocketry.

As the advisor didn't have to be an expert, was adult supervision even necessary? Stine (15:6) said yes, because a young rocketeer's natural enthusiasm and excitement over flying a model rocket could cause him to overlook some important part in the count-down sequence.

> Although many young people are perfectly capable of building and launching model rockets safely, as the record has shown, the double check feature of adult supervision can often prevent mistakes made in haste and excitement.

Model rocketry had a place in the classroom and was an exciting club activity, but could it be a father-son

activity? The answer to this question was definitely yes. Stine (15:6) said:

> Model rocketry knows no age limits. It is an ideal father-son activity--and is even a mother-daughter activity in some families! Model rocketry combines modern technology and science, craftsmanship and shop practice, individual creativity and group co-operation and the pursuit of excellence along with a healthful outdoor activity. Model rocketry is not confined to youngsters nor to NASA rocket experts, although both participate in the hobby. . . .
>
> A father can use model rocketry to teach his children many things beyond the simple activity of putting together a model rocket kit and flying it. Sportsmanship, craftsmanship, self-reliance, discipline, and pragmatic approach are but a few of the things that can be learned with model rocketry as a tool.

Although the initial introduction to model rocketry occurred in the classroom, the families of these students were generally exposed to model rocketry as well. Families were invited to school launches or they became interested in model rocketry due to their child's enthusiasm. As Matson (11:2) pointed out, ". . . when a boy takes a model rocket home and shows his father how it works, he usually finds himself with a new rocketry partner."

The book, Parent's View on Model Rocketry by Estes, was a testimonial to the way some families became involved in model rocketry. The following excerpts were taken from letters contained in this book:

> . . . This most exciting and educational hobby has found favor with the whole family.
>
> I might add that the chase over hill and dale to recover a nose cone adds to the flavor as it provides beneficial exercise for the more portly members of our tribe . . . (6:9).

> . . . I might also add that I have built one model myself, the Astnon Sky Hook, and I enjoy launching and recovering it along with watching the boys and their rockets (6:10).
>
> . . . I must also tell you that my husband finds model rocketry as exciting as the boys and works with them on each project, so you see you are responsible for a healthy family interest (6:12).
>
> . . . My son and I have found a new hobby in rocketry. I believed that model rocketry was a dangerous hobby until a pupil of mine introduced me to your products. Your products have helped me greatly in illustrating space travel in the classroom and out in the field (6:9).
>
> . . . I will try to promote this hobby and education in rocketry all I can in this community. I think it is swell for Dad and Son. I have been a pilot for several years, built model airplanes (control line all classes) and in my opinion model rocketry has it all over any other hobby in education and enjoyment (6:5).

The forenamed literature described types of groups that could participate in model rocketry. It also suggested a variety of correlated model rocketry activities. Although any of the individual groups mentioned could obtain satisfactory results working independently, they could be more effective through the sharing of ideas. Mutual enjoyment and continuance of a hobby are more easily obtained when two or more groups of participants, such as parents, teachers, youth leaders, and students, work together using model rocketry as a nucleus for their involvement in aerospace science.

LITERATURE ON SOURCES OF INSTRUCTIONAL TECHNIQUES FOR THE EFFICIENT CONSTRUCTION OF MODEL ROCKETS

As model rocketry was a relatively new field, there were not many general publications available dealing with it. Public libraries, college libraries and book stores had few if any books on the subject. The printed material that was available was chiefly in pamphlet or booklet form and primarily published by model rocket manufacturers.

In some instances, relying solely on manufacturers' publications for information might lead to invalid conclusions and recommendations. However, in this case, the exact opposite is true. The manufacturers wanted to increase sales. One way to accomplish this was to provide published information that would lead to successful usage of their products. Model rocket companies have produced and published reliable instructional techniques to assist the model rocketeer in construction. Those publications that were judged most useful by this researcher are listed below.

The Estes Damon Company has published excellent materials on construction techniques. Their materials include:

1. Model Rocketry The Educational Space-Age Hobby, a booklet of construction tips, directions for

obtaining detailed patterns for rocketry assembly, and a variety of technical reports.

2. Model Rocket News Library Collection, a compilation of the best articles from all issues of Model Rocket News published prior to April, 1971. Many construction ideas are located in this collection but are scattered throughout the contents. Utilization of these ideas might be increased if the suggestions were located in one general area. Regular features such as "Free Plans" and "The Idea Box" occur in nearly every issue and contain helpful suggestions for model rocket construction.

3. Model Rocketry Library Collection, Estes Damon's finest publications, including safety, technical, club, and school information. It incorporates the history of model rocketry and information on how to become an expert craftsman, designer, and competetor.

4. Aerospace Education and Model Rocketry, a booklet that suggests ways to conduct model rocket classes and proposes methods for constructing, painting, and decorating rockets. It also includes a variety of activities that can be used to correlate other subject areas with model rocketry.

5. Estes Model Rocketry Catalogue, with an excellent section on model rocket construction entitled "Model Rocketry Technical Manual".

6. Space Age Technology, a guide for teaching the theory of flight, the history of jets and rockets, power plants, rocket propulsion systems, guidance and controls, and model rockets. Although useful in connection with teaching a space unit, the material does not emphasize techniques in model rocket construction.

The Centuri publication, Educators Guide, Model Rocketry, offers suggestions to educators concerning safety, launching procedures, and subject areas that can be taught with model rocketry, but it is quite lacking in construction techniques.

The preceding literature indicated sources for obtaining instructional techniques for efficient model rocket construction. Specific construction ideas have been incorporated into the handbook in Appendix F.

CHAPTER III

INFORMATION GAINED FROM MODEL ROCKETRY CLASSES THROUGH COLLECTION AND RECORDING OF DATA TECHNIQUE

Three classes in model rocketry were conducted as a part of this study. The first class was offered as an elective in the Maywood Hills Elementary School Activity Program. This program began in January, 1972 and culminated in March, the same year. Student response was so heavy that two sections of model rocketry were offered instead of just one as was originally planned. Richard Giger, principal of the school, conducted one section while the experimenter taught the other. Only the latter class was surveyed and used as a source for the collection of data for this study.

The evening model rocketry classes for students and adults were held in April, 1972. This course was open to all fifth and sixth grade Maywood Hills' students and their adult partners. The class was filled within several days after the announcement (Appendix A) was distributed. Many inquiries were received after registration was closed.

In May, 1972, the final model rocketry course in this study was held at Maywood Hills Elementary School. The participants were students in the experimenter's fourth-fifth grade combination class.

All participants were surveyed in order to determine the reasons for their interest, previous experience, and present involvement in model rocketry. They were allowed to check all appropriate items under each section of the survey (see Appendixes B and C).

RESULTS OF THE STUDENT SURVEY

The results of this survey are presented in Table I. In all three classes the students stated their primary source of interest in model rocketry was watching other students work with or launch rockets at school. Table I shows that 38 out of 57 students indicated this was one reason they became interested in model rocketry.

The second most popular reason for becoming interested in model rocketry was because of a friend's, sister's, or brother's involvement in a rocketry program. Of the 57 participants, 27 checked this as a reason for their interest in model rocketry.

Reading about model rocketry in magazines and newspapers or seeing rocketry programs on television was listed by 21 of the 57 respondents as a reason for their interest in model rocketry.

Other reasons for interest in model rocketry included building model rockets as part of: (1) a classroom aerospace study; (2) Maywood's Activity Program; (3) a youth club

TABLE I

STUDENT INTEREST, PREVIOUS EXPERIENCE, REASONS FOR INVOLVEMENT, AND FUTURE PLANS IN MODEL ROCKETRY

	Activity Program Participants*	Student-Team Members in Evening MR Classes*		Students in 4/5 Combination Class*	
	11 Male	17 Male	5 Female	12 Male	12 Female
Reasons for Interest in Model Rocketry					
By watching other students work with or launch model rockets at school	6	8	5	9	10
By building a model rocket as part of a classroom aerospace study		3		2	2
By building a model rocket as part of Maywood's Activity Program	11	3			
By building a model rocket as part of a youth club activity		1		3	1
By building a model rocket as part of another type of rocket class		1		3	3
By reading about model rockets in magazines or newspapers	2	5	2	8	4
By becoming interested in model rocketry because of a friend's, sister's, or brother's involvement in a rocketry program	5	6	2	7	7

TABLE I (continued)

	Activity Program Participants*	Student-Team Members in Evening MR Classes*		Students in 4/5 Combination Class*	
	11 Male	17 Male	5 Female	12 Male	12 Female
Reasons for Interest in Model Rocketry					
Because of my parents' interest in model rocketry		2	2	1	
Other reasons	3	2	2	5	1
Previous Experience in Model Rocketry					
None	8	10	5	6	8
Previous experience	1	6		5	3
Built but never launched a rocket	3	1		1	1
Reasons for Present Involvement in Model Rocketry					
Like to build models	11	14	3	11	5
Interested in aerospace science	4	11	3	8	7
Have watched others construct model rockets and wanted to try it	4	7	3	10	5

TABLE I (continued)

	Activity Program Participants*	Student-Team Members in Evening MR Classes*		Students in 4/5 Combination Class*	
	11 Male	17 Male	5 Female	12 Male	12 Female
Reasons for Present Involvement in Model Rocketry					
An adult wanted me to participate in this program		2	1		
It was required as part of a classroom aerospace study	2	4		10	12
I chose to participate in model rocketry as part of Maywood Hills' Activity Program	11	5			
Desire to work with model rockets in the future	9	9	1	11	9
How or Where?					
Building model rockets as a hobby	7	7	1	11	6
A family activity	5	8		5	5
At school	8	9	1	9	3
In a youth group	5	5	1	5	2
Other	1			1	2

*Students were not limited in their number of choices, thereby the discrepancies between totals and total class members.

activity; and (4) another type of rocket class such as a class sponsored by a hobby shop.

Parent's interest in model rocketry and classroom displays also had sparked student interest. These young people also commented "because it's fun", "I like building rockets", "my friends talk about them", "because they are very exciting".

Table I shows that 37 of the 57 students had no model rocketry experience at the time they filled out the survey. This was somewhat misleading as 10 of the 57 students participated in more than one of the model rocketry classes offered in connection with this study and filled out two surveys. In other words, before this study 47 of the 57 students had no previous experience in model rocketry. Of the 10 students who indicated they had previous model rocketry experience, 5 had obtained their experience in preceding years at Maywood. Other types of rocketry experience included building rubber band rockets, working with a brother, and building, but not launching, model rockets.

There was a variety of reasons why the students participated in the model rocketry classes at Maywood. Regardless of which of the three programs they were in, most children stated they enjoyed building models. More

boys than girls found this enjoyable. Out of the 40 boys in the classes 36 liked building models while 8 of the 17 girls enjoyed building them.

