AN EXAMINATION OF THE APPROPRIATENESS OF PREVALENT SCIENCE FAIR METHODS AND OBJECTIVES

A Thesis

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by

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CHAPTER I

THE PROBLEM AND THE NATURE OF THE STUDY

I. THE PROBLEM

Statement of the Problem

The display of student-constructed science exhibits has become a significant part of the educational process of many secondary school science departments. The popularity of this activity is founded upon the interest and participation of science teachers, science educators and professionals in the sciences. The enthusiasm among the members of these groups is not, however, unanimous.

This study was undertaken as a result of the suspicion that the cynicism and disillusionment expressed by a few of those people who are actively interested in science education is symptomatic of basic faults in the science fair idea. Informal observations have led this writer to conclude that science fairs, in their somewhat crystallized form, are open to improvement--not the improvement that evolves from "trial and error," random corrections, but rather from an examination of the objectives of fairs, the criteria used to perform the evaluation, the nature of the judges' backgrounds, and the awards granted to participants whose exhibits are judged to be superior.

Need for Making the Study

There is no research available today concerning the appropriateness of some of the facets of science fairs. That is to say, no one has critically examined the objectives of science fairs; no reports about evaluative criteria applicable to all fairs is available; and, although it is generally recognized that the methods of making evaluation are open to criticism, no research has been conducted that supplies a technique acceptable to all.

II. NATURE OF THE STUDY

Premise of the Study

The premise of this thesis is that a significant number of those who are interested in science education question some of the aspects of science fairs. It is reasonable to declare that, if 25 per cent of the respondents in each of the three groups queried (as well as 25 per cent of the entire group) express doubt about the value accruing to a certain aspect of fairs, then that aspect is justifiably suspect. The foundation for this argument centers on the position that all who responded did so conscientiously, and further, that they have made some judgments about science fairs in the light of their experience. The judgments of 25 per cent of such a group, therefore, should not and cannot be dismissed lightly.

This position acquires additional force from the fact that those who dissented did not do so on every aspect. This implies that those who are not in favor of fairs in toto did not respond. The implication is correct, since not a few questionnaires were returned uncompleted, with the explanation that the respondent had lost interest in fairs, or had never regarded them as worthwhile. Those who did respond, then, are presumably in favor of science fairs but are aware of anomalies.

Limitations of the Study

The study is restricted to the examination of science fairs conducted in public, private and parochial secondary schools. No attempt was made to garner the opinions of the students who have participated in fairs. Presumably, science teachers and science educators are more aware of the implications involved in fairs, and their judgments, therefore, will be more meaningful. The thesis is not concerned with the organization of fairs--the classification of exhibits by grade and subject, and so on. These minutiae do not greatly affect the subjects which are the concern of this study.

Definition of Terms

The definitions of certain words and phrases commonly used in considering science fairs have not been carefully spelled out. In the interest of clarity, the following definitions will apply to the terms used in this thesis.

Science fair. A science fair is a display of student-constructed scientific exhibits. The display is usually open to the public. The term, "science fair," includes such designations as, "science day," "science show," and the like, if these activities have, as part of their objectives, the determination of superior exhibits and, if awards are offered to the successful exhibitors.

Exhibit. An exhibit is a construction produced by a student in order to explain a scientific activity he has carried out. The adjective, scientific, is used in its broadest sense.

Project. The word, "project," signifies the identification and examination of a problem.

Award. An award is a token offered in recognition of student participation in a science fair. Generally, awards have distinct degrees of value, either intrinsic or monetary.

Science educator. The term, "science educator," is used to identify those who engage in the professional preparation of secondary school science teachers.

Previous Studies

Studies which have already been conducted do not question the validity of the objectives of the fairs examined. Rather, the reporters confine themselves to suggesting ways of improving procedure after having studied a certain aspect of science fairs.

Brunette, in a study of fairs in Delaware, reported on judging techniques.[1] Bowers' study centers around the benefits of fairs to the students participating.[2] MacCurdy and Bagshaw related why and how they reorganized judging procedures for their fair.[3] Chappell's study involves the determination of the value of science fair participation as a means of enhancing scientific scholarship.[4]

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[1] Rev. Bernard M. Brunette, "Judging Local Science Fairs" (unpublished Master's thesis, The University of Delaware, Newark, 1957).

[2] Elmer J. Bowers, "The Contribution of Science Fair Projects to Student Growth in Science" (unpublished Master's thesis, The Ohio State University, Columbus, 1958).

[3] Robert D. MacCurdy and Thomas L. Bagshaw, "Are Science Judgments Fair?," Science Education, XXXVIII (April, 1954).

[4] Walter E. Chappell, "Science Fair Participation as a Criterion to Assist Scholarship in the High School Science Classes in Wichita Public Schools" (unpublished Master's thesis, The University of Wichita, Wichita, 1960).

Rogers wrote of the development of the Rhode Island Science Fair and reported on the attitudes of former participants who ranked highly in the judging.[5] Kell looked into the factors that motivated students to participate in the Texas Science Talent Search (an activity which is similar to fairs in this respect).[6]

None of the researchers doubted that science fairs are of value nor did they propose sweeping revisions.

The Questionnaire

It was decided, early in the study, that the literature did not convey enough information about science fairs over wide segments of the country. A questionnaire was designed to solicit the opinions of a significant proportion of those who are involved in organizing and conducting science fairs. The questionnaire, and the cover letter sent with it, are in Appendix A.

The people queried comprise three distinct groups. A total of one hundred fifteen high school science teachers were asked to fill out the questionnaire. Their names were selected from the National Science Teacher

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[5]Arnold Rogers, "A Study of the Rhode Island Schools' Science Fair Program and its Effectiveness as Reported by Former Exhibitors" (unpublished Master's thesis, Rhode Island College of Education, Providence, 1960).

[6]J. R. Kell, "An Investigation of Factors of Motivation and Training of Students Participating in the Texas Science Talent Search for 1957-58" (unpublished Master's thesis, University of Texas, Austin, 1960).

Association's membership roster, using life membership as a criterion of the teacher's interest in the profession. Names were also chosen from the list of "Star" science teachers recognized by the national association from 1952 through 1958. Geographical representation was also a consideration. College professors of science were sent questionnaires. A total of seventy-five names were obtained from the Sponsor Handbook, published annually by Science Service, which lists the regional directors of science fairs affiliated with Science Service through the Science Clubs of America. The reader may assert that selection of teachers from this list would color the study since they are all, presumably, agreed upon the value of science fairs. This argument will be eliminated in the discussion surrounding the various aspects of science fairs as they are taken up. In any event, this method of selection was the only means available, since there is no list of college science teachers who have demonstrated interest in science fairs. A random roster of college teachers would surely have led to uninformed responses in many instances. A few names were gleaned from the membership list of the National Association for Research in Science Teaching.

Science educators were also asked to respond to the questionnaire. A list of seventy-five was obtained from the source cited immediately above and from college and university catalogues. Geographical distribution was also a consideration for the above two groups and, in addition, the science educators were chosen because of their activity in secondary school science.

Of the high school science teachers, eighty-one (70%) replied; forty-five (60%) of the college science teachers made responses; and forty-nine (65%) of the science educators who were contacted returned questionnaires. The response for the entire group numbered one hundred seventy-five (66%).

No attempt was made to quantify the responses geographically. Suffice it to say that returns were made from each of the major segments of the country: the west and east coasts; New England; the midwest states; and the southern states.

Organization of the Remainder of the Thesis

The subsequent chapters of the thesis delineate the history and objectives of fairs, the techniques used to rate exhibits, the backgrounds of the judges who make the ratings, the criteria by which the exhibits are rated, the types of awards granted to participants and, finally, a summary as well as recommendations for improving science fairs in the light of the findings of the study.

CHAPTER II

THE HISTORY AND OBJECTIVES OF SCIENCE FAIRS

I. HISTORY OF SCIENCE FAIRS

An investigation of science fairs would not be complete without some mention of their development. The literature does not present a comprehensive outline of the increase in popularity of the science fair idea, but it does permit the reader to piece together an approximate history.

Sheldon describes the reasons for the organization of what is commonly referred to in the literature as the first science fair of importance:

> As County Fair No. 1 of the State of New York it was necessary for the Institute to hold some form of fair in order to be eligible for such state support as is given to such fairs. Accordingly, the idea arose of holding a science fair for children. The first . . . was an outstanding success, attracting approximately 500 exhibits and (in its four day duration) attracting approximately 400,000 spectators.[1]

The fairs mentioned in the quotation prior to the establishment of science fairs for children, concerned neither children nor their exhibits. The Institute mentioned is the American Institute of the City of New York. This

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[1] H. H. Sheldon, "The Science Club Program of the American Institute," School Science and Mathematics, XL (April, 1940), 366.

first science fair was held in 1928.

The American Institute Science Fair maintained its popularity and excited interest elsewhere as well. Only glimpses of this success in the early years are available. Ten years after the inception of the science fair one commentator pointed out, indirectly, that the fair idea was continuing to generate enthusiasm, since, "during the last ten years, the Junior Science Clubs have exhibited their work annually at the Junior Science Fairs . . . ."[2] This note concerns the Clubs of New York City and the Institute.

Others began to interest themselves in seeking out science minded youths. State science academies initiated activities for young people. For example, Herbert wrote, "In Ohio, a movement started in 1949 on a statewide basis . . . . This . . . came to be known as the Ohio Junior Academy of Science."[3] Many state academies of science took up the science fair as one kind of activity for the young people of their respective states.

Science Service and the National Science Fair

By 1950, the continuing increase of participation and interest stimulated the creation of the National

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[2]"Junior Science Clubs at the World's Fair," School and Society, XLVIII (July 2, 1938), 10.

[3]Gale A. Herbert, "Junior Academy of Science Searches for Needed Scientific Minds," Ohio Schools XXX (March, 1952), 140.

Science Pair. Patterson wrote:

> . . . the First National Science Fair [was held] at the Franklin Institute in Philadelphia in 1950.
> . . . .
> Each National Science Fair . . . [is to be] . . . the culmination of dozens of local science fairs held in large and small communities.[4]

The National Science Fair is an activity of Science Service. Science Service, according to its Sponsor Handbook, is an institution created in 1921 as a non-profit organization for the popularization of science. Science clubs, through affiliation with this organization, may develop science fairs in order to select winners to send to the National Science Fair, which is conducted annually, each year in a different major city in this country.[5] The scope of influence which Science Service enjoys as a result of this network of fairs can be inferred from a map taken from the Sponsor Handbook. The map denotes the location of the regional science fairs associated with Science Service. The map described can be found in Appendix B.

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[4]Margaret E. Patterson, "Opportunity for Nation's Junior Scientists," The Science Teacher, XVII (October, 1950), 124.

[5]Leslie Watkins (ed.), "How to Run a Science Fair," Sponsor Handbook for 1960-61, pp. 38-40.

II. THE OBJECTIVES OF SCIENCE FAIRS

It is convenient to permit oneself to be lulled into believing that science fairs have settled into a sound educational pattern. The relative uniformity of practices in science fairs throughout the country occurs because many have their programs derived from suggestions in Science Service handbooks. It should be disconcerting to discover that the objectives of science fairs are not well established on a foundation of research.

Objectives in the Literature

The literature provides a diversity of opinion about the number and the nature of objectives for science fairs. High and Lash, early writers on the subject, said, in 1935:

> . . . the science fair was conceived as a method to teach more of the possibilities in science than can be done with ordinary class-room procedure.[6]

In 1956, The High School Journal for February presented a group of authors whose opinions differ in many respects. In that issue, Large points out:

> The Oak Ridge Institute of Nuclear Studies Science fair program . . . was activated in 1954 to help alleviate a serious condition

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[6]L. O. High and Elizabeth Lash, "Science Fair--A New Way to Explore Science," Ohio Schools, XIII (May, 1935), 166.

> which exists in the United States: . . . the percentage of young people embarking on science careers is decreasing.[7]

Kraus, in that same issue, cites a statement made by Blackwell, who was speaking at the West Virginia Science Fair Work Conference in November 1955. Blackwell said, in part:

> As a representative of higher education, I cannot resist the urge to express what I believe is our concept of the value of science fairs in education . . . the science fair is an educational tool of tremendous significance, for
>
> . . . .
>
> (3) it gives the parent a special opportunity to gain a greater appreciation of the advantages of education; and (4) it links the college . . . very closely with the student through the assistance which is given to the student in preparing the exhibit and through the assistance which is given to the institution of higher learning in discovering talent which it should share in developing.[8]

Kraus goes on to say, "The National Science Fair is dedicated to inspiring greater interest among students in the fields of pure and applied science."[9] This is, essentially, the same objective expressed by the Oak Ridge Institute.

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[7]Dewey E. Large, "Activities at the Oak Ridge Institute of Nuclear Studies," High School Journal XXXIX (February, 1956), 263.

[8]Joseph H. Kraus, "The National Science Fair: Purposes and Program," High School Journal, XXXIX (February, 1956), 268, citing part of an address by Dr. Ashby C. Blackwell.

[9]*Ibid.*, p. 265.

Coutant, still another author in the same issue, claims:

> The purposes of all this activity are to encourage and locate boys and girls with scientific promise and to broaden their horizons.[10]

Rice's first opinion is somewhat novel:

> . . . we have observed a steadily rising recognition of the Science Fair as one of the best means ever presented for advancing the place of science studies at the preparatory school level.[11]

He continues, giving an objective more amenable to the others already noted:

> The more serious science students respond to the fair as a means of achieving wider recognition for their talents and thus being stimulated to further effort.[12]

Lefler suggests an objective that might well be mated to Rice's first opinion:

> Science fairs lend encouragement to the establishment of an offering intended for the students with special interest in science--a course where students can carry on intensive investigation of some problem. . . .[13]

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[10]Madeleine F. Coutant, "The Science Congress: Training Ground for Future Scientists," High School Journal, XXXIX (February, 1956), 278.

[11]Robert A. Rice, "Promotion and Public Relations of Science Fairs," High School Journal, XXXIX (February, 1956), 292.

[12]*Ibid.*, p. 290.

[13]R. W. Lefler, "Educational Implications of Science Fairs," High School Journal, XXXIX (February, 1956), 308.

Authors in other periodicals provide still more diversity. Ryan, writing a year earlier than the above authors, said:

> A project well developed explained partly by charts and partly by the student at the site of the exhibit, . . . introduces the student to self confidence in expressing his ideas publicly, meeting people, thinking on his feet and even realizing the importance of his classes . . . .[14]

Weaver relates first what a fair is and then, what it is not:

> A science fair is simply an exhibit of the work of students on science projects.
>
> Science fairs are not places of amusement and the exhibits of work done should not be for amusement purposes.[15]

Finally, Jones lists, among others, the following objectives:

> Purpose of the Fair
>
> . . . .
>
> 4. To provide stimulation for scientific hobby pursuits.
>
> 7. To provide constructive suggestions for teachers and pupils of science.[16]

Deciding which of these objectives science fairs

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[14]Kevin Ryan, "High School Science Fairs," American Journal of Physics, XXIII (October, 1955), 473.

[15]Elbert C. Weaver, "Projects for Science Fairs," The Science Teacher, XX (February, 1953), 17.

[16]Norman R. D. Jones, "Science Fairs--Science Education in the Community," Bulletin of the National Association of Secondary School Principals, XXXVII (January, 1953), 168.

actually satisfy is a problem of the first magnitude. Because the efforts of so many people are channelled into this one endeavor, it is vital that the objectives of fairs be realistic and attainable. Therefore, it is not to be construed that the above cited objectives are subscribed to by the author of this thesis. Their validity is the very point in question.

Objectives Determined by the Respondents

The first part of the questionnaire asked the respondents to make a judgment about the appropriateness of each objective contained in a comprehensive list culled from those described in the literature. Although they were not primary sources, the objectives mentioned in both the Science Service's Sponsor Handbook and the Oak Ridge Institute's Science Fair Handbook, are represented in this list. Specifically, the respondents were asked to determine, by checking one of four columns, whether a certain objective was most appropriate, appropriate, not very appropriate or inappropriate. The results have been tabulated on the following pages. These, and the rest of the tables in this thesis, contain percentages rounded off to the nearest whole number.

The two categories--not very appropriate, and inappropriate--were considered in eliminating an objective. If the percentages of response under these two headings totalled 25 per cent or more for a certain objective, then that objective was eliminated.

Judgments of the high school science teachers. Using the above criterion, the high school teachers accepted six of the fourteen objectives listed. The objectives follow in decreasing order of percentage of the group accepting each.

Science fairs should:

1. encourage students of promise.
2. exhibit the work of students on projects.
3. promote self confidence in the entrant.
4. develop interest in science among the visitors (student and adult).
5. broaden students' horizons (entrant and visitor).
6. promote scientific research.

The exact tabulation has been made in Table 1. Discussion of the objectives accepted by each group will be forestalled until all have been listed.

Judgments of the science educators. Science educators displayed more generosity toward two of the objectives than did the high school teachers. This group deemed eight of the fourteen objectives acceptable. Their

TABLE 1. Objectives and the responses of high school science teachers in per cent

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappropriate
promote self confidence in the entrant	31	53	12	4
provide a means for entrants to meet people	10	42	32	16
encourage entrants to think on their feet	23	51	21	5
develop interest in science among the visitors (student and adult)	31	53	15	1
exhibit the work of students on projects	44	48	7	1
encourage the establishment of a course for students with special interests	13	28	38	21
encourage students of promise	58	40	1	1
broaden students' horizons (entrant and visitor)	38	45	14	3
promote scientific research	44	37	15	4

TABLE 1 (cont'd)

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappro-priate
stimulate students and teachers in classwork	34	38	25	3
focus attention on science experiences in school	21	48	23	8
stimulate hobbies	22	52	21	5
provide a special opportunity for parents to appreciate the advantages of education	12	47	33	8
link college teachers and students through assistance	13	45	25	17

NOTE: The percentages are based on the number who responded to each objective. All did not commit themselves on every objective. The percentages are to be read from left to right.

choices are listed in decreasing order of percentages assigned to each objective.