Of the 40 boys and 17 girls who participated in these classes, the following breakdown taken from Table I, pages 26-28, notes the reasons for involvement in model rocketry and indicates the number of favorable responses each received: (1) 23 boys and 10 girls stated they were interested in aerospace science; (2) 21 boys and 8 girls had watched others construct model rockets and wanted to try it; (3) 3 students were taking the class because an adult wanted them to; (4) 28 of the students either had previously taken or were presently taking model rocketry as part of a classroom aerospace study; (5) 11 boys took model rocketry from the experimenter as part of Maywood's Activity Program; (6) 5 boys in Mr. Giger's model rocketry section of the Activity Program took the evening classes with adults; and (7) 39 wanted to work with model rocketry in the future. Many of these 39 indicated they would like to work in several areas of model rocketry. The responses as to future plans in model rocketry were as follows: (1) 32 were interested in making it a hobby; (2) 23 hoped it would become a family activity; (3) 30 wanted to continue working in this field at school; (4) 18 had the desire

to work in this area as part of a youth group; and (5) 2 children noted they would like to build rockets independently and as a summer activity.

RESULTS OF ADULT SURVEY

The data in regard to adult interest, previous experience, reasons for involvement, and future plans in model rocketry are presented in Table II. The adult team members consisted of 17 males and 3 females. Of these participants, 14 males and 3 females were parents; 3 fathers were also youth leaders and 1 mother was also a teacher. In addition to the fathers who were youth leaders, there were 3 youth leaders who were not fathers.

Table II illustrates the most common reason for adult interest in model rocketry was a result of a child's interest in rocketry. Of the 20 adult participants, 18 listed this as a reason for their initial interest in model rocketry. This becomes even more significant when compared to 4 responses for the second most popular item. This item concerned watching students work with or launch rockets at school. Other reasons included: (1) participating in model rocketry as a leader of a youth club; (2) building a model rocket as part of another type of class; (3) reading about model rockets; (4) hearing talk about model

TABLE II

ADULT INTEREST, PREVIOUS EXPERIENCE, REASONS FOR INVOLVEMENT, AND FUTURE PLANS IN MODEL ROCKETRY

	Males	Females	Comments
Participating As a:			
Parent	14	3	3 fathers were also youth leaders; 1 mother was also a teacher
Teacher			
Youth leader	3		These 3 were not parents
How You Became Interested in Model Rocketry			
By watching students work with or launch model rockets at school	2	2	
By participating in model rocketry as a leader of a youth club	1		
By building a model rocket as part of another type of rocket class	1		(a course in Jr. High)
By reading about model rockets in magazines or newspapers	2		
Became interested in model rocketry because of a child's interest	16	2	In 15 cases it was their own child. In 2 cases the adults were older brothers. In one instance the adult was a friend.

TABLE II (continued)

	Males	Females	Comments
How You Became Interested in Model Rocketry			
Other reasons	3	1	"Heard people talk about model rockets." "Previously built liquid propellant rocket." "Goddard was a favorite." "Interested because my husband had taken an aerospace workshop."
Previous Experience in Model Rocketry			
None	13	3	
Some	4		"I had built a liquid propellant rocket." "I had worked with modified fireworks." "I had worked with model rockets in an aerospace class." "I had worked with rockets in an astronomy class."
Reasons for Involvement in This Particular Model Rocketry Program			
Like to build models	6		
Am interested in aerospace science	3		

TABLE II (continued)

	Males	Females	Comments
Reasons for Involvement in This Particular Model Rocketry Program			
Have watched others construct model rockets and wanted to try it	1		
A child wanted me to participate in this program	15	3	In 16 cases it was their own child. One child was a younger sister. One child was a youth club member.
To obtain a Model Rocket Coordinator's License	5	1 maybe	
To teach model rocketry in the classroom			
To teach model rocketry as a youth club activity	1*		*In spite of the fact this item was not checked, 3 other participants indicated they planned to use model rocketry with their youth clubs.
I would like to teach model rocketry			
As a motivational activity for the study of space			
Additional comments	1	1	"I participated because it sounded interesting." "The amount of future involvement is dependent about my 2 sons continuing their interest."

rockets; (5) previous experience with a liquid propellant rocket; (6) admiring Goddard; and (7) becoming interested in model rocketry because of a husband's participation in an aerospace workshop.

Of the 20 adults, 16 had no previous experience with model rocketry; 4 indicated they had some experience which included building a liquid propellant rocket, working with modified fireworks, taking model rocketry as part of an aerospace class and working with rocketry as part of a class in astronomy.

In 18 cases the reason for the adult's involvement in the model rocketry class was because a child had asked them to participate. In 16 cases the child was their own, one child was a younger sister, and one child was a youth club member. Six people indicated they wanted to obtain model rocket coordinator licenses and actually did get them at the conclusion of the classes. Two older brothers would have liked to obtained licenses but were not old enough. The following were reasons stated for involvement in the model rocketry classes: (1) liking to build models; (2) an interest in aerospace science; (3) having watched others construct rockets and wanting to try it; (4) planning to teach model rocketry as a youth club activity; and (5) because it sounded interesting.

The participating teams consisted of the following combinations:

Types of Teams	Number
Father and Daughter	4
Father and Son	10*
Mother and Daughter	1
Mother and Son	2
Brother and Sister**	1
Brother and Brother**	1
Youth Leader and Student	1

*One father had 2 sons in the class.

**The older brothers were also youth leaders.

Assisting with, and largely responsible for the success of the evening classes, were: (1) Dr. Robert Gesell, Aerospace Consultant to the Washington State Aeronautics Commission; (2) Mary Curtis, mathematics and science teacher with the Tahoma School District and also the first woman model rocket coordinator in the State of Washington; and (3) Sandy Kline, a third grade teacher at Maywood Hills and an aerospace enthusiast.

A comparison of Table I, pages 26-28, and Table II, pages 32-34, makes it readily apparent that when children were interested and enthusiastic about the subject the parents also became interested and involved.

OBSERVATIONS

Many observations were recorded as a result of conducting the 3 sessions in model rocketry. As these observations are included as recommendations in Chapter VI and are also incorporated into the handbook in Appendix F, they are listed here without elaboration.

I. Methods for motivating new students in model rocketry
   - A. Use students with previous model rocketry experience.
     1. Have them hold a demonstration launch.
     2. Let them lecture on model rocketry.
     3. Have them display their models.
     4. Have them assist with the class construction.
   - B. Teach an extensive unit on aerospace.
     1. Use a variety of audio-visual materials.
        a. Include tapes and records.
        b. Show models, films, filmstrips, transparencies, telelectures, etc.
     2. Invite resource people to work with the students.

II. Suggestions for constructing model rockets
   - A. Have children of intermediate age build the same rocket.

B. Caution the children to take their time.

C. Exercise care when working on the fins.

1. Cut the fins with the grain.

2. Use care when cutting and handling.

3. Sand sparsely.

4. Have extra balsa on hand.

5. Place the root edge on correctly and align the fins with the body tube.

D. Remember to attach the launch lug.

E. Have worksheets available for the quicker students to work on independently.

F. Use shoe boxes for storing individual materials.

G. Take care not to lose the screw eyes and launch lugs.

III. Suggestions for painting model rockets

A. Use spray paint.

1. Hold the paint 12 inches from the rocket to avoid globby appearance.

2. Don't paint the nose cone joint as it will need sanding in order to fit.

3. For a speckled affect, apply the basic color, then hold a contrasting color back 16 inches and spray a mist on the rocket.

4. For a patterned rocket spray basic color, dry, attach masking tape, repaint, dry, and remove tape.

B. Drying freshly painted rockets

1. Hang the nose cones from wires attached to the ceiling beams.

2. Hang rockets and nose cones from a tree.

IV. Storing rockets

A. Place rockets in high window sills or cupboards and make them off limits to the students.

B. Get a wooden pop case or segmented box to store and carry rockets to and from the launch area.

V. Suggestions for a more efficient launch

A. Have a box of materials handy.

1. Have extra igniter wires.

2. Have something to use for tapping in igniter wires.

3. Have extra fire-proof wadding.

4. Have extra tissue for holding igniter wires in place.

5. Have a screw driver, knife, scissors, and dowel or ice pick for miscellaneous jobs.

6. Have masking tape.

7. Have powder for the parachutes.

B. Effective usage of engines

1. Separate the engines by size and store them in a tackle box or segmented box.
2. Clean micro-clips with sand paper to avoid corrosion.
3. Don't drop the engines as the fuel can crack and cause improper firing.
4. If engine fails to ignite, scrape the nozzle as clay material may be present.
5. Staging is generally more successful than clustering.

C. Efficiency improves when two or more adults supervise a launch.

D. During a small launch let the owners track their own rockets.

E. Include students who have previous experience.

F. Have a storage area available for rockets that have been launched.

SUMMARY

The three classes of model rocketry conducted as part of this study were surveyed and observed. Reasons for the participants' interest, present involvement, and future

plans in model rocketry were noted. Observations were made and recorded in order to improve construction and launching techniques for the benefit of future model rocketeers.

CHAPTER IV

RESULTS OF THE QUESTIONNAIRE SENT TO MODEL ROCKET COORDINATORS

TECHNIQUE

A questionnaire concerning model rocket activities was set to fifty licensed model rocket coordinators in the State of Washington. As the information requested was not of a nature that demanded random sampling for validity, the experimenter conversed with Dr. Robert Gesell, Aerospace Consultant to the Washington State Aeronautics Commission, to formulate a list of educators knowledgeable in the field of model rocketry. These fifty coordinators were then mailed letters of explanation and questionnaires (see Appendixes D and E). Thirty questionnaires, 60 percent, were completed and returned to the experimenter.

Types of model rocketry classes being conducted in the state, community involvement in model rocketry, construction problems and suggested remedies, courses that could be correlated with model rocketry and suggested methods of implementation, and opinions concerning the usefulness of a slide presentation and handbook on model rocketry were solicited. For ease in interpretation, only

the items requiring a yes or no response are recorded in Table III, pages 51-53. Questions that required an essay type response have been summarized and listed below.