Science fairs should:

1. encourage students of promise.
2. broaden students' horizons (entrant and visitor).
3. promote self confidence in the entrant.
4. focus attention on science experiences in school.
5. exhibit the work of students on projects.
6. stimulate students and teachers in classwork.
7. promote scientific research.
8. develop interest in science among the visitors (student and adult).

The educators rearranged the objectives somewhat, except for the first, from the order of the list determined by the science teachers. The two objectives accepted by the educators and rejected by the high school teachers are numbers four and six. The teachers probably have more realistic experiences with these objectives. The responses of the science educators are to be found in Table 2.

Judgments of the college science teachers. College science teachers also selected eight of the objectives listed; they, in fact, chose the same objectives as did the science educators. The order of preference is changed, however. The objectives listed below are taken from Table 3 and are ordered in the same manner as were the previous two.

Science fairs should:

1. encourage students of promise.

TABLE 2. Objectives and the responses of science educators in per cent

Objectives	Most Appropriate	Appropriata	Not very Appropriate	Inappro-priate
promote self confidence in the entrant	8	56	6	0
provide a means for entrants to meat people	2	39	37	22
encourage ontrants to think on their feet	21	47	26	6
develop intarest in science among the visitors (student and adult)	29	49	22	0
exhibit the work of students on projects	42	48	6	4
encourage the establishment of a course for students with special interests	13	12	50	25
encourage students of promise	63	35	2	0
broaden students' horizons (entrant and visitor)	35	61	4	0
promote scientific research	46	33	13	8

TABLE 2 (cont'd)

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappropriate
stimulate students and teachers in classwork	35	51	8	6
focus attention on science experiences in school	39	51	8	2
stimulate hobbies	28	48	18	6
provide a special opportunity for parents to appreciate the advantages of education	13	56	21	10
link college teachers and students through assistance	21	48	31	0

NOTE: The percentages are based on the number who responded to each objective. All did not commit themselves on every objective. The percentages are to be read from left to right.

TABLE 3. Objectives and the responses of college professors of science in per cent

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappropriate
promote self confidence in the entrant	16	68	14	2
provide a means for entrants to meet people	16	41	27	16
encourage entrants to think on their feet	34	39	16	11
develop interest in science among the visitors (student and adult)	29	51	20	0
exhibit the work of students on projects	47	53	0	0
encourage the establishment of a course for students with special interests	7	16	45	32
encourage students of promise	71	27	2	0
broaden students' horizons (entrant and visitor)	49	47	4	0
promote scientific research	40	49	7	4

TABLE 3 (cont'd)

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappropriate
stimulate students and teachers in classwork	46	43	11	0
focus attention on science experiences in school	34	52	14	0
stimulate hobbies	16	41	27	16
provide a special opportunity for parents to appreciate the advantages of education	18	45	33	4
link college teachers and students through assistance	20	41	32	7

NOTE: The percentages are based on the number who responded to each objective. All did not commit themselves on every objective. The percentages are to be read from left to right.

2. broaden students' horizons (entrant and visitor).
3. exhibit the work of students on projects.
4. stimulate students and teachers in classwork.
5. promote scientific research.
6. focus attention on science experiences in school.
7. promote self confidence in the entrant.
8. develop interest in science among the visitors (student and adult).

The college teachers, in general, did not choose the objectives in the above list quite as decisively as did the other two groups, even though they were selected, for the most part, from a list of Regional Fair Directors. This is a reassurance that their responses are not weighted in favor of science fairs.

Judgments of the entire group. The argument that 25 per cent of the group is a significant percentage of dissenters acquires greatest meaning when all three groups' responses are examined as one. This is not to imply that the other tabulations are open to question. The number of respondents for each group is large enough to justify their separation.

The weight of the opinions of science educators and college science teachers overcomes the opinions of the third group and the following list of objectives results. Again in order of preference:

Science fairs should:

		%
1.	encourage students of promise.	98
2.	exhibit the work of students on projects.	93
3.	broaden students' horizons (entrant and visitor).	92

		%
4.	promote self confidence in the entrant.	87
5.	promote scientific research.	83
6.	stimulate students and teachers in classwork.	82
7.	focus attention on science experiences in school.	82
8.	develop interest in science among the visitors (student and adult).	81

The strength of judgment is indicated by the percentage of the group who said the objective was either most appropriate or appropriate. The distribution of percentages is developed in Table 4.

The Validity of the Selected Objectives

The second objective listed immediately above is not open to argument except in its relationship to the seventh and eighth objectives. Several respondents in each group commented on the "exhibition" aspect of science fairs. (The statements written by respondents and quoted here and throughout the thesis have been selected for their representation of the minority opinion). Two high school teachers point out that overemphasis of these objectives may obliterate others just as valuable. One of the teachers declares that:

> . . . the important achievement of a science fair is that it gives encouragement to the student to learn . . . research methods. The exhibit is a secondary factor which is often given too much emphasis.

Science fairs are, "not a publicity gimmick," wrote the second teacher.

TABLE 4. Objectives and the responses of the entire group in per cent

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappropriate
promote self confidence in the entrant	28	59	11	2
provide a means for entrants to meet people	9	41	32	18
encourage entrants to think on their feet	26	46	20	8
develop interest in science among the visitors (student and adult)	30	51	19	0
exhibit the work of students on projects	44	49	5	2
encourage the establishment of a course for students with special interests	11	19	44	26
encourage students of promise	64	34	2	0
broaden student's horizons (entrant and visitor)	41	51	7	1
promote scientific research	43	40	13	4

TABLE 4 (cont'd)

Objectives	Most Appropriate	Appropriate	Not very Appropriate	Inappropriate
stimulate students and teachers in classwork	38	44	15	3
focus attention on science experiences in school	31	51	15	3
stimulate hobbies	22	47	22	9
provide a special opportunity for parents to appreciate the advantages of education	15	49	29	7
link college teachers and students through assistance	18	45	29	8

NOTE: The percentages are based on the number who responded to each objective. All did not commit themselves on every objective. The percentages are to be read from left to right.

Some college teachers qualified their acceptance of these same objectives. Said one, "I don't feel fairs are big shows for the public . . .," and a second claimed "Science fairs with their emphasis on the dramatic . . . actually do more harm than good because of the attitudes they mold."

A brief comment by a science educator is a précis of the dissension surrounding these objectives. He said that science fairs are, "not for show but to share."

The second, seventh, and eighth objectives are not formulated primarily in the best interests of the students who participate in fairs. The remaining five <u>are</u> directed toward student development. Their virtue, however, does not assure their attainability. A few words about each will suffice to indicate why it is necessary to consider them carefully before accepting them without qualification.

<u>Encouraging students of promise</u>. "I know of schools that drill a few so they will win the fair award and ignore the balance of the pupils," a science educator wrote. A college science teacher wryly comments, "I have observed 3 <u>science</u> [italics not in the original] projects in about 1300. Only one of these was awarded a prize."

Broaden students' horizons. "I further question," writes a high school teacher, "whether these fairs should appropriately be called 'science fairs' or 'technology and hobby fairs'." The question being raised concerns which "horizons" are being broadened.

Promote self confidence in the entrant. "What if he loses?" asks another high school teacher, implying the prevalence of competition.

Promote scientific research. Project work, it should go without saying, involves scientific research. This premise is apparently ignored in many instances. A large number of respondents commented on this point. One college science teacher made a rather violent statement about the reasons for this failure. "Only about 0.1% of high school science teachers really know what science is," he claimed. Lest this be thought impatience on the part of an "academician," a high school teacher agreed, saying, "I think very few science teachers have any real conception of what scientific research is." Another teacher confirms this suggestion by writing that, ". . . emphasis is on research. Only the best pupils can do it." Whether or not the teachers who direct the activities of students are aware of the requirements of research is not within the realm of this study. The status of the background of science teachers in this country is well known to be open to improvement. The point is, however, that science fairs <u>are</u> stimulating activity. And this activity is not scientific research. "The great majority of projects in these fairs," observed a high school teacher, "concerned exhibiting some principles or facts the student had read from a textbook rather than the results of some research . . ." Such activities do not deserve the title of "project."

<u>Stimulate students and teachers in classwork</u>. This stimulation has sometimes had unfortunate ramifications. In fact, the results of this stimulation is, in some cases, "anti-educational." One high school teacher's experience mirrors such a situation. He advises, in a context about fairs, that, ". . . we require a science project from each 7th, 8th, and 9th grade pupil . . .. Failure to turn in a science project results in a failing grade regardless of academic average." This attitude does not always go unchallenged. "Their [parents] complaints to the school board . . . has caused a change in policy," another teacher explains, "No projects may be required for a grade or otherwise."