RESULTS

I. Construction problems particular to adults
   - A. Lack of observation and attention to directions in kits
     1. Failure to follow directions step by step
     2. Need for patience in procedure
   - B. Use of too much glue on the fillets
   - C. Improper cutting and sealing of fins
   - D. Poor painting techniques
   - E. Improper parachute packing

II. Construction problems particular to children
   - A. Problems of following step by step directions
     1. Inability to read and comprehend plans
     2. Lack of confidence
     3. Trying to hurry
   - B. Difficulty with fins
     1. Cutting
        - a. Improper use of Exacto-knife
        - b. Difficulty using a razor blade
        - c. Splitting the balsa
        - d. Lack of coordination

2. Sanding

3. Gluing

a. Using too much glue

b. Aligning the fins incorrectly

C. Finishing

1. Sealing the rocket

2. Mismatching lacquer and dope

III. Model rocketry correlated with mathematics

A. Determining altitudes

1. Use of angles

2. Measuring distances

3. Using coordinates

4. Trigonometry

5. Constructing graphs

B. Introduction to speed and velocity units

C. Calculating the center of pressure and center of gravity

D. Ordering rockets

E. Metric system versus the English system

F. Weights

IV. Model rocketry correlated with social studies

A. Rocket construction and employment location

1. Saturn V, Boeing, etc.

2. Mobility of people

B. Spin-off

C. World wide tracking stations

D. History of rocketry

1. Chinese inventors

2. Apollo space shots

3. Russian space program

E. Photography by rockets and satellites

1. Study of geography

2. Space exploration

3. Conservation

4. Weather forecasting

F. Current events

G. Transportation

V. Model rocketry correlated with reading

A. Independent reading

1. Magazines

2. Directions

3. Diagrams

4. Books

5. Catalogues

6. Periodicals

B. Directions for comprehension

1. Construction

2. Ordering

C. Researching reports

D. Space science unit in basal reader

E. Motivational

F. Taking inventory of rocket kits

VI. Model rocketry correlated with science

A. Meteorology

B. Aerospace

1. Aviation

a. History

b. Theory

2. Astronautics

a. Rockets

(1) Newton's third law

(2) Principles of flight

(3) Inertia

(4) Propulsion

(5) Engines

b. History

c. Biology

C. Chemistry

1. Rocket fuel

a. Rocket engines

b. Model rocket engines

c. Danger of student experimentation

2. Airplane fuel

D. Electricity

1. Continuity

2. Wiring

3. Circuits

a. Short

b. Solid

c. Remote controlled

4. Power source

E. Astronomy

VII. Model rocketry correlated with other subject areas

A. Photography

B. Spelling

C. Special education

D. English

1. Oral

2. Written

E. Art

1. Construction

2. Symmetry

3. Original designs

4. Improving standard designs

5. Finishing

a. Decorating

b. Painting

(1) Matching colors

(2) Technique

(3) Care of paints

(4) Care of brushes

VIII. Recommended rockets

A. For beginners

1. Alpha

2. Almost any single stage

B. A second rocket

1. Bertha

2. Individual choice depending on ability

IX. Useful aids in teaching model rocket construction

A. Partially constructed rockets

B. Transparencies

C. Publications from Estes and Centuri

D. Model rocket engine

E. Compass, protractor, and closet bar

F. Large scale model of a rocket engine

G. 35 mm slides of rocket activities

H. Student-made films

I. Commercial films

J. Experienced student helpers

K. Completed models

L. Pictures

M. Charts

X. Suggestions concerning model rocketry as a result of teaching experiences

A. Set goals.

B. Seek discount prices.

C. Instructor handles money.

D. Teach aerodynamics.

E. Take time constructing rockets.

1. Follow directions carefully.

2. For 8-11 year olds work step by step.

3. Exert care on fins.

a. Have extra balsa.

b. Pin fins together.

c. Help with the alignment.

d. Use a good glue.

e. Avoid using a two edged razor.

f. Seal the balsa.

F. Use a kit for beginners.

G. Encourage experienced rocketeers to roll tubes.

H. Be familiar with the rocket the students are constructing.

I. Require students to have a shoe box and construction materials.

J. Check the kit contents.

K. Have student notebooks.

L. Encourage father-son involvement.

M. Hold frequent launches.

N. Paint with care.

1. Demonstrate painting techniques.

2. Allow drying time between coats of paint.

The material presented immediately above contains the essay type responses that occurred on the model rocket coordinators' completed questionnaires. The most applicable of these essay responses have been incorporated in the handbook in Appendix F.

Table III, pages 51-53, shows that model rocket coordinators, who were also educators, conducted 70 percent of their classes for public school children. Approximately 15 percent of the classes held were for youth groups and another 15 percent were held for adults. The adult classes were primarily for educators rather than for lay citizens of the community. There were no combinations of student and adult classes offered. Of the 30 respondents, 3 had never conducted model rocketry classes.

Of the coordinators conducting student rocketry classes, 75 percent had observed construction problems particular to children. The comment section revealed the primary problems resulted from failure to follow directions,

TABLE III

NUMBERS AND PERCENTAGES OF RESPONSES ON MODEL ROCKET COORDINATORS' QUESTIONNAIRE

	Number of Responses		Favorable Percent
	Yes	No	
Have you conducted model rocket classes or activities?	27	3	90
*If yes,			
for adults?	5	25	15
for children in public schools?	24	6	70
for a youth group?	5	25	15
Have you observed model rocket construction problems particular to adults?	7	22	12
Have you observed model rocket construction problems particular to children?	22	6	78
Are you using model rocketry in correlation with mathematics?	19	11	63
Are you using model rocketry in correlation with social studies?	6	23	20
Are you using model rocketry in correlation with reading?	12	17	41
Are you using model rocketry in correlation with science?	23	7	76
Are you using model rocketry in correlation with any other subjects?	10	18	35

TABLE III (continued)

	Number of Responses		Favorable Percent
	Yes	No	
*Should these concepts be taught in a model rocket course?			
principles of flight	25	5	83
propulsion	23	7	76
safety	26	4	86
tracking	23	7	76
construction	25	5	83
other	9	21	30
Is model rocketry taught in your district?	22	6	78
Are any courses or activities taught as part of the curriculum?	20	6	76
Is model rocketry taught as an extra school curricular activity in your district?	14	9	65
Is there any community involvement in model rocketry in your district?	12	12	50
Would a slide sequence showing community involvement in model rocketry be useful to educators?	21	7	75
Should the sequence contain advice for conducting adult and student classes?	21	3	87

TABLE III (continued)

	Number of Responses		Favorable Percent
	Yes	No	
Should the presentation contain suggestions and pitfalls in model rocket construction?	24	3	88
*Would a booklet of suggestions for efficient model rocket construction techniques be useful to			
you as a coordinator?	19	11	63
beginning students?	19	11	63
beginning instructors?	21	9	70

*These were the only responses computed using the basis 30 which was the total number of coordinators who returned the questionnaire. Due to a variety of teaching assignments and the applicability of the questions, all other responses were computed by using the total number of responses that the individual questions received.

rushing through construction, and improper cutting, sanding, and aligning of the fins. A number of coordinators also concluded children need close supervision and a patient instructor.

In general, the teaching assignment of the coordinator determined the units that were correlated with model rocketry. For example, a junior high science teacher correlated model rocketry with science rather than social studies. However, many subject area specialists offered suggestions for correlating model rocketry with subjects they themselves did not teach.

Among the people surveyed, model rocketry was most commonly correlated with mathematics and science. In the elementary self-contained classrooms, model rocketry was generally correlated with a wider variety of subjects than in the junior or senior high schools.

The responses to the questionnaire also revealed the following percentages of coordinators who were correlating model rocketry with selected subjects: (1) social studies, 20 percent; (2) reading, 41 percent; (3) mathematics, 63 percent; (4) science, 76 percent; and (5) art or other subjects, 35 percent.

The coordinators were asked if principles of flight, propulsion, safety, tracking and construction should be taught in a model rocketry course. The results were as

follows: (1) 83 percent favored teaching principles of flight; (2) 76 percent were in favor of teaching propulsion; (3) 86 percent indicated safety should be taught; (4) 76 percent thought tracking should be taught; (5) 83 percent believed construction should be included; and (6) 30 percent suggested other concepts to be taught in the course.

Table III, pages 51-53, shows 78 percent of the coordinators surveyed worked in districts where some type of model rocket classes were taught. The following breakdown in percentages shows how these districts were using model rocketry: (1) 76 percent included it as part of the curriculum; (2) 60 percent offered it as an extra curricular activity such as summer school, an elective, after school, or at noon; and (3) 50 percent indicated there was community involvement such as help for Scouts, church groups, Civil Air Patrol, 4-H groups, and rocket clubs.

The coordinators were asked for their opinions on the usefulness of a model rocketry slide presentation. Table III shows that 75 percent indicated a slide sequence illustrating community involvement in model rocketry would be useful to educators; 87 percent said the slide sequence should contain advice for conducting adult and student classes and 88 percent thought the presentation should contain suggestions for model rocket construction and pitfalls that should be avoided.

When asked if a booklet of suggestions for efficient model rocket construction techniques would be of value, 63 percent said it would be useful to coordinators and students and 70 percent thought it would be helpful to beginning instructors.

The responses regarding the slide presentation and handbook indicated there is a need for, and interest in, the type of materials developed as a result of this study. The following comments made by the coordinators further attested to the need for such materials: "paperback information is greatly needed"; "materials like this are usable if well done"; "they would be good for public relation purposes"; "a booklet of suggestions would probably be useful to parents. . . ."

SUMMARY

The questionnaire for model rocket coordinators in education revealed the type of courses and activities that were already being conducted in the State of Washington. It also revealed subjects that had been correlated with model rocketry and suggestions for additional types of correlations. In addition, techniques of construction and views on the usefulness of a model rocket slide presentation and booklet were disclosed.

CHAPTER V

NARRATIVE SCRIPT FOR THE 35 MM SLIDE PRESENTATION

The primary purpose of the slide presentation was to illustrate school and community involvement in model rocketry. The presentation also depicted motivational and educational aspects of model rocketry, state requirements for obtaining a coordinators' license, and various construction, launching, and safety techniques.

The slide script narration follows:

NARRATION FOR SLIDE PRESENTATION "SCHOOL AND COMMUNITY INVOLVEMENT IN MODEL ROCKETRY"

Slide

1 Many model rocketeers have their initial experiences with model rocketry in the schools.

2 Model rocketry is an extremely motivating subject for students. It is an exciting way to study aerospace and can serve as a lead up activity to an in depth study of astronautics. The next series of 19 slides will illustrate this point.

3,4 Model rockets are actually models of full sized rockets and as such they have many similarities.

Slide

5 Full size rockets require an assembly building for their final stages of construction.

6 Model rockets can be assembled in the classroom, a club house, or in a home.

7 For security reasons, rockets must be safely stored in restricted areas until launch time.

8 Fully constructed model rockets should be stored in an "off limits" area to avoid excessive handling and resultant fin damage by overexuberant model rocketeers.

9,10 Both types of rockets require an upright position at launch for directional guidance.

11,12 Both rockets use a propulsion system requiring engines and fuel.

13,14 During final countdown, distance restrictions from the launch sites are in effect.

15,16 Electrical systems spark ignition.

17,18 Tracking is a method of in-flight rocket observation.

19 Rockets place weather, television, and communication satellites in orbit.

20 Some satellites photograph the earth.

21 There are model rockets that also photograph the earth. You even have your choice of prints or movies.

Slide

22 The study of model rockets often arouses interest in other areas of aerospace. Children enjoy constructing gas engine airplanes.

23 Field trips to local airports or actual flight experiences are excellent experiences for aviation-oriented students.

24 Helicopter rides, touring a helicopter, or having one land on the school playground are exciting ways to learn about this aeronautical vehicle.

25 A field trip to the space-oriented Seattle Center with its models, satellites, mock-ups, space capsules, films, and planetarium is an excellent motivational or culminating activity for an aerospace unit.

26 Constructing kites, whether for decoration or for flight, leads to speculation about flight.

27 Model rocketry can be correlated with many subjects. For example the history of flight might be incorporated in a model rocketry unit in the manner illustrated in the next five slides.

28 Since the beginning of time man has watched the birds and wanted to fly.

29 With the success of the Wright Brothers at Kittyhawk, man's dream came true.

Slide

30 Charles Lindberg's transatlantic flight in the Spirit of St. Louis brought the people of the world closer together.

31,32 In an exceedingly minute span of history, man has developed the airplanes, jets, and helicopters.

33 With the perfection of the rocket, space exploration has become a reality.

34 In similar ways mathematics, social studies, science, reading, and art can also be correlated with model rocketry.

35 A particular grade level can be designated to include model rocketry as part of its curriculum. Generally speaking, this would be an intermediate grade that has some aspect of aerospace science as a part of its existing curriculum. An individual teacher might include model rocketry as part of her program if it is not possible to include it at the entire grade level.