<u>Summary</u>

The objectives listed by the respondents as desirable are clearly not without blemish. Ideally, of course, all of them are worthwhile. Every one of them needs critical appraisal by all who are responsible for involving young people in science fairs. The comments made by some of the respondents amplify the suspicion that science fairs sometimes have negative results and this possibility cannot be permitted to exist where so many young minds can be impressed. Perhaps the most insidious result is that the culmination of project activity--the science fair--sometimes overshadows the preliminaries--the project itself--causing worthless expenditure of time in producing "something" for exhibition.

CHAPTER III

JUDGES' TECHNIQUES AND BACKGROUNDS

I. JUDGES' TECHNIQUES

The process of evaluating exhibits is perhaps the most discussed facet of science fairs. Wherever there is a method of selecting superior exhibits from a larger group of exhibits, there also exists an element of competition. Read justifies the situation by declaring:

> Judging is a serious business when it eventually may mean a college education or none for a contestant; but awards are here, and are not foreign to American philosophy, both in school and out.[1]

This position is open to attack, however. Richardson makes a provocative assertion by noting that:

> If the prizes are high and the competition severe, an effort is made through the rating system to quantify the score that represents the student's achievement. The problem of making such comparisons with the essential narrow lines of discrimination raises a question as to the desirable emphasis upon a high degree of competition.[2]

Science Service's <u>Sponsor Handbook</u> contains the statement

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[1]John Gammons Read, "Pitting Science Fair Activities into the Total Academic Program," <u>High School Journal</u>, XXXIX (February, 1956), 282-83.

[2]John S. Richardson, <u>Science Teaching in Secondary Schools</u> (Englewood Cliffs: Prentice-Hall, 1957), p. 214.

that "[in the National Science Fair] all elements of a stiff competition are present to urge the student to do his best, . . ."[3] Since the majority of science fairs in this country are patterned after the National Science Fair, it can be assumed that, Richardson's point notwithstanding, there is a significant degree of competition in each of them.

Scoring Systems in the Literature

The problem of deciding upon the means of discriminating among the exhibits has been approached in a variety of ways. Ward and Carleton, speaking of the Rhode Island State Science Fair for 1946, said, in part, "Each exhibit was judged on its own merits without competing against any other exhibit."[4] Armacost describes a technique found satisfactory in Syracuse, New York:

> Point systems have been tried and found decidedly objectionable. After a given judge has chosen what he considers the best . . . exhibits, he briefly records specific reasons for his choices, and then joins his fellow judges for a round table discussion of the relative merits of all choices made by the entire committee . . . if stalemates occur, equal recognition is given . . .[5]

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[3]Leslie Watkins (ed.), "Science Fairs, National and Local," Sponsor Handbook for 1960-61, p. 37.

[4]J. Herbert Ward and R. K. Carleton, "The Rhode Island State Science Fair--1946," Science Teacher, XIII (December, 1946), 74.

[5]Richard R. Armacost, "Syracuse University Science Congress," Science Teacher, XIII (April, 1946), 76.

MacCurdy and Bagshaw, on the other hand, affirm the superiority of the method discarded above:

> It was noted that there were wide variations in project scores among many judges . . . it was apparent that winners had been established by a method that was open to serious criticism.
>
> . . . .
>
> A probable cause of the judges' wide variation was discovered [in the scoring system] . . . . It was noted that the standards [for judging] were rigid and definite and that large score units were assigned to each item that was judged.
>
> . . . .
>
> A new score card was built in which . . . items . . . were delimited, there were exact definitions and small scores for each item.[6]

Davis, writing of the methods used in the National Science Fairs, remarks:

> . . . the judges have considerable latitude and may give greater values to some criteria, less weight to others, or substitute other criteria if they choose to deviate from the usual procedure.[7]

<u>Scoring System Favored by the Respondents</u>

The respondents were asked to decide among three techniques for evaluating exhibits. The techniques involved: (1) a highly quantified checklist as described by MacCurdy and Bagshaw, (2) a generalized checklist (giving maximum limits to criteria), (3) permitting the judges to assign weights to each criterion as they see fit.

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[6]Robert D. MacCurdy and Thomas L. Bagshaw, "Are Science Judgments Fair?" <u>Science Education</u>, XXXVIII (April, 1954), pp. 224-31.

[7]Helen Miles Davis, <u>Science Exhibits</u> (Washington: Science Service, 1955), p. 8.

Table 5 indicates that the respondents prefer to have the judging controlled somewhat by allowing the judges to arbitrate within certain limits. The table also shows that this preference is not decisive, since the remaining two techniques are each considered desirable by at least twenty per cent of the entire group. Permitting the judges carte blanche is the least popular of the three methods. This indicates, perhaps, a lack of faith in the judges' ability to discriminate effectively. This indication gains stature when the problem of obtaining judges is examined, as it shall be, below.

Ipterviewing the Student

Besides suggesting ways to determine the value of an exhibit, many authors note that judges can find their way out of the dilemma by meeting the exhibitor and asking him questions which will reveal his competence and understanding. Wilder, for example, relates that:

> . . . there are some science fairs which are organized so that the exhibitor is present at the time of the judging and is questioned by the judges about the exhibit. This is a very commendable procedure and should be encouraged; it has great educational value. In most science fairs . . . [however,] . . . the exhibit must 'speak' for the student.[8]

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[8]Charles G. Wilder, "Preparing and Displaying Exhibits," High School Journal, XXXIX (February, 1956), 296.

TABLE 5. The technique of rating the exhibits in terms of the criteria in per cent

The teehnique	High school teachers	College science teachers	Science educaters	Entire group
a highly quantified cheok-list, defining points for eaeh of the oriteria	31	24	41	32
a generalized cheeklist to permit the judges te arbitrate	47	47	41	45
permit the judges to give weights to each criterion as they judge each project	22	29	17	22

NOTE: Percentages add in vertical columns.

Meister describes the situation in the School Science Pair of the American Institute, noting:

> Most important . . . the finished display is not a requirement. The child . . . is there to explain . . . and answer questions.[9]

Shannon reinforces the above comments by suggesting in part:

> . . . the judging team's brief survey of all the exhibits . . . can be facilitated if the fair committee will . . . have each student with his exhibit.[10]

Coutant implies that the interview should have more than one purpose, in her description of the New York State Science Congress. She writes that:

> Scientists and science professors . . . interview each participant and [are] asked to discuss with him the quality of his work and to make suggestions for the future development of the experiment. These scientists also act as judges . . ..[11]

Murphy, reporting the results of a symposium which discussed the various aspects of the Ohio Junior Academy Science Day program, says that not only is it advisable

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[9]Morris Meister, "The School Science Fair," High Points XXXIX (May, 1957), 75.

[10]Henry A. Shannon, "Judging Exhibits and Awarding Prizes," High School Journal, XXXIX (February, 1956), 301.

[11]Madeleine F. Coutant, "The Science Congress: Training Ground for Future Scientists, " High School Journal, XXXIX (February, 1956), 279.

for the student to be at the site of his exhibit, but also:

> A student should be able to answer questions related to the project. Questions on basic principles involved or related to the project are expected to be answered [italics not in the original].[12]

Brunette agrees that interviewing the participant is valuable and comments that this technique is used at the State of Delaware Fair. He goes on to write that:

> The National Fair does not do this because of its time consuming nature, although the value of this procedure is recognized by the officials.[13]

In addition to the literature about the problem, a number of respondents expressed the conviction that judges must interview the exhibitors to make realistic evaluations. The opinions are best summarized in the words of a college science teacher, who noted:

> It seems almost mandatory to me that the students who are being considered for awards in any given fair, be interviewed by a panel of judges . . . . Only be talking to the individual students is it possible to determine whether the project . . . is a product of his own creativity . . . the students can benefit by the advice and counsel of the judges . . . one often obtains a better insight as to the depth of the student's understanding of the principles and ideas associated with his project.

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[12]Donald Murphy, "Experienced Panel Discusses Projects and State Science Days," (Columbus) Ohio Academy of Science News, November, 1960.

[13]Rev. Bernard M. Brunette, "Judging Local Science Fairs" (unpublished Master's thesis, University of Delaware, Newark, 1957), p. 10.

Read substantiates the need for probing into the student's understanding of his exhibit's relationship to the rest of science in writing:

> No exhibit stands alone in science. Each is an exemplification of the interaction of science and mathematics.[14]

That interaction among participants and judges can be a meaningful experience for the student can hardly be questioned. That is, it will be meaningful if the judges do more than inquire about the student's fund or information in order to evaluate his exhibit. Unfortunately, in a number of science fairs, judges can take only a few minutes to examine each exhibit. The instructions to judges, described in the brochures received from the respondents, advised the judges to apportion their time wisely. Since judges usually act in a voluntary capacity, the fair committee cannot make unreasonable demands on their time. Rather than the beneficial interaction described above occurring, too often the judges are forced to evaluate each exhibit somewhat hastily. This situation obviously defeats any intentional communication of ideas among exhibitors and judges.

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[14]John G. Read, "Fitting Science Fair Activities into the Total Academic Program," High School Journal, XXXIX (February, 1956), 284.

Methods of Organizing Judges

The circumstances under which judges are forced to give short shrift to each participant are understandable in the light of the information collected in Table 6. This table reveals that the respondents are about evenly divided between having several judges evaluate a few, or many, exhibits. The former case is preferable, but the latter is more realistic; the respondents were probably influenced by the problem of providing the numbers of effective judges required for the first method. Increased interest in exhibiting at a science fair complicates this problem.

TABLE 6. The method of organizing judges in order to evaluate exhibits in per cent

The method	High School Teachers	College Science Teachers	Science Educators	Entire group
one judge evaluating a few projects	3	4	0	2
several judges evaluating a few projects	53	38	45	45
one judge evaluating many projects	1	2	4	2
several judges evaluating many projects	43	56	51	50

Note: Percentages add in vertical columns.

II. JUDGES' BACKGROUNDS

Backgrounds Described in the Literature

Finding judges who can be trusted to perform worthwhile evaluations is sometimes frustrating. MacCurdy and Bagshaw explain that:

> As a result of the great demand the supply [of judges] has come from Inexperienced but willing science teachers whose judgments may not be as reliable as might be desired.[15]

This compromise is most often made at the local fair level. It is unreasonable to expect college science teachers and science educators to make themselves available for small fairs. The high school science teachers who administer local fairs must content themselves with judging in each others' fairs and with capturing judges whom they know personally or who are members of the local community. Regional fair directors have a wider field from which to choose, but the attributes which they desire in their judges are of universal application. Armacost describes the kinds of judges he prefers, in advising:

> Past experience indicates that the best committees of judges are composed of representatives of industry, teachers, and supervisors of junior and senior

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[15]Robert D. MacCurdy and Thomas L. Bagshaw, "Are Science Judgments Fair?" <u>Science Education</u>, XXXVIII (April, 1954), 224.

> high school science, and college professors of science who are interested in the accomplishments of boys and girls.[16]

Herbert writes of one system, that:

> All projects are judged by teams composed of one university professor and one high school teacher chosen for their specialties.[17]

That larger fairs attract distinguished judges is substantiated by Kraus, who, in describing the National Science Fair, says, "Famous judges, each a recognized authority in a specialized field of science, evaluated exhibits . . . ."[18] Shannon summarizes the attributes of a good judge in the following:

> In general one might list the following qualifications . . .
> (1) good training in the biological sciences, the physical sciences, the earth sciences, or in specific areas of the larger scientific fields;
> (2) acquaintance with the science programs of junior and senior high schools;
> (3) recognition of good techniques of science teaching;
> (4) a keen interest in young people;
> (5) a desire to help improve the science work of students.[19]

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[16]Richard R. Armacost, "Syracuse University Science Congress," Science Teacher, XIII (April, 1946), 76.

[17]Gale A. Herbert, "Junior Academy of Science Searches for Needed Scientific Minds," Ohio Schools, XXX (March, 1952), 140.

[18]Joseph H. Kraus, "The National Science Fair: Purposes and Program," High School Journal, XXXIX (February, 1956), 266.

[19]Henry A. Shannon, "Judging Exhibits and Awarding Prizes," High School Journal, XXXIX (February, 1956), 301.

Backgrounds Preferred by the Respondents

Often, judges are chosen on the basis of Shannon's first criterion, while the necessity of using those who best satisfy the other four criteria is generally bemoaned. Table 7 bears out this assertion. If the preference for a particular background is determined by the largest percentage in a horizontal column, then the entire group ranks its choices of background in the following order:

1. college professors of science.
2. professionals in the sciences.
3. high school science teachers.
4. science educators.

The three groups who make up the list of respondents did not arrive at the same ranking. Table 8 shows that the high school science teachers preferred themselves first, then; (2) college professors of science, (3) science educators, (4) professionals in the sciences. College science teachers, on the other hand, decided that they were to be most preferred in light of their backgrounds. Table 9 reveals that they ranked the remaining three as: (2) professionals in the sciences, (3) high school science teachers, (4) science educators. It was extremely difficult to quantify the thinking of the science educators. Not a few of them refused to rank the groups at all, claiming that representation from each was desirable. At the same time, many quite rightly

TABLE 7. Preferences for particular backgrounds in the judges of exhibits expressed by the entire group in per cent

	First preferred	Second preferred	Third preferred	Fourth preferred
high school science teachers	34	21	53	26
professionals in the sciences	21	29	19	29
science educators	13	20	15	39
college professors of science	33	29	13	5

NOTE: Percentages add in vertical columns. In general the largest percentage in each horizontal column is used to determine the order of preference.

TABLE 8. Preferences for particular backgrounds in the judges of exhibits expressed by high school science teachers in per cent

	First preferred	Second preferred	Third preferred	Fourth preferred
high school science teachers	34	24	29	13
professionals in the sciences	25	25	16	39
science educators	10	20	27	39
college professors of science	31	31	27	9

NOTE: Percentages add in vertical columns. In general the largest percentage in each horizontal column is used to determine order of preference.

TABLE 9. Preferences for particular backgrounds in the judges of exhibits expressed by college science teachers in per cent

	First preferred	Second preferred	Third preferred	Fourth preferred
high school science teachers	20	11	56	24
professionals in the sciences	21	44	22	20
science educators	14	17	16	56
college professors of science	45	28	6	0

NOTE: Percentages add in vertical columns. In general the largest percentage in each horizontal column is used to determine order of preference.

noted that it was not the profession of the judge that was important, but rather his perspicacity in evaluating young people in the light of their abilities and limitations. Table X points out their indecision. No intelligible ranking is possible.

Summary

Competition inherent in science fairs has directed attention toward the necessity of making intelligent evaluations of exhibits. Of the techniques of evaluation already known, a checklist permitting judges to arbitrate in their evaluation is preferred to a more stringent checklist or to giving judges complete freedom in making their selections. Interviewing the exhibitor is a laudable practice but the realities of obtaining enough competent judges stifles this procedure in some fairs; judges are pressed for time and cannot significantly contribute to the exhibitor's need for the interplay of ideas.

The backgrounds of the judges themselves are a subject of some controversy. The disagreement evolves from determining whether a background in science or a background in education is more desirable. Apparently, college science teachers do not feel that the two are

TABLE 10. Preferences for particular backgrounds in the judges of exhibits expressed by science educators in per cent

	First prefarred	Seocnd preferred	Third preferred	Fourth preferred
high school science teachers	47	29	73	42
professionals in the sciences	16	18	19	29
science educators	16	24	2	23
college professors of science	22	29	6	6

NOTE: Percentages add in vertical columns. In general the largest percentage in each horizontal column is used to determine order of preference.

compatible, and prefer "scientists" to anyone else. High school science teachers are more confident of their qualifications, while science educators recognize that a dilemma exists and avoid it by suggesting that interest in and knowledge of young people is more important; thus, they indicate, high school science teachers may well be the happiest choice.

CHAPTER IV

CRITERIA FOR EVALUATION AND AWARDS OFFERED

I. CRITERIA FOR EVALUATION

In all of the fairs which attempt to determine superior exhibits from among a group of exhibits, the judges are given a list of criteria by which they are to make their evaluations. The criteria for determining the superior exhibits have been influenced by two organizations. They are the Educational Branch of the American Museum of Atomic Energy, and Science Service. The first organization publishes a handbook entitled Science Fair Handbook for Exhibitors. This handbook lists five standards for evaluating exhibits. This list is reproduced in Appendix C.[1] These criteria as well as those found in the Science Service's handbook. Sponsor Handbook for 1960-61 dictate, effectively, the criteria used at the local level. Fair officials would be foolish indeed to substitute a list of their own, if such a list would diminish the local winner's chances

[1] Science Fair Handbook for Exhibitors, (Oak Ridge: Educational Branch American Museum of Atomic Energy), p. 5.

at the National Science Fair. The criteria in the Sponsor Handbook are listed in Appendix C.[2]

Criteria in the Literature

The ultimate sources of these lists were the fairs that had been established well before 1950, the year of the First National Science Fair. Meister tells us of the early criteria:

> In the first School Science Fair [1928], these were the criteria for judging the student's work: general educational value, clearness of objective, accuracy of information given, attractiveness and neatness, originality and effectiveness of display. . . . the stress was placed upon the exhibit.[3]

Ransom relates that six years later, the criteria had not changed and were incorporated by the New Jersey Science Fair for 1936:

> The judging was done on the following basis:
> General value of the idea.
> Originality shown.
> Effectiveness of presentation of material.
> General attractiveness, neatness and care.
> Accuracy of information.
> Clearness of objectives.[4]

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[2]Leslie Watkins (ed.), "Criteria for Judging the National Science Fair-International," Sponsor Handbook for 1960-61, p. 42.

[3]Morris Meister, "The School Science Fair," High Points, XXXIX (May, 1957), 75.

[4]Sarah Bent Ransom, "The Science Fair as an Aid to Project Teaching," Science Education, XXII (March, 1938), 134.