36 In addition to regular classes in model rocketry, some schools encourage noon time and after school activities.

Slide

37 Some grade schools are trying to prepare students for the future and the leisure time that sociologists predict Americans will have. "Mini Courses" and "Activity Programs" are short term, high interest programs in which students learn hobby skills. Model rocketry lends itself well to this type of program.

38 Activity Programs also afford an excellent opportunity for community involvement. Parents, youth leaders, and interested citizens often are willing to offer their time and share their talents in conducting an activity class.

39 Junior high and senior high schools can also include model rocketry in regular courses such as aviation, astronomy, or astronautics as well as offering it as an elective course. A demonstration launch, held for a grade school that doesn't have model rocketry in its curriculum, can be an exciting experience for both groups of students.

40,41 Primary students should not be excluded. They should be invited to school launches, or a primary teacher could conduct a demonstration launch. Rockets tie in nicely with science and transportation units. Dittos of rockets and the space program can be made from coloring books. The children themselves can

Slide

have a delightful time constructing clothespin rockets.

42,43 An enthusiastic teacher usually has a classroom of enthusiastic students. Through participation in an "United States Air Tour Workshop" such as Central Washington State College has offered, a model rocket workshop, or an aerospace awareness program, teachers usually get "turned on" to aerospace education.

44 Teachers who wish to become more involved in aerospace education may wish to inquire about activities of their local Civil Air Patrol Wing or join the Washington Aerospace Association. The latter's sole purpose for existence is to be of assistance to aerospace educators.

45 In addition to conducting classes and launches, there are many ways a teacher can inspire involvement in model rocketry. She might work with individual students, tape launching procedures for future groups, or write articles for the school paper.

46 She could take pictures of model rocketry activities and use them for bulletin board displays in the classroom, hallways, office, faculty room or district display areas.

Slide

47 She could have the students include model rockets in a science fair or display them at open house or during grade level meetings.

48,49 An experienced aerospace educator could also share her knowledge with others in her district by: (1) ordering free or inexpensive materials for the district; (2) collecting and filing materials for others to use; (3) informing the librarian of current aerospace books, pictures, and audio-visual materials; (4) speaking to other classes about aerospace, rockets, and spin-off from space exploration; (5) showing slides at a school assembly; and (6) making other educators aware of the vast amount of services that are available to them.

50 NASA provides free publications, films, pictures and tele-lectures . . .

51 . . . expert speakers . . .

52 . . . and Spacemobile lecturers . . . .

53 The Federal Aviation Administration (FAA) furnishes publications, films and speakers. Civil Air Patrol offers high school courses in aviation education and the National Aerospace Education Association offers much assistance to its members.

Slide

54,55 Model rocket manufacturing companies and their personnel are eager to assist you with publications and purchases.

56,57 Whenever possible work with your administrators. An interested science coordinator could handle most of the aforementioned activities. He often has channels to work through of which the classroom teacher is not even aware. He can coordinate model rocketry efforts in the district, purchase a multi-launcher and communication equipment, and correlate activities.

58 Inform the district curriculum director of the motivational and educational potential of model rocketry.

59 School boards may be interested in model rocketry activities.

60 Getting the support of the local education association can be helpful to a model rocketry program. Here North Shore Education Association President, Carol Coe, hears once again about the glories of model rocketry. Some local associations have funds set up for teacher projects. When instigating a model rocketry program this can be an excellent source for financial assistance.

Slide

61 Be sure to include your principal in your planning! Maybe he will even become involved in model rocketry himself.

62 Encourage and enlist the support of the PTA. The support may be moral or financial. Both are helpful! A slide presentation, a speech, or an invitation to a launching where safety, educational value, and hobby potentials are illustrated, may even encourage parental participation in the model rocketry program.

63,64 Parents can be extremely helpful in a model rocketry program. They can help with rocket construction and launches. It is extremely helpful to have several knowledgeable adults assisting with the tracking, recording of data, stability testing, replacing igniter wires, and checking incomplete circuits and distance requirements.

65 Model rocketry can be an excellent family activity. Classes offered for students and adults can be a fantastic experience. Parents become nearly as excited as their children.

66 They enjoy constructing the models, as well as learning about propulsion, safety, principles of flight, tracking, state requirements . . .

Slide

67 . . . launching . . .

68 . . . apogee . . .

69 . . . and recovery.

70 Older brothers, parents, youth leaders, and teachers found that participating in a model rocket class with a child for a partner was an interesting and rewarding experience.

71 Both mother and father attended evening classes with their son and the entire family turned out for the launch.

72,73 Dr. Robert Gesell, Aerospace Consultant to the Washington Aeronautics Commission, met with the parents who were interested in obtaining coordinators' licenses. He tested their knowledge of model rocketry, safety, and state requirements. He then signed the authorization forms necessary for the issuance of Washington State Coordinators' Licenses by the State Fire Marshal in Olympia.

74,75 This father not only participated in the evening model rocketry class with his son, he furnished the battery for the launch, worked as part of the tracking team, and by demonstrating his competency in model rocketry obtained his Washington State Coordinator's License. He planned to continue model rocketry as a

Slide

family activity, volunteered to assist with school launches, and intended to incorporate model rocketry as an activity in his Boy Scout troup.

76 Youth groups such as Boy Scouts find model rocketry a fascinating activity. "Youth organizations such as the YMCA . . ., 4-H, CAP, Boys Club . . ." (7:Vol. 11, No. 2, p. 2) and Girl Scouts also enjoy rocketry.

77 The National Association of Rocketry has local units throughout the state.

78 "Potential club activities include sport flying, launches, various types of contests, research and development projects, and aerospace workshops. Field trips, conferences, films, guest speakers, educational activities, demonstrations and exhibits are also available to organized clubs" (Ibid., p. 1).

79 Potential sponsors for model rocketry classes include recreational centers . . .

80 . . . and hobby shops that carry model rocket kits and materials.

81 People engaged in model rocketry should communicate their activities to the community. Teachers' letters and articles written for the local newspapers are helpful. Often a local paper will notify the public

Slide

of the launch and will carry a follow-up article and pictures in a later edition.

82 Regardless of age, participants in model rocketry seem to enjoy being involved in . . .

83 . . . an exciting space age hobby.

84 With such a wide variety, model rocketry is indeed a very challenging experience!

SUMMARY

The 35 mm slides were produced and edited in order to depict school and community involvement in model rocketry. The narrative script was written, edited, and produced to be used in conjunction with the slides.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

SUMMARY AND CONCLUSIONS

It was the purpose of this study (1) to broaden involvement in aerospace education to include parents and youth leaders as well as students and teachers; (2) to use model rocketry as a nucleus for this four way involvement; (3) to provide an opportunity for more adults to participate in a model rocketry construction and safety course in order to obtain their Washington State Model Rocket Coordinators' Licenses; (4) to compile a handbook of tips for the efficient construction and use of model rockets; and (5) to produce a color slide sequence illustrating community and school involvement in model rocketry.

Model Rocket Classes and Surveys

Three sessions of model rocketry classes were held. Two classes consisted entirely of students while the participants of the third class were students and adults. The popularity of these classes, judged by the number of participants, indicated that model rocketry did serve as a nucleus for school and community involvement in a common endeavor.

All participants were surveyed as to the reasons for their interest and involvement in model rocketry. The results of the surveys revealed that children primarily became interested by seeing their peers construct and launch rockets. Most adults became involved in model rocketry because of their children's interest.

Observations of the classes by the experimenter revealed various problems in construction and launch techniques. Suggestions for solving these problems are incorporated in a handbook found in Appendix F.

Adult participants in the model rocketry class who demonstrated competency in model rocketry were issued coodinators' licenses.

Questionnaire

Licensed model rocket coordinators in Washington were sent questionnaires to determine types of classes and activities offered in their districts. They were also asked for construction tips and aerospace related units to correlate with model rocketry. These aerospace educators were willing and eager to lend assistance to this aerospace project.

The tabulated questionnaires disclosed that most model rocketry classes in Washington are being conducted for public school children. These classes are often taught

in conjunction with other subjects. The coordinators also indicated pitfalls common to model rocketeers and suggested techniques for overcoming these problems.

Handbook

The findings from the review of literature, the observations made of the rocketry classes, and the results of the questionnaires were compiled to create a handbook entitled, Handbook of Tips for the Efficient Construction and Use of Model Rockets.

Slide Presentation

A slide sequence and narrative titled "School and Community Involvement in Model Rocketry" was produced as a result of this study.

RECOMMENDATIONS

Based on the findings of the study and the professional background of the investigator, it is recommended that (1) a Handbook of Tips for the Efficient Construction and Use of Model Rockets be printed by an appropriate organization or agency and be made available to educators; (2) the slide presentation, "School and Community Involvement in Model Rocketry", be made available to educators through an instructional materials center or an organization of that nature; (3) the model rocket coordina-

tors and school districts offer student and adult model rocketry classes to encourage school and community involvement in a common project; (4) more opportunities be provided for adults who are not educators to obtain model rocket coordinators' licenses; and (5) authorization to train adults and recommend the issuance of model rocket coordinators' licenses to them, be granted to additonal qualified aerospace educators by the state coordinator of model rocketry.

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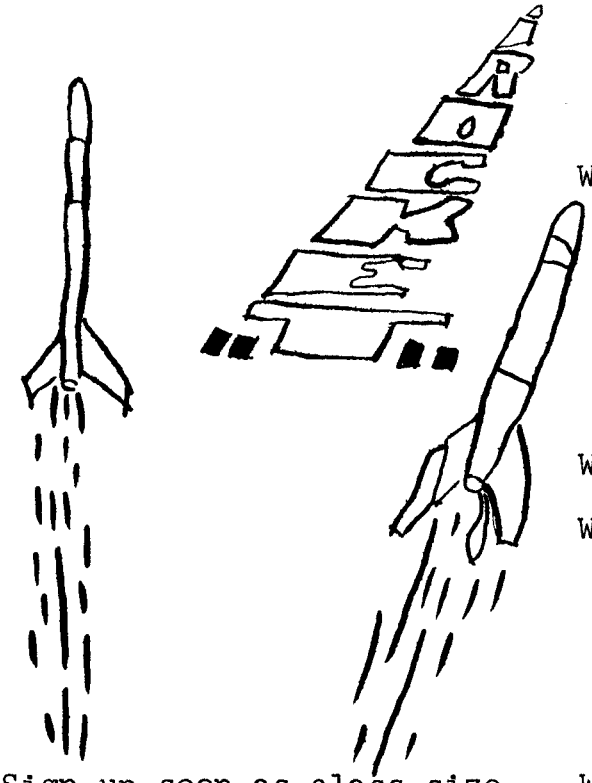
APPENDIX A

MODEL ROCKET CLASS



WHAT? A class in model rocket construction and launching (Here too is an opportunity for adults to obtain a Model Rocket Coordinator's License)

WHERE? Maywood Hills

WHEN? Tuesday, April 11
Thursday, April 13
Thursday, April 20
Saturday, April 22
From 7:00-9:00 except for the Saturday morning launch

WHO? TEAM MEMBERS
A team consists of
1. a parent and an intermediate* aged child
or 2. a youth leader and an intermediate* aged child
or 3. a teacher and an intermediate* aged child

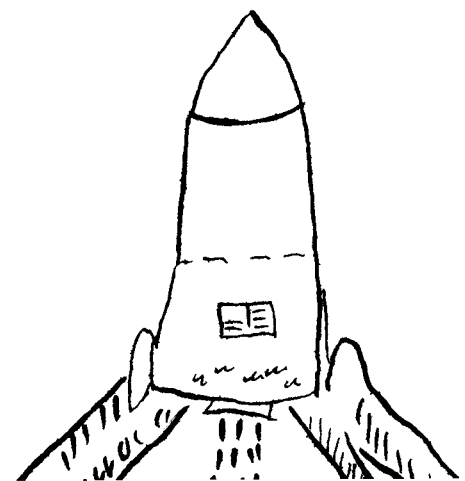
Sign up soon as class size is limited!

Cost? Approximately $2.00 per team for one rocket and engine (payable at first class session)

Instructor: Helen Frizzell

Washington State Aeronautic Consultant:
Dr. Robert Gesell

*Intermediate refers to children in grades 4, 5, and 6.



Complete either section I or section II and return by Friday, March 24 if you wish to participate in the model rocketry class

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Section I - (for team members)

I _____, wish to participate
name
in the model rocketry class. I will be participating as (circle) 1. a parent, 2. a teacher, 3. a youth leader.

My intermediate age partner is _____.
name

He/She is in _____.
Grade and Room

Section II - (Rocketeers without partners)

If the class is not full and the instructor could locate a partner for me I would like to participate in the model rocket course.

Name _____

I would be participating as (circle)
1. a teacher
2. a parent
3. a youth club leader
4. a student

Students please fill in your grade and room_____

APPENDIX B

MODEL ROCKETEER SURVEY
STUDENT QUESTIONNAIRE

Name_____Age____ Grade_____ Sex_____

I. How did you become interested in model rocketry? (Check all appropriate items.)

_____ A. By watching other students work with or launch model rockets at school.

_____ B. By building a model rocket as part of a classroom aerospace study.

_____ C. By building a model rocket as part of Maywood's Activity Program.

_____ D. By building a model rocket as part of a youth club activity. (example: scouts) If yes, what is the name of the sponsoring organization?_____

_____ E. By building a model rocket as part of another type of rocket class. (example: a class sponsored by a hobby shop specializing in rocketry) If yes, what is the name of the sponsoring organization?_____
_____

_____ F. By reading about model rockets in magazines or newspapers. If yes, please name the magazine or newspaper_____

_____ G. By becoming interested in model rocketry because of a friend's, sister's, or brother's involvement in a rocketry program.

_____ H. Because of my parents' interest in model rocketry.

_____ I. Other reasons_____
_____

II. What previous experience have you had in model rocketry?

_____ A. None (Go on to section III.)

_____ B. Types of previous experience (examples: rocket construction, participation in a launch, etc.)_____

_____ C. I have built a rocket but I have never launched it.

III. What are the reasons for your present involvement in model rocketry?

_____ A. I like to build models.

_____ B. I am interested in aerospace science.

_____ C. I have watched others construct model rockets and I wanted to try it.

_____ D. An adult wanted me to participate in this program. If yes, was the adult a parent, a youth leader, or a teacher? (circle)

_____ E. It was required as part of a classroom aerospace study.

_____ F. I chose to participate in model rocketry as part of Maywood Hills' Activity Program.

_____ G. I want to work with model rockets in the future. If no, you are finished. Thank you for your assistance. If you checked yes, please answer the following:

_____ 1. I am interested in building model rockets as a hobby.

_____ 2. I hope model rocketry will become a family activity.

_____ 3. I would like to work further in the field of model rocketry at school.

_____ 4. I would like to work further in the field of model rocketry in a youth group.

_____ 5. Other _____

APPENDIX C

MODEL ROCKETEER SURVEY
ADULT QUESTIONNAIRE

Name _____ Sex _____

Participating as: ____ a parent ____ a teacher
____ a youth leader

I. How did you become interested in model rocketry? (Check all appropriate items)

_____ A. By watching students work with or launch model rockets at school.

_____ B. By participating in model rocketry as a leader of a youth club. If yes, what was the organization? _____

_____ C. By building a model rocket as part of another type of rocket class. (example: a class sponsored by a hobby shop specializing in rocketry) If yes, what is the name of the sponsoring organization? _____

_____ D. By reading about model rockets in magazines or newspapers. If yes, which ones? _____
_____

_____ E. By becoming interested in model rocketry because of a child's interest. If yes, was the child 1. your child, 2. a student, 3. a youth club member? (circle)

_____ F. Other reasons _____
_____

II. What previous experience have you had in model rocketry?

_____ None (Go on to section III.)

_____ I have had previous experience in model rocketry. If yes, what type? _____

_____ I have built a rocket but I have never launched it.

III. What are the reasons for your present involvement in model rocketry?

_____ A. I like to build models.

_____ B. I am interested in aerospace science.

_____ C. I have watched others construct model rockets and I wanted to try it.

_____ D. A child wanted me to participate in this program. If yes, was the child 1. your child, 2. a student, 3. a youth club member? (circle)

_____ E. I want to obtain a Model Rocket Coordinator's License.

_____ F. I want to teach model rocketry in the classroom.

_____ G. I want to teach model rocketry as a youth club activity.

_____ H. I would like to teach model rocketry as a motivational activity for the study of space.

_____ I. Additional comments _____

_____

_____

APPENDIX D

March 28, 1972

Dear Model Rocket Coordinator and Fellow Educator,

This year I find myself secretary and co-chairman of elementary aerospace curriculum for the Washington Aerospace Association. I am also working on a master's degree at Central Washington State College. As a result of these responsibilities, I am working on a project in model rocketry that is correlated with both endeavors.

Recently I conversed with Dr. Robert Gesell, Aerospace Consultant to the Washington State Aeronautic Commission, to formulate a list of educators who are knowledgeable in the field of model rocketry. As your name appeared on this list, I am requesting your assistance on the model rocketry project. I would certainly appreciate your time and effort as the success of such a project depends on the cooperation of people like you.

Enclosed is a questionnaire on model rocketry. If you would take time out of your busy schedule to complete and return it to me by April 30, I would be sincerely grateful.

As a result of this questionnaire, a booklet of tips and suggestions for teaching model rocketry will be compiled

and made available through the Washington Aerospace Association for interested Washington Educators.

If you would like to receive a copy of the booklet when it is completed, please indicate this desire in the appropriate section of the questionnaire.

Thank you so much for your assistance.

Sincerely,

Helen Frizzell

APPENDIX E

QUESTIONNAIRE FOR MODEL ROCKET COORDINATORS IN EDUCATION

Name_____ Sex_____ Grade or Subject_____

I. Have you conducted model rocket classes or activities? (Check all appropriate items)

Yes____ No____ If yes, ____ 1. for adults
____ 2. for children in a public school
____ 3. for a youth group

A. Have you observed model rocket construction problems particular to adults? What?_____

Yes____ No____ _____

_____

Yes____ No____ B. Have you observed construction problems particular to children? What?_____

_____

_____

Yes____ No____ C. Are you using model rocketry in correlation with mathematics? How?

_____

_____

Yes____ No____ D. Are you using model rocketry in correlation with social studies? How?_____

_____

Yes____ No____ E. Are you using model rocketry in correlation with reading? How?

_____

_____

Yes____ No____ F. Are you using model rocketry in correlation with science? How?

_____

_____

Yes____ No____

G. Are you using model rocketry in correlation with any other subjects? Which subjects and how are you using model rockets?_____

H. With what units can model rocketry be successfully correlated? (example: astronomy)_____

How?_____

I. Which concepts should be taught in a model rocket course?

_____ 1. principles of flight
_____ 2. propulsion
_____ 3. safety
_____ 4. tracking
_____ 5. construction
_____ 6. other_____

J. What rocket would you recommend for beginners?_____

As a second rocket?_____

K. What aid or models have you found to be useful in teaching model rocket construction?_____

L. From your teaching experience what suggestions or tips can you recommend for efficient rocket construction?_____

M. Comments:_____

II. Is model rocketry taught in your district? (If No, continue to section III.)

Yes____ No____

A. Are any courses or activities taught as part of the curriculum?

Yes____ No____

B. Is model rocketry taught as an extra school curricular activity in your district?

Yes____ No____

C. Is there any community involvement in model rocketry in your district? (examples: model rocketry clubs, scouts, etc.)
If yes, what kinds?_____
_____

III. Would a slide sequence showing community involvement in model rocketry be useful to educators?

Yes____ No____

A. Should the sequence contain advice for conducting adult and student classes?

Yes____ No____

B. Should the presentation contain suggestions and pitfalls in model rocket construction?

IV. Would a booklet of suggestions for efficient model rocket construction techniques be useful to
_____ 1. you as a coordinator?
_____ 2. beginning students?
_____ 3. beginning instructors?

Comments_____
_____
_____
_____

Yes____ No____ Would you like a copy of the results of this questionnaire?

Yes____ No____ As a result of this questionnaire there will be a booklet compiled on efficient model rocket construction. Would you like a copy?

APPENDIX F

HANDBOOK OF TIPS FOR THE EFFICIENT CONSTRUCTION AND USE OF MODEL ROCKETS

TABLE OF CONTENTS

FOREWORD

In any endeavor there are several ways to do things--the hard way, the impossible way, or the easy way. The purpose of this handbook is to set down guidelines for working with model rockets in the hope that model rocketeers will be able to construct model rockets easily and efficiently while avoiding pitfalls common to model rocketeers. This booklet contains tested ideas and techniques and stresses construction rather than technical aspects of model rocketry.

The handbook also contains suggested reference materials and aids, motivational activities, and launch and storage tips. It advocates school and community involvement in model rocketry, recommends concepts that could be taught in a model rocketry unit, and suggests subjects that could be correlated with model rocketry.

There are many ideas presented in this handbook. They should be viewed as suggestions or possible rather than absolute methods. Some sections suggest beginning and advanced procedures, specialized equipment, and large quantities of materials. It is expected that instructors and coordinators will select materials and ideas relevant to their needs.

This handbook was compiled from information obtained from questionnaires set to a sampling of model rocket coordinators in Washington State, model rocket publications and personal experiences of the author. It was not designed to replace directions in model rocket kits, or to be used as a step-by-step guide for construction or launching.

Saltrick and Kubota have written an excellent guide for teaching model rocketry. This book, titled Aerospace Education and Model Rocketry, is available through Estes Industries.

I. METHODS FOR MOTIVATING STUDENTS

A. Use students with previous model rocketry experience to motivate new rocketeers.
   1. Have them hold a demonstration launch.
   2. Let them lecture on model rocketry.
   3. Have them display their models.
   4. Let them talk informally about model rockets with the new students.
   5. Have them assist with the construction.

B. Teach an extensive unit on aerospace.
   1. Use a variety of audio-visual materials.
      a. Include tapes and records.
      b. Show models, films, filmstrips, charts, slides, transparencies, telelectures, and photographs.
   2. Invite resource people to work with the students.