By 1945, a refinement of terms had taken place but the principles remained essentially the same. Ward and Carleton listed the criteria used in the Rhode Island State Science Fair for 1946:

> There were nine criteria . . .
> 1. Uniqueness of Concept
> 2. Originality of Execution
> 3. Scientific Thought
> 4. Thoroughness
> 5. Technical Skill
> 6. Dramatic Value
> 7. Social Implications
> 8. Timeliness
> 9. Advancement of Science[5]

The impact of the National Science Fair can be inferred from article by Jones written in 1953. He suggests a quantified list:

> Items to be Considered in Judging
> 1. Scientific Thought - 20 points
> 2. Originality of Concept - 20 points
> 3. Thoroughness - 20 points
> 4. Ingenuity, Technical Skill and Workmanship - 20 points
> 5. Dramatic Value - 20 points[6]

This quantification is, of course, elementary. It does indicate however, Jones feeling about the value of the criterim listed as number four in the above.

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[5]Herbert J. Ward and R. K. Carleton, "The Rhode Island State Science Fair--1946," Science Teacher, XIII (December, 1946), 73-74.

[6]Norman R. D. Jones, "Science Fairs--Science Education in the Community," Bulletin of the National Association of Secondary School Principals, XXXVII (January, 1953), 168.

After 1950, many writers report lists of criteria similar to those already noted. This plethora, implying the general agreement among authors over the acceptability of the criteria, prompted the inclusion of most of them in the questionnaire. Some of the more novel criteria mentioned in the literature were also included in the list in order to offer the respondents a larger field from which to choose.

Criteria Selected by the Respondents

The premise of the thesis has been used to eliminate criteria in the tabulation. That is, if 25 per cent of the group expressed dissatisfaction with the criterion by marking either the column headed "not very useful" or, "useless", then it was eliminated.

Selected by the entire group. Of twenty-one criteria listed, the entire group of respondents eliminated nine. Those that were eliminated have a certain ring of familiarity about them. As determined from Table 11, they are:

An exhibit should be evaluated with regard to:
1. attractiveness.
2. dramatic value.
3. social implications.
4. timeliness of subject.
5. degree of advancement of science.
6. interest value.
7. economy of time.
8. economy of money.
9. whether a problem is solved.

TABLE 11. The evaluation criteria listed in the questionnaire with the responses of the entire group in per cent

The criteria	Most useful	Useful	Not very useful	Useless
attractiveness	4	59	31	5
neatness	11	75	13	1
accuracy	83	17	0	0
clarity of approach	64	35	1	0
uniqueness of concept	57	31	10	3
scientific thought	91	8	0	0
thoroughness	79	21	1	0
entrant's technical skill	12	67	21	1
dramatic value	1	33	46	20
social implications	4	34	41	20
timeliness of subject	3	30	46	22
degree of advancement of science	11	49	29	12
creative ability	67	27	5	0

TABLE 11 (cont'd)

The criteria	Most useful	Useful	Not very useful	Useless
interest value	6	57	32	5
economy of time	1	16	51	32
economy of money	2	28	52	18
scope of the project	15	64	16	6
knowledge achieved by the entrant	70	26	4	0
whether a problem is solved	23	49	20	9
whether a principle is clarified	45	46	7	1
attitudes developed on the part of the entrant	46	45	7	2

NOTE: Percentages are relative to the number who evaluated the criterion. Read percentages from left to right.

The first four criteria, as well as the sixth, correlate with the objective that science fairs should develop interest in science among the visitors (student and adult). This objective was the least popular of those selected as is noted on page 26. Many respondents expressed doubt about the meaning of the fifth criterion. Although respondents asserted that their judges were informed of the implications of the criteria by which they were to make evaluations, the brochures usually available to the exhibitors were not so explicit. The questionnaire did not elaborate on the meanings, therefore, to discover whether they really are well understood. Comments about these and the rest of the criteria will be noted as each group's opinions are examined.

The entire group, by eliminating the above criteria, left the following in order of preference:

An exhibit should be evaluated with regard to:

1.	accuracy.	100%
2.	thoroughness.	100
3.	scientific thought.	99
4.	clarity of approach.	99
5.	knowledge achieved by the entrant.	96
6.	creative ability.	95
7.	whether a principle is clarified	91
8.	attitudes developed on the part of the entrant.	91
9.	uniqueness of concept.	88
10.	neatness.	86
11.	scope of the project.	79
12.	entrant's technical skill.	79

Five of the twelve criteria are concerned with the exhibit itself. They are: (1) neatness, (2) clarity of approach, (3) entrant's technical skill, (4) creative ability, (5) whether a principle is clarified. Apparently, the "students of promise" who are to be encouraged as pointed out on page 17, should prepare exhibits which satisfy these criteria in order to compete successfully. In the accepted criteria listed above, the fifth and eighth make it absolutely essential that the judges interview the exhibitor. No serious judgment about the knowledge he has achieved nor about the attitudes he has developed can be made through observing a student's exhibit.

The rest of the criteria accepted, and those mentioned in the preceding, amplify the need for intelligent evaluation. All of them are subjective and each judge must decide whether to base his evaluation in relationship to the student, to himself, or to the laity who attend the exhibition. Obviously, what is clear to the judge may not be clear to the passersby; what is common to him may be unique to them and to the exhibitor. The other criteria suffer similarly.

Selected by the high school teachers. The high school teachers chose the same criteria in essentially the same order as did the entire group, with one exception as is tabulated in Table 12. They did not believe that the entrant's technical skill was significant and they considered the attitudes he developed least important of the list selected. One of the teachers who had become disenchanted with fairs indicated a reason for lack of faith in these criteria when he said that there was "too much adult help." Another teacher claimed that many of the criteria "[are] simply immeasurable by persons who do not know the student." Still another teacher explained his alternative to the problem, "I have students do projects--no contest--just display all projects at a 'Biology Night' to which the public comes . . . ." The impression given from the comments is that local fairs suffer from lack of effective judging in light of the criteria.

Selected by the college science teachers. College science teachers selected the same list, and in essentially the same order, as did the entire group. The calculated percentages are found in Table 13. Even though "dramatic value" and the like were eliminated, one respondent claimed that, " . . . it is almost

TABLE 12. The evaluation criteria listed in the questionnaire with the responses of the high school teachers in per cent

The criteria	Most useful	Useful	Not very useful	Useless
attractiveness	5	58	29	7
neatness	15	75	8	1
accuracy	85	15	0	0
clarity of approach	66	31	3	0
uniqueness of concept	54	29	11	6
scientific thought	93	5	1	0
thoroughness	84	15	1	0
entrant's technical skill	8	63	29	0
dramatic value	1	31	35	32
social implications	1	28	45	26
timeliness of subject	4	24	45	28
degree of advancement of science	19	46	23	13
creative ability	59	30	9	1

TABLE 12 (cont'd)

The criteria	Most useful	Useful	Not very useful	Useless
interest value	7	49	38	7
economy of time	0	18	50	32
economy of money	3	33	52	12
scope of the project	21	58	17	4
knowledge achieved by the entrant	69	29	3	0
whether a problem is solved	24	46	17	13
whether a principle is clarified	41	50	9	0
attitudes developed on the part of the entrant	38	47	10	5

NOTE: Percentages are relative to the number who evaluated the criterion. Read percentages from left to right.

TABLE 13. The evaluation criteria listed in the questionnaire with the responses of the college science teachers in per cent

The criteria	Most useful	Useful	Not very useful	Useless
attractiveness	2	71	23	5
neatness	7	80	13	0
accuracy	75	25	0	0
clarity of approach	66	34	0	0
uniqueness of concept	64	32	2	2
scientific thought	93	7	0	0
thoroughness	78	20	2	0
entrant's technical skill	16	69	13	2
dramatic value	2	51	38	9
social implications	2	36	39	23
timeliness of subject	2	38	45	16
degree of advancement of science	10	54	31	5
creative ability	73	24	2	0

TABLE 13 (cont'd)

The criteria	Most useful	Useful	Not very useful	Useless
interest value	2	61	33	5
economy of time	2	16	45	36
economy of money	2	25	49	25
scope of the project	14	70	16	0
knowledge achieved by the entrant	68	28	4	0
whether a problem is solved	18	55	16	11
whether a principle is clarified	49	44	4	2
attitudes developed on the part of the entrant	38	52	10	0

NOTE: Percentages are relative to the number who evaluated the criterion. Read percentages from left to right.

impossible to judge without putting too much weight on . . . in a word, showmanship." Another college teacher points up the subjective nature of the criteria when he notes that, "groups of judges are too often anxious to compromise."

<u>Selected by the science educators</u>. Table 14 shows that the science educators were in close agreement with the other groups in their preferences, with two exceptions. They ranked the attitudes developed on the part of the student as fifth in importance and eliminated "scope of the project." A science educator reveals some of the problems concomitant with the judging in writing:

> . . . often we have tended to reward craftsmanship rather than imaginative work in science . . . too often the evaluation . . . is of the contribution of a parent or some other interested person . . . the emphasis on . . . judging sometimes has a detrimental effect on the science program.