C. Have students make club emblems.
   1. Use them on notebooks or posters.
   2. Place them on "T"-shirts (6:5).
      a. Draw emblem on T-shirt with ordinary crayon. Take your time and get plenty of each color worked into material.
      b. Set iron for "cotton" and while waiting for it to get up to temperature spread the T-shirt and put a sheet of newspaper under the emblem, and one over the emblem.
      c. Holding the top sheet in place, iron over the area of the emblem (or if it is small enough, place iron over emblem) for 30 seconds. Lift top sheet of newspaper and allow shirt to cool before moving. Hand washing is recommended.

D. Offer model rocketry as an extra curricular activity.
   1. Summer school class
   2. Noon time activity
   3. After school class
   4. Mini course
   5. Activity Program

II. TEACHER PREPARATION

A. Set the goals to be reached before starting the program.

B. Try to get rockets at a discount as this will allow you to buy extras such as paint, sandpaper, glue, and brushes at no extra cost to the students.

C. Handle all money yourself as this can really be a headache if you do not check and recheck orders and money.

D. "Build a model rocket. This will give you the needed experience to determine how difficult this task will be for your class" (10:9).*

E. "Test fly your rocket before the units begin" (10:10).

F. Hold a demonstration launch.
   1. Before going outside for the launch, briefly discuss the following with the students.
      a. The similarity of the model to be flown to a full sized rocket.
      b. The safety code that you will follow in executing the launch (10:11-12).
   2. "Select the Launch Operations Team to assist you during the launch" (10:12).
   3. "Outside for the demonstration launch: Prepare for the launch. (Use a small engine for the first flight.) Have students join you in the countdown, 'Lift-off', and then recovery of the rocket. Then ask for questions or comments" (10:13).
   4. "Return to the classroom and prepare the questions and comments made by the students for display in a prominent place" (10:14).

G. First rockets should be of the kit type; all beginning students should build the same kit.

H. Advanced students should roll their own tubes over a waxed closet pole or broom stick.

---

*The first number refers to the position of this source in the bibliography. The second number is the page reference.

I. Accumulate extra balsa wood for broken fins.

J. Have knives, glue, sandpaper, sharp pencils, scissors, rulers, shoe boxes, rocket kits, a launcher, engines, paint, igniters, cutting board, fireproof wadding, and altiscopes all at your fingertips. Don't begin until all the materials are present.

K. Have a lesson on the rocket parts.
   1. Show a cardboard model with parts glued on and labeled.
   2. Show the model rocket parts from a package.
   3. Use a transparency to illustrate model rocket parts.
   4. Distribute descriptive drawings of rocket parts to be completed by the students.

L. Discuss the use of Exacto-knives.

M. Have students prepare a small notebook. Prior to each construction period, they can jot down notes regarding that phase of construction, including drawings.

N. Assign work areas.

O. Distribute the rocket kits and necessary materials.

P. Have the children use the parts list to inventory the contents of their kits.

Q. Have the owner place his name on assigned numbers on the kit and inside the body tube.

R. Discuss the procedure that they are expected to follow.
   1. Children from ages eight through eleven construct "by the numbers" or all together one step at a time.
   2. Older children or experienced rocketeers may work independently.

S. Insist that all directions be read twice before construction begins.

III. PITFALLS (CONSTRUCTION PROBLEMS)

Listed below are problems commonly encountered during model rocket construction. Suggested remedies for these problems are found in section IV, "Construction Techniques".

A. Problem areas for adults
   1. Lack of observation and attention to directions in kits
      a. Failure to follow directions step by step
      b. Need for patience in procedure
   2. Use of too much glue on the fillets
   3. Improper cutting and sealing of fins
   4. Poor painting techniques
   5. Improper parachute packing

B. Problem areas for children
   1. Difficulty in following step by step directions
   2. Inability to read and comprehend plans
   3. Lack of confidence
   4. Trying to hurry
   5. Difficulty with fins
      a. Cutting
         (1) Improper use of Exacto-knife
         (2) Difficulty with using a razor blade
         (3) Splitting the balsa
         (4) Lack of coordination
      b. Sanding
      c. Gluing
         (1) Using too much glue
         (2) Aligning the fins incorrectly
   6. Improper placement of engine mount
   7. Finishing
      a. Sealing the rocket
      b. Holding the spray can too close
      c. Mismatching lacquer and dope

IV. CONSTRUCTION TECHNIQUES

The "Model Rocketry Technical Manual", section of the Estes Model Rocketry Catalog, and direction sheets in model rocket kits contain step-by-step construction procedures. The purpose of section IV, "Construction Techniques", is to offer additional suggestions and techniques for more efficient model rocket construction.

A. General comments
   1. Do not allow the kits or rockets to go home during construction. In this way you will avoid lost parts, broken or misplaced rockets, and idle children who have left their rockets at home.
   2. Have a model rocket storage area that is off limits to the students except during construction periods.
   3. You may wish to start with three or four students and work with them putting rockets together. Then you have helpers to work with the rest of the class.
   4. Most children have a tendency to rush, encourage them to work slowly and carefully.
   5. Allow plenty of time during construction periods as you do not want to rush the students.
   6. Have worksheets and reading materials available for students who finish early.
   7. Be patient! Do not find fault. Praise the students and lead them to better work.

B. Engine holder
   1. Leave 1/8" of the engine holder sticking out of the body tube to avoid swelling.
   2. Use a steady, continuous motion when inserting the engine holder to avoid freezing.

C. Engine block
   1. "Balsa or paper engine blocks will stay where you install them if you first bevel the edge that enters the tube first" (6:Vol. 4, No. 3, p. 6).
   2. Get the right engine block position for sure by using a gauge. "A few layers of 1/2" masking tape wrapped around one end of an engine casing makes engine block installation a deft one-move operation without fear of freezing out of place. The 1/2" unit gives proper positioning for upper stages; the 1/4" unit allows the engine to be taped to the engine tube for easy installation and removal" (6:Vol. 5, No. 1, p. 5).

D. Glue dispensers for hard-to-reach places
   1. Use a fair sized straw or launching lug. Squeeze glue into the straw. Stick the straw inside the body tube. Then use your finger on the end of the straw to control the flow of glue (6:Vol. 6, No. 1, p. 5).
   2. Apply a liberal amount of glue to a cotton swab. Insert it into the work to the desired depth and roll on the glue (6:Vol. 4, No. 2, p. 8).

E. Shock cord
   1. For an invisible shock cord attachment use gauze rather than a shock cord anchor pattern. Hold the end of the shock cord in place with glue and place a small piece of gauze over it. Let the shock cord dangle free until dry (6:Vol. 5, No. 2, p. 5).
   2. A strip of masking tape, cut to 1/4" width, can be wrapped around the shock cord and will securely attach it to the screw eye (6:Vol. 8, No. 1, p. 5).

F. Making the fins
   1. "The first rule in proper fin making is to get the correct grain direction. This direction is indicated by slightly darker lines scattered along the wood. In all but a few cases these lines must run parallel to the leading edge of the fin" (6:Vol. 4, No. 3, p. 2).
   2. Transferring fin patterns to the balsa (Ibid.)
      a. Use carbon paper.
      b. The pattern is cut directly from the plans and positioned on the fin material. A line is then drawn around the pattern.
      c. Lay the pattern on the fin material. Push the point of a pin through the plan into the wood at all corners of the fin pattern. Lift the plan and join all holes with a line. If the pattern has a curved section, put the pin-holes every 1/8" around the entire curved portion to faithfully transfer the shape. Cut this fin and use as a master pattern for the others.
   3. Cutting
      a. Use sharp blades or an extra sharp knife.
      b. Cut on firm cardboard.
      c. Cut across the grain first to minimize splitting.
      d. "Cut along the center of the line with light pressure. Make several strokes along a line with the blade to cut through rather than try to cut all the way in one stroke" (Ibid.).

4. Sanding
   a. Avoid sanding for younger children as fins seem to disappear.
   b. "Straight pins help you to flat-sand all fin edges to a common shape at one time. Stack 'em together and push a pair of pins through them all. When sanded, remove the pins and sand each fin to its final airfoil shape" (6:Vol. 3, No. 1, p. 8).
   c. "When sanding fins on rockets that have an airfoil, it is easier to hold the two wings together back to back, sanding the two wings at the same time. This gives you a complete airfoil, and your parts will be more uniform, thus improving stability in your boost glider" (6:Vol. 11, No. 2, p. 5).
   d. Tape sand paper to a flat surface "then move the fin back and forth across the surface to produce a perfectly flat root edge. (This method is good for producing an evenly tapered or beveled leading or trailing edge also.) (6:Vol.8, No. 2, p. 5).
5. Marking the lines on the body tube
   a. Most drawers have a flange along the top. Rest the body tube of a rocket in the "Vee" notch and turn the tube to your mark and draw a line. The top of the drawer serves as a straightedge (6: Vol. 3, No. 4, p. 6).
   b. Add a paper ruler to the edge of a desk drawer and use it for marking guide lines (6:Vol. 9, No. 1, p. 5).
   c. Use a door sill to draw the lines parallel to the centerline of body tubes.
   d. "Hardware stores have aluminum angle strips in the 'Do-it-yourself' supplies. Select a piece having at least 1/2" sides and cut it to 4" or 6" long. Sand off the cut edges on each end with medium or coarse grit paper and you have a tool for a variety of jobs requiring a metal straightedge" (6:Vol. 5, No. 1, p. 5) such as marking lines on a body tube.
6. Attaching fins to the body tube
   a. Use any "wood model" glue. Make sure it is compatible with paint.
   b. Sand a small section of the cardboard tube before gluing fins on the body. This will help the fins adhere to the body tube.
   c. Help young children.

d. Use "double gluing". Put glue on the tube and one fin then set them both aside, then glue again, attach, set aside and let it dry completely before proceeding to the next fin.
e. Support the body horizontally between two objects such as two jars of paint. Attach a fin then stand back about ten feet and sight down the rocket to make sure the fin sticks straight out from the tube.
f. Teach students to "eyeball" fins for proper alighment.

7. Fin drying holders
   a. Cut "V" shaped wedges on two parallel sides of a shoe box. Place rocket with freshly attached fins between wedges to dry.
   b. A piece of metal 1/2" wide, bent to match the curve of a body-tube, with a slot long enough to receive fin to be fitted, will hold the fin perpendicular to the body tube while the glue dries (6:Vol. 3, No. 4, p. 6).
   c. Cut wedges in the rim of a paper cup to support a rocket while the fin joints or fillets dry (6:Vol. 10, No. 1, p. 5).
   d. Set the top end of the body tube in a candle holder, or slip the tube over a tapered candle. This way all fins can dry at once.
8. Damaged fins
   a. "If your bird develops fin-sag during construction or after a repair, heat the white glue joint over a 60 to 100 watt lamp for about 45 seconds, then gently straighten the fin and hold it in place as the joint cools" (6:Vol. 8, No. 1, p. 5).
   b. "Fin damage may be minimized by gluing a piece of dowel to the inside trailing edge of the fin" (6:Vol. 6, No. 2, p. 8).