II. AWARDS

The nature of the awards offered successful contestants in science fairs is an indication not only of the degree of competition engaged in but also suggests the educational value attached to the fair itself. It may be said that the educational value is inversely proportional to the value of the awards offered, since

TABLE 14. The evaluation criteria listed in the questionnaire with the responses of the science educators in per cent

The criteria	Most useful	Useful	Not very useful	Uselss
attractiveness	6	49	40	4
neatness	10	69	19	2
accuracy	88	12	0	0
clarity of approach	61	39	0	0
uniqueness of concept	53	31	16	0
scientific thought	88	12	0	0
thoroughness	74	27	0	0
entrant's technical skill	12	67	21	0
dramatic value	0	18	64	18
social implications	10	38	40	12
timeliness of subject	4	28	47	21
degree of advancement of science	5	45	33	17
creative ability	70	26	4	0

TABLE 14 (cont'd)

The criteria	Most useful	Useful	Not very useful	Useless
interest value	9	61	26	4
economy of time	0	15	57	28
economy of money	2	25	56	17
scope of the project	9	64	15	13
knowledge achieved by the entrant	72	21	6	0
whether a problem is solved	26	46	24	4
whether a principle is clarified	45	45	9	2
attitudes developed on the part of the entrant	61	37	2	0

NOTE: Percentages are relative to the number who evaluated the criterion. Read percentages from left to right.

it is easy to agree that students are directly influenced by the awards available to them. This agreement is made reasonable by the suggestions made to Rogers by the successful participants in the Rhode Island State Science Fair. He reports that they recommended in part that the fair committee should, "provide more financial benefits (scholarships)."[7] Students seem to recognize this incentive more readily than they do one more, "academic."

An examination of the brochures, describing science fairs, sent in by the respondents reveals a repetition of awards that have monetary significance--either money itself or a scholarship. In one case, a "wish award" reminiscent of the Westinghouse Science Talent Search award was offered. There was an important exception, however. In the Science Talent Search, the winner chooses apparatus or the like whose value equals a certain amount of money commensurate with his standing in the final competition. In the science fair described in the brochure, the student was granted the money with the <u>expectation</u> that it would be used to purchase material of a scientific nature.

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[7]Arnold R. Rogers, "A Study of the Rhode Island Schools' Science Fair Program and its Effectiveness as Reported by Former Exhibitors" (unpublished Master's thesis, Rhode Island College of Education, Providence, 1960), p. 61.

Often, the first award mentioned in the brochures is an all expense paid trip to the National Science Fair, in which of course, the student would enter his exhibit.

Fortunately, the brochures indicate that all participants are granted some form of recognition. A medal, pin, or certificate or their equivalent is awarded to each entrant. The more successful of these receive more "valuable" prizes ranging from money itself to scholarships to a sojourn aboard a ship of the United States Navy.

Judgments of the Respondents

The respondents, in their respective groups, generally agreed on the order of preference of the awards they were asked to rank. Part of the reason for this is that many of them ranked several awards equally, in defiance of the instructions. Because of this defiance, some rationalization of the tabulations was necessary. Once an award was selected by a majority of the group being considered, it was eliminated from the remaining choices even though it may have obtained a greater percentage in a lesser rank. This procedure was not held inviolate, however, if it made the ranking unrealistic in terms of the thinking of the group. Comparison of the lists below with the corresponding tables will make this explanation more clear.

<u>Judgments of the high school teachers</u>. Following the technique described above, high school science teachers ranked the awards in the following order of preference, as taken from Table 15.

1. scholarships.
2. apparatus.
3. certificates.
4. trophies.
5. ribbons.
6. pins.
7. prize money.

The awards are seen to diminish in monetary value as the list is read, except for the last. Teachers apparently realize that there is "something" uneducational about money. Neither this list nor those that follow should be construed as the unanimous opinion of the group being discussed. Most of the respondents who made comments on the questionnaire concerned themselves specifically with the problem of making worthwhile awards. One teacher complained that,

> . . . local firms . . . asked to make prizes, e.g., typewriters, radios, etc., available . . . all wished their awards to go to first place winners. As a result the first place winner would get five or six awards, the third place a certificate.

Another teacher touches on two of the fundamental issues in fair activity by arguing that, "unfortunately, Science Fairs have been perverted into a money-making, ego-building affair." A third teacher suggests that, "The more

TABLE 15. Awards in order of preference as determined by high school science teachers in per cent

	First preferred	Second preferred	Third preferred	Fourth preferred	Fifth preferred	Sixth preferred	Seventh preferred
certificates	20	11	24	17	31	5	5
ribbons	13	11	16	19	21	14	5
pins	14	2	16	17	17	27	10
trophies	4	16	16	19	10	23	5
prize money	3	16	13	11	10	9	42
scholarships	39	16	5	11	0	9	5
apparatus	7	29	10	6	10	14	26

NOTE: Percentages add in vertical columns. In general, the highest percentage in horizontal column determines the ranking.

recognition that can be given to the greatest number . . . the more stimulating to the young scientists." Finally, a fourth science teacher explains that, "the pupil's most important award is what he learns."

Judgments of the college science teachers. College science teachers, according to Table 16, chose awards in exactly the same order of preference as did the high school science teachers.

Again, prize money is least favorable to the group. If scholarships are included under the heading of "educational value" awards, then both high school and college science teachers favor that type of award over the alternatives. One college science teacher pointed out, however, that scholarships awards are not quite germane, since, "scholarships will be available for the capable in any case." Another said he preferred, "no prizes--just the internal satisfaction one gets from seeing a job well done and appreciated by others." A third remarked that, "those who should be doing this kind of individual work shouldn't need monetary encouragement." "Typical science students," noted a fourth, "are not ostentatious, do appreciate simple plaques or framed certificates."

TABLE 16. Awards in order of preference as determined by college science teachers in per cent

	First preferred	Second preferred	Third preferred	Fourth preferred	Fifth preferred	Sixth preferred	Seventh preferred
certificates	30	9	37	14	10	6	8
ribbons	12	9	20	14	24	12	17
pins	19	18	7	11	10	19	8
trophies	7	15	13	29	14	19	17
prize money	6	9	10	11	14	12	33
scholarships	19	15	3	11	5	12	0
apparatus	6	24	10	11	24	19	17

NOTE: Percentages add in vertical columns. In general the highest percentage in a horizontal column determines the ranking.

Judgments of the science educators. Table 17 indicates the responses of the science educators. Their ranking developed the following order of preference:

1. certificates.
2. ribbons.
3. scholarships.
4. trophies.
5. pins.
6. apparatus.
7. prize money.

They also ranked prize money seventh while rating scholarships lower than did the other two groups. One educator noted a difficulty from administrative control in writing, "We would prefer trophies to money prizes but we have to take the award money from New York State which cannot be used for trophies." Another educator commented that, "usual criteria used for science fairs are not sufficient bases for awarding scholarships . . . ." A third related something of a compromise, " . . . we decided . . . not to send winners to the National Science Fair but to use the money . . . for student scholarships."

All of the respondents were given an opportunity to list alternative awards if they so desired. Many suggested that scientific books or subscriptions to scientific magazines would be valuable awards. There was no way to intelligently tabulate these and they are thus mentioned in passing.

TABLE 17. Awards in order of preference as determined by science educators in per cent

	First preferred	Second preferred	Third preferred	Fourth preferred	Fifth preferred	Sixth preferred	Seventh preferred
certificates	45	13	13	12	10	12	0
ribbons	14	29	8	25	20	0	0
pins	8	6	21	6	20	25	0
trophies	3	16	21	31	0	12	20
prize money	5	16	4	12	20	0	60
scholarships	20	10	21	6	10	12	20
apparatus	6	10	13	6	20	38	0

NOTE: Percentages add in vertical columns. In general the highest percentage in a horizontal column determines the ranking.

Summary

Competition in science fairs has led to the quantification of the criteria for evaluation. The criteria themselves are subjective in nature and are not readily amenable to quantification. This dilemma leads to serious questions about the appropriateness of awards which carry monetary value. In any event, no matter how valuable the top awards, all participants deserve recognition.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

I. SUMMARY

Objectives of Science Fairs

The objectives of science fairs found to be most realizable by the majority of respondents are to:

1. encourage students of promise.
2. exhibit the work of students on projects.
3. broaden students' horizons (entrant and visitor).
4. promote self confidence in the entrant.
5. promote scientific research.
6. stimulate students and teachers in classwork.
7. focus attention on science experiences in school.
8. develop interest in science among the visitors (student and adult).

These objectives are not without drawbacks and deserve careful scrutiny by everyone concerned with fairs.

Judging Techniques

Several judges evaluating a few exhibits is a desirable technique, but it is more realistic to expect that, through the lack of large numbers of judging personnel, judges will continue to be pressed for time because they must evaluate many exhibits. This practice effectively curtails useful communication among judges and participants.

A generalized checklist permitting the judges to arbitrate, within limits, is preferred by the majority of respondents. This practice is carried out in many of the science fairs about which this author received literature.