G. Launch lug
1. Take extra care of launch lugs as they are easily misplaced.
   a. Keep them for the children.
   b. Replace lost lugs with straws cut to the correct length.
2. Align the launch lug carefully. Use the launch rod to align two or more lugs. "Put a length of launch rod through them while the glue is still wet and align as needed to eliminate binding" (6:Vol. 8, No. 1, p. 5).
3. Don't forget to attach the launch lug. It causes disappointment on the firing range.

H. Screw eye and nose cone
   1. Keep the screw eyes for the children.
   2. Have extra screw eyes on hand.
   3. Some dents can be romoved from balsa nose cones. "Put a drop of water on the dent and touch lightly with a wood burning pencil or smoldering gun. Heat and moisture will swell the wood fibers and refill the depression" (6:Vol. 5, No. 3, p. 5).

I. Recovery system
   1. To trim a parachute neatly, place a ruler exactly on a line, hold the ruler firmly in place and run the knife along the ruler to cut on the line (6:Vol. 5, No. 2, p. 5).
   2. "Glue a loose-leaf paper reinforcer to each side of a streamer, surrounding the hole through which a static line or shock cord will pass"(6:Vol. 9, No. 2, p. 5).

J. Finishing
   1. "Make sure all glue fillets are smooth and have no air holes. If fillet isn't right apply another layer of glue and smooth it out with your finger tip" (3:63).
   2. Wood sealing
      a. "All balsa surfaces should be 'filled'. To do this, apply a coat of sanding sealer, let dry completely, and sand with extra fine (or finer) sandpaper. Apply another coat, let dry, and sand again. Continue this procedure until all the tiny holes (pores) in the wood are filled and the surface is perfectly smooth" (3:63).
      b. Use a mixture of white glue and water as a filler to paint over the entire rocket, then be sure to sand.
      c. Seal all balsa with both a filler coat and a sealer.
      d. Use clear dope for a sealer and sand between coats.
      e. "A smoother finish is obtained by rubbing the last sealer coat with fine steel wool. The first coat of the finish color should also be rubbed lightly with fine steel wool" (6:Vol. 8, No. 2, p. 5).

3. Base coat
   a. Begin each painting session with a good demonstation by the instructor.
   b. Paint from plans. Careless painting procedures may ruin the rocket.
   c. "Once you feel the balsa surfaces are prepared, it's time to apply the base color. The base color is the lightest of the colors to be used on the model. Usually this will be white. If the model is to be painted with fluorescent colors, the base coat must be white.
   Apply a light, even coat to the base color and set the model aside to dry. Always spray or brush thin coats; thick ones dry slowly and tend to 'sag'. When the first coat has dried completely, sand lightly with extremely fine sandpaper. Wipe any dust off with a clean, slightly damp cloth and apply another coat. Let this day, then follow with additional light coats until the model has a clear, pure color.
   Let the base coat dry completely. Allow at least four hours in a warm, dust-free area (a day is better when possible). Don't let the temperature get over 120° while the model is drying" (3:76).
   d. Use three to five base coats of clear dope before using colors. Sufficient sanding should be done between coats.
4. Second color
   a. Spray paint should be held about 12" away from the rocket in order to avoid a "globby" appearance.
   b. If spray paint is used, be sure it is enamel.
   c. Place a rolled newspaper inside the body tube to hold the rocket while spraying it.
5. Multi-colors
   a. Taping to a painted surface risks pulling off paint with the removal of tape, particularly on the cardboard portion.
   b. Avoid uneven, smudgy lines at masking points by painting along the taped edge with the same colored paint as the tape is laying on. If paints run under the tape, it is the same color. A second coat of a different color will not run under the tape.

c. For a speckled affect, apply the basic color, then hold a contrasting color back 16" and spray a mist on the rocket.
d. For a patterned rocket, spray basic color, dry, attach masking tape, repaint, and carefully remove tape to avoid peeling.
e. "For a different appearance, try outlining the major features of a model in a darker contrasting or harmonizing color. Boost-gliders especially look good when given this treatment. If done with spray paint, the colors can blend into each other" (6:Vol. 9, No. 1, p. 5).
f. Use the plastic bag from the kit and masking tape to protect the first color when applying the second color trim (6:Vol.9, No. 3, p. 5).
g. Use dymo-tape for striping body tubes.
h. Use dymo-tape for labeling the rocket with the owner's name, address, and phone number.
i. "For easy to make paint designs . . . use PRM-1 reinforcing paper cut to wanted design, applied to model and then paint [the rocket] [and] remove [the tape]" (6:Vol. 11, No. 1, p. 5).

6. Don't paint the nose cone joint as it may not fit in the rocket without sanding.
7. Drying
   a. Use half-straightened paper clips to hang wet nose cones on wires stretched across the ceiling in your room.
   b. Place a brush or dowel through the screw eye of a nose cone. Dip the cone in paint and place the brush or dowel across the top of a baby food, pint jar, or frozen food can. The nose cone dries inside in a nearly dust free atmosphere. This is less messy also, for the drippings go in the jar not on your workbench (6:Vol. 6, No. 2, p. 8).
   c. To quickly dry and cure a freshly painted rocket, "stand the rocket before an electric fan-circulated heater. This procedure is excellent for drying glue joints as well. Aside from suggesting that you revolve the rocket to promote even drying, we strongly advise that you place your rocket no closer than two feet from the heater. [If you put it] Closer, you risk blistering your paint job" (6:Vol. 4, No. 1, p. 6).
   d. Hang nose cones and rockets from the branches of trees to dry.

8. Paint and brush care
   a. Shake spray paint before using. Wipe the nozzle after painting.
   b. An easy way to mix bottle paint is to drop a ball bearing into the bottle. Recap the bottle and shake (6:Vol. 8, No. 2, p. 5).
   c. Brush "some thinner around the edge of a paint bottle cap that's hard to get open. More than one application may be necessary before the cap turns freely" (6:Vol. 8, No. 1, p. 5).
   d. "Use a 3" piece of plastic straw as a protector for a paint brush if you should have to leave your brush for a short time." Put the straw over the handle, then slip it down over the brush (Ibid.).

K. Rocket display and storage
1. Place rockets on a high window sill.
2. Place the rockets in a cupboard and make them off limits until launch time. This avoids broken fins and general handling of the rockets.
3. Get a wooden pop case or segmented box to store and carry rockets to and from the launch area.
4. Have rockets stored in individual shoe boxes.
5. "Save your expended Series I or II engine casings from the next flight-date. Glue each one to the center of a 4" x 4" piece of cardboard. These holders will make an excellent stand for those birds not able to stand alone due to fin design. You may wish to hang one on a wall hook to hold the bird horizontally while the glue fillets dry" (6:Vol. 4, No. 2, p. 8).
6. "Build a combined display and storage rack for your birds that is both practical and good looking. Materials required are 8 1/8" (WD-1) dowels, 2(SE-2) screw eyes, 1" x 4" x 36" pine board, sandpaper and paint or varnish.
Sand all edges and one face of the board. Drill 1/8" holes 4" apart starting 4" from the left edge and 2" from the bottom edge of the board, drilling at 45° angle. Coat 1/2" of one end of a full length dowel with glue and insert into a hole. Continue this action with the remaining dowels. Install the screw eyes 8" in from each end along the top edge of the board and apply paint or varnish to the entire structure.

When dry, mount the rack on the wall at the desired level with nails or standard picture hangers" (6: Vol. 4, No. 3, p.). Slip the launch lugs over the dowels and slide the rockets into place.

7. "Screw eyes placed in the ceiling at strategic points will provide additional spots for hanging rockets" (6:Vol. 5, No. 1, p. 2).
8. Rockets can be displayed on shelves. Carefully selected space-related pictures clipped from magazines can be used as a background for models.
9. Attach a snap-swivel to each parachute and hang it in an open position. They won't stick together and can be put on just before launching (6:Vol. 10, No. 2, p. 5).

V. LAUNCHING TECHNIQUES

A. General comments
   1. Plan the procedures in the classroom before going to the launch area.
   2. Have a junior or senior high school woodshop make you an altiscope.
   3. Take care not to drop the engines as the fuel inside may crack and cause poor engine performance.
   4. Clustering is not generally very successful; staging is much more satisfying.
   5. Take materials and equipment with you when you launch. The following things should be included:
      a. Extra ignition wires (These can be stored in an old pill bottle.)
      b. Large box or tray for carrying materials
      c. Segmented box for storing rockets
      d. Sandpaper for cleaning micro-clips
      e. Ice pick for scraping the nozzle of the engine
      f. A partitioned box for engines or to keep things sorted out
      g. Fire-proof wadding
      h. Tissue for holding the igniter wires in place
      i. Powder for parachutes
      j. Altiscope
      k. Power source
      l. Launcher
      m. Miscellaneous items such as masking tape, exacto-knife, scissors, pencil tweezers, and a clip board

6. Use a spare battery for a source of power rather than trying to use the battery in a car. Cars can get scratched.

B. Final assembly
   1. Follow the directions that come with your kit.
   2. Apply baby powder to the chute prior to launch. It is easier to track and less likely to stick together.
   3. When packing always roll the parachute from the bottom.
   4. Always repack just prior to launching.
   5. A hole cut in a parachute will generally make the rocket come down faster.
   6. Replace damaged parachutes with a streamer.
   7. Use a countdown checklist to make sure you don't forget anything.
   8. Fire-proof crepe paper will work as a substitute if you run out of fire-proof wadding.
   9. Do not use a flammable substitute such as tissue paper for fire-proof wadding. There is a danger of fire.
   10. Do not fire without wadding.

C. Launching and tracking
   1. Use a guide like Centuri's Education Guide to Model Rocketry for complete procedures.
   2. For a launch site use an unpopulated area that has no dry weeds or highly flammable materials. Avoid windy or overcast weather. Have a short countdown and use only electrical means to ignite the engines.
   3. For a small launch you might try the following:
      a. Use a small portable launcher.
      b. Use a bull horn rather than a public address system.
      c. Use one altiscope.
      d. Have each rocketeer launch and recover his own rocket.
   4. Efficiency improves when two or more adults supervise a launch.
   5. Experienced rocketeers can be helpful in assisting during a beginning students' launch.
   6. Have a storage container available for rockets that have been launched. (They are not so apt to get broken.)
   7. "If you tend to misplace the interlock key of the Electro Launch, tie a 3 foot length of streamer material to it" (6:Vol. 10, No. 1, p. 5).

8. "Easy cleaning and prevention of rust is the result of rubbing a film of ordinary bar soap on your blast deflector before launches" (Ibid.).
9. "An ordinary inch or inch-and-a-quarter wood screw in the field kit will help you pull those really stubborn engines. Screw it into the nozzle end of the expired engine and by gripping the rocket in one hand and the head of the screw with fingers or pliers, the engine casing should come away with a steady pull without damage to your rocket" (6:Vol. 4, No. 3, p. 6).
10. To hold rockets off the wiring during countdown, if the fins do not hold rocket-end off of the launch-pad, use a wooden, spring-clip type clothespin clipped on the launch-rod at the desired height (6:Vol. 3, No. 3, p. 5).
11. Use an old tooth brush to remove the ejection charge deposits from the inside of rockets. This makes the engine a lot easier to insert and insures a trouble free ejection every time (6:Vol. 4, No. 1, p. 6).
12. "Polish your launch rod with steel wool every time it begins to show rust or has been used in an afternoon of firing. This not only saves the rod but makes it work smoother as well" (6:Vol. 4, No. 2, p. 8).
13. Safety caps for launch lugs
    a. Pack a wad of glue-soaked tissue into the ejection end of an expended engine and then paint the casing red. After a shot just replace the protector on the rod tip as you go to recover the rocket (Ibid.).
    b. Use an engine mailing tube. "Secure a cork at the 5 & 10 which will tightly fit the mailing tube. Insert the cork. Make a hole in the end cap large enough to receive the tip of the launching rod. Or use the tube with one end cap 'as is'" (6:Vol. 5, No. 3, p. 5).
    c. Place a 1/4" piece of pencil or dowel in the end of a plastic straw. Attach a piece of red paper or plastic tape at the top. Slip the straw over the top end of the rod between launches. In addition to its primary function it also works well as a wind indicator (6:Vol. 9, No. 1, p. 5).

D. An alternative activity to the altiscope
   1. Have all children use the same type rockets, the same engines, and identical length streamers for recovery.
   2. Use a stop watch. Start it at lift-off and stop it when the rocket lands. Record the time.
   3. After everyone has launched, have the rocketeers compare "air time".
   4. Examine the craftsmanship of the rockets. Check for correlation between "air time" and quality of construction. (The better constructed rockets should have a longer "air time" which indicates they attained a higher altitude.)

E. Misfiring
   1. Check for an incomplete circuit.
   2. Check to make sure the ignition wire has not fallen out.
   3. Make sure the ignition wires are not touching each other.
   4. Make sure the ignition wire is touching the propellant.
   5. Scrape the inside of the nozzle to remove any ceramic material.
   6. Sand the micro-clips.

VI. CORRELATED SUBJECTS

A. Model rocketry correlated with mathematics
   1. Determining altitudes
      a. Use of angles
      b. Measuring distances
      c. Using coordinates
      d. Trigonometry
      e. Constructing graphs
   2. Introduction to speed and velocity units
   3. Calculating the center of pressure and the center of gravity
   4. Ordering rockets
   5. Metric system versus the English system
   6. Weights

B. Model rocketry correlated with social studies
   1. Rocket construction and employment location
      a. Saturn V, Boeing, etc.
      b. Mobility of people

2. Spin-off
3. World wide tracking stations
4. History of rocketry
   a. Chinese inventors
   b. Apollo space shots
   c. Russian space program
5. Photography by rockets and satellites
   a. Study of geography
   b. Space exploration
   c. Conservation
   d. Weather forecasting
6. Current events
7. Transportation

C. Model rocketry correlated with reading
   1. Independent reading
      a. Magazines
      b. Directions
      c. Diagrams
      d. Books
      e. Catalogues
      f. Periodicals
   2. Directions for comprehension
      a. Construction
      b. Ordering
   3. Researching reports
   4. Space science unit in basal reader
   5. Motivational
   6. Taking inventory of rocket kits

D. Model rocketry correlated with science
   1. Meteorology
   2. Aerospace
      a. Aviation
         (1) History
         (2) Theory
      b. Astronautics
         (1) Rockets
            (a) Newton's third law
            (b) Principles of flight
            (c) Inertia
            (d) Propulsion
            (e) Engines
         (2) History
         (3) Biology

3. Chemistry
    a. Rocket fuel
        (1) Rocket engines
        (2) Model rocket engines
        (3) Danger of student experimentation
    b. Airplane fuel
4. Electricity
    a. Continuity
    b. Wiring
    c. Circuits
        (1) Short
        (2) Solid
        (3) Remote controlled
    d. Power source
5. Astronomy

E. Model rocketery correlated with other subject areas
1. Photography
2. Spelling
3. Special education
4. English
    a. Oral
    b. Written
5. Art
    a. Construction
    b. Symmetry
    c. Original designs
    d. Improving standard designs
    e. Finishing
        (1) Decorating
        (2) Painting
            (a) Matching colors
            (b) Technique
            (c) Care of paints
            (d) Care of brushes

VII. MODEL ROCKET CONCEPTS

The following items could be covered in a model rocketery unit.

Rocket types
Stability
Center of gravity
Center of pressure
Recovery systems
Staging
Launching
Clustering
Finishing
Tracking
Boost-glide
Safety
Rocket engine design
Engine adapters
Engine classification
Model rocket performance
Measurement
Rocket design
Principles of flight
Newton's law of motion
Rocket photography
Club organization
Construction techniques
Propulsion
Rules and regulations
Ordering procedures
Reading catalogues
Level of rocket challenge
Circuits
Use of patterns

VIII. COMMUNITY INVOLVEMENT

A. Have a model rocket slide presentation to show school board members, parents, students, youth groups, administrators, and other interested community members.

B. Request parental help during model rocket construction and launching.

C. Invite the community to school launches.

D. Keep the local newspapers informed on rocket activities.

E. Offer evening classes for adult and student team members. Teams could be student and parents, students and teachers, and youth leaders and student members.

D. Encourage adults to become model rocket coordinators.

E. Have a workshop for teachers.

F. Start or help a model rocket club get started. Dane Boles (1:Vol. 11, No. 2, p. 9) suggests the following list of potential sponsors:

CIVIC ORGANIZATIONS

Recreation Department
School
College
University
Chamber of Commerce
Fire Department
Police Department
P.T.A.
Social Service
Forestry Department

SERVICE CLUBS

Lions
Optimists
Rotary
Kiwanis
Elks
V.F.W.
Masons
Eagles
Order of the Moose
American Legion
Salvation Army
Sertoma

YOUTH GROUPS

Explorer Scouts
Boy Scouts
Cub Scouts
Big Brothers
Boy Clubs
4-H
Y.M.C.A.
Indian Guides
Church Groups
Girl Scouts
Camp Fire Girls
Boy Scouts of Canada

COMMERCIAL FIRMS

Hobby Shops
Merchants
Aerospace Companies
Corporations

MILITARY AFFILIATIONS

Civil Air Patrol
Special Services
Royal Canadian Air Cadets

IX. SUGGESTED AIDS AND REFERENCES

A. Refer to section II, "Methods for Motivating Students".

B. Use a cutaway view of an engine to illustrate the construction of a rocket, the purpose of the parts, and the way it works.

C. Use transparencies of launching steps, rocket parts, and engines.

D. Display a picture scrapbook of previous model rocketry classes or let the children prepare one of their own.

E. Use a partially constructed rocket to show various stages of construction, fins, fillets, engine holder, etc.

F. Have a completed model of the rocket the class is constructing.

G. Estes puts out a free Alpha kit for rocket coordinators or club advisors. The instructor can put it together for the group.

H. Have catalogs available for students to browse.

I. Centuri and Estes publish charts illustrating engine and rocket parts, etc.

J. Quizzes
   1. "Model Rocketry Examination - 1" (9:32-35)
   2. "A Quickie Quiz for Beginners" (6:Vol. 11, No. 2, p. 7)

K. Washington State resource people
   1. Charles Carpenter
      District Office
      Spokane School District #81
      Spokane, Washington 99208
   2. Dr. J. Wesley Crum
      Professor of Education
      Central Washington State College
      Ellensburg, Washington 98926
   3. Dr. Lee Dallas
      Department of Education
      Western Washington State College
      Bellingham, Washington 98225

4. Mr. Lee Fisher
   Department of Aerospace Studies
   Central Washington State College
   Ellensburg, Washington 98926
5. Dr. Robert Gesell
   Aerospace Consultant Aeronautics Commission

   Toll free phone 1-800-552-0666
6. Mr. Jess Medina
   National Association of Rocketry

7. Mr. Walter West

8. Mr. Jim Worthen

L. Sources for materials
   1. Federal Aviation Administration Regional Offices
   2. Model Rocket Manufacturing Companies
      a. Centuri
      b. Cox
      c. Estes
   3. National Association of Rocketry
      P. O. Box 178
      McLean, Virginia 22101
   4. Regional National Aeronautics and Space Administration Offices
   5. United Air Lines Educational Office
   6. U. S. Government Printing Office
   7. Washington Aerospace Association
      8600 Perimeter Road S.
      Seattle, Washington

M. Films
   1. Available from Estes or Dr. Robert Gesell
      "T Minus One and Counting"
      The Model Rocket Story (motion picture)-
      Estes Industries 1970 / Film #70-D
      11:30 min., sound, color 16 mm.
      Eastman Color
      Filmed at the Air Force Academy, Colorado Springs, Colorado.
      Summary: Depicts the excitement of a national model rocket meet. Includes the launching of payload,

scale, boost gliders, and many other competition vehicles. Footage from the new model rocket movie camera (Cineroc) is shown.

2. Available from King County Film Service
The following description of films was taken directly from the King County Film Service Guide:
   a. Rockets: How They Work
      40255 Color
      grades 4-9 - 16 min.
      EBEC-1958
   b. SND Vol. 3-9
      15 min. B & W 4-12
      Father of the Space Age
      Robert Goddard
      Hearst 1961
   c. SND Vol. 7-9
      15 min. B & W 4-12
      45056
      Focus Story, The
      Space Age - A Special Report
      Presents an historic and exclusive documentary recording the sights and sounds of the Space Age from Robert Hutchings Goddard to Project Gemini
      Hearst 1965
   d. SDN Vol. 12-1
      Walk on the Moon 15 min.
      45092 color 4-12
      Exploration of space from pioneering flights to Dr. Goddard to the lunar landing of Apollo 11.
      Hearst 1969

N. Some hobby shops in the Seattle area that carry model rocket supplies are listed below:
   1. Bob's Lynnwood Hobby Shop
      Lynnwood Shopping Center, Lynnwood
      Phone: 776-7334
   2. Dow's Hobbies
      2663 N. E., University Village Mall, Seattle
      Phone: 525-7700
   3. Campus Hobby Center
      4738 University Way N. E., Seattle
      Phone: 525-2222

4. Hobby Barn
   6302 N. E. Bothell Way, Kenmore
   Phone: 485-1111
5. Tiny's Hobbies
   Anderson Shopping Center
   9113 Evergreen Way, Everett
   Phone: 355-7015

O. See the bibliography for useful publications.

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3. Estes Industries, Inc., Model Rocketry Catalog. Penrose, Colorado: Estes Industries, Inc., 1972.

4. _____, Model Rocketry Library Collection, Penrose, Colorado: Estes Industries, Inc., 1971.

5. _____, Parents' View on Model Rocketry, Penrose, Colorado: Estes Industries, Inc., 1965.

6. _____, Model Rocket News Library Collection, Penrose, Colorado: Estes Industries, Inc., 1971.

7. _____, Model Rocketry the Educational Space-Age Hobby, Penrose, Colorado: Estes Industries, Inc., 1966.

8. Hajek, Stanley M., and Raymond L. Schuette, Space Age Technology, Penrose, Colorado: Estes Industries, Inc., 1970.

9. Matson, Wayne, Educators Guide to Model Rocketry, Phoenix, Arizona: Centuri Engineering Company, 1968.

10. Saltrick, Daniel F., and Alfred M. Kubota, Aerospace Education and Model Rocketry, Penrose, Colorado: Estes, 1970.