When composing teams for judging purposes, the group considers the following list as representative of the most effective judges, in descending order of preference:

1. college professors of science.
2. professionals in the sciences.
3. high school science teachers.
4. science educators.

Criteria for Evaluation of Exhibits

The criteria generally accepted as useful in determining superior exhibits are, in descending order of preference:

1. accuracy.
2. thoroughness.
3. scientific thought.
4. clarity of approach.
5. knowledge achieved by the entrant.
6. creative ability.
7. whether a principle is clarified.
8. attitudes developed on the part of the entrant.
9. uniqueness of concept.
10. neatness.
11. scope of the project.
12. entrant's technical skill.

The criteria bear a modicum of inefficiency because they are subjective. Some of them concern themselves with the exhibit and not with the student. Some doubt exists about whether their quantification is efficacious.

Awards

Monetary awards that are not related to science in some way are frowned upon. All students who participate should be granted some form of recognition. Participation should not be encouraged by the possibility of receiving other than academic recognition.

II. CONCLUSIONS

The objectives of science fairs are worthy of attainment. Unfortunately, some fairs operate primarily to focus attention on science rather than on the student. The visitor and his interest are deemed almost as important as the exhibitor. Science fairs as practised today, offer real recognition to the "student of promise" who probably does not need such encouragment.

The criteria, judging techniques and awards offered all indicate that competition is the watchword in science fairs. Many participants who are not mechanically inclined or able to extemporize probably suffer in the judging. The "grand awards" offered participants very likely overshadow the educational value of fairs. In any event, the educational value to be derived from fair participation culminates with the completion of the project and not with the completion of the exhibit. The ability to construct an effective exhibit is not a reliable indication of scientific ability and from this results the discomfort of some serious observers about the outcomes of science fairs.

III. RECOMMENDATIONS

That we learn best by doing is a well established precept. In science fairs, the connotations of the precept have largely been ignored. The "doing" has overcome the "learning" in exhibit construction. One author has been realistic enough to devote himself to an article explaining how to win at science fairs.[1]

A significant number of respondents expressed a feeling of disillusionment about the values of science fairs as they are conducted today. Quite frankly, the blame for the situation can be laid at two doors. The first to be called to account are science teachers, including junior and senior high school teachers, college science teachers and the educators who are responsible

[1]Maitland P. Simmons, "Let's Join the Science Fair Winners," Science Teacher, XXIV (September, 1957), 225-27.

for the professional preparation of our science teachers. They have shown a remarkable lethargy in developing intelligent extra-curricular programs to take advantage of the increased interest in science that is being expressed on every side. This lethargy has, no doubt, been sustained by the comforting feeling that science fairs are satisfying the craving for an increase in science activities. Second in default is Science Service, a thoroughly admirable and effective institution. They have, all unwittingly of course, stolen the initiative in science education from those who are supposed to be responsible. This organization, although not under public influence, is indirectly controlling the science curricula of a large majority of our schools. The enthusiasm of this organization and its influence on the public thinking has generated great amounts of activity in science classes. Regrettably, this activity is more often carried on in order to "have something for the fair" rather than to investigate a problem. Many who are concerned with science fairs are, without thinking, calling "exhibits", "projects", and thereby confusing the situation. Such activities and such thoughtlessness cannot lead to good learning.

Because of the influence of the National Science Fair, too much emphasis is placed on the exhibit. The student is the one who needs and deserves evaluation. The "creative ability" demonstrated by his exhibit is not, by any means, an indication of his scientific ability. In fact, none of the abilities required to construct an exhibit is a defendable attribute of a scientific person.

The word, "project", has come to signify the construction and display of posters, apparatus, photographs and other paraphernalia. It should, of course, mean the process of searching out a problem, defining its limits, exploring its facets, deriving pertinent conclusions and sometimes explaining it to persons interested. Such persons may require aids in order to understand the project in its entirety, but if they are competent in the science area that the project involves then they certainly must find superfluous, catchy titles, commercial apparatus and explanations posted on backer board "to read from left to right so that the observer has no difficulty following the idea of the display."

All too often, "projects" get in the way of evaluating the student. There must be, and there is, a better technique for recognizing and encouraging students whose scientific abilities are already evident, as well as to encourage students who would benefit from learning how a scientist really works.

The preparation and presentation of a scientific paper is such a technique. No scientist worthy of the title would waste his time and effort in building a display so that his colleagues might evaluate his efforts in carrying out a project. The regular and recognized procedure that scientists follow--and this can be observed on any campus where serious scientific studies are undertaken--is to prepare and present a paper which is a concise explanation and summary of an investigation. The presentation is made primarily to people already knowledgeable in the area of the investigation. If visual aids are required in explanation, no one expects the researcher to have prepared the final materials him-self (although he does direct their preparation). The particular arts of these preparations properly belong to those who are experienced in such matters. No one judges the observer on his attitudes or on the unique-ness of the concepts of his investigation. (A res-pondent challenged the author to, "name a scientific concept that is not unique.") In fact, if the investigator's conclusions are the essence of the paper, then his conclusions are examined and criticized; if the researcher is demonstrating his ability to carry out a project, then that ability is judged.

Why, then is the science fair idea, which is supposed to give students a taste of the scientific world, so unrealistic? Can we not better satisfy the objectives of fairs by changing our technique to this more realistic approach?

We will, as a result, eliminate much of the criticism now directed at fairs, and deserved by them. If the art classes and the photography club and the various shops have a hand in conducting a project and presenting a paper and if the participant is not judged on what he has not personally constructed we need fear no longer the contention that parents and teachers play unfair roles in "project" construction. Let the typing class prepare copies of the paper; permit English classes to criticize and improve them. Such an approach would dramatically demonstrate the interaction of the arts and sciences to all the students involved.

It is immediately obvious that large "fairs" will be impossible. The presentation of a paper is an involved process and judges cannot be expected to listen and deliberate for many hours. It will also be far more difficult to determine superior projects from ordinary papers. This is advantageous. The only reason for stiff competition is to make large awards. More students would benefit from more equal awards, from presenting their papers before a learned group of men, from answering questions from the floor.

In every respect, the preparation of a paper and its concomitant requirements is superior to constructing an exhibit. It forces elimination of the disadvantages of science fairs, while retaining all of their desirable objectives.

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APPENDIXES

APPENDIX A

The Ohio State University
Smith Hall - Room 306
92 West 11th Avenue
Columbus 10, Ohio
April 17, 1961

As a person who is interested and active in the teaching of science, you are doubtless aware that Science Fairs (or Science Days) are beginning to suffer from a groundswell of disillusionment. I am sure that you have made some judgments about Science Fairs. These judgments, taken collectively with those of your colleagues, will clarify the appropriateness of Fair objectives. They will also indicate the proper means of evaluating those objectives through the projects produced by students.

I am preparing a thesis on this very problem and none that I might query can have more valuable ideas than those who are in science teaching and science education. Therefore, any worth which may accrue to this study will be directly proportional to your response. I ask you, then, for your time and effort in filling out the enclosed questionnaire.

Thank you in advance for your cooperation and interest.

Sincerely yours,

Robert J. Brennan

P.S. I would greatly appreciate your enclosing the scoring sheet used by your judges as well as the instructions to the judges, if you have such forms available.

QUESTIONNAIRE

LISTED BELOW ARE THE OBJECTIVES FOR SCIENCE FAIRS WHICH ARE MENTIONED IN THE LITERATURE.

PLACE AN X IN THE COLUMN WHOSE HEADING BEST DESCRIBES THE OBJECTIVE.

Science Fairs should:	MOST APPROPRIATE	APPROPRIATE	NOT VERY APPROPRIATE	INAPPROPRIATE
promote self confidence in the entrant;				
provide a means for entrants to meet people;				
encourage entrants to think on their feet;				
develop interest in science among the visitors (student & adult);				
exhibit the work of students on projects;				
encourage the establishment of a course for students with special interests;				
encourage students of promise;				
broaden students' horizons (entrant & visitor);				
promote scientific research;				
stimulate students and teachers in classwork;				
focus attention on science experiences in school;				
stimulate hobbies;				
provide a special opportunity for parents to appreciate the advantages of education;				
link college teachers and high school students through assistance.				

The end product of a Science Fair is the display and evaluation of demonstrations and exhibits. Listed below are the criteria cited in the literature for evaluating projects.

PLACE AN X IN THE COLUMN WHICH BEST DESCRIBES THE CRITERION.

A project should be evaluated with regard to:	MOST USEFUL	USEFUL	NOT VERY USEFUL	USELESS
attractiveness;				
neatness;				
accuracy;				
clarity of approach;				
uniqueness of concept involved;				
scientific thought displayed;				
thoroughness of investigation;				
the entrant's technical skill;				
dramatic value;				
social implications;				
timeliness of subject;				
the degree of advancement of science;				
creative ability displayed;				
interest value;				
economy of time;				
economy of money;				
scope of the project;				
knowledge achieved by the entrant;				
whether a problem is solved;				
whether a principle is clarified;				
attitudes developed on the part of the entrant.				

Evaluation techniques are fully as significant as the criteria themselves. If you were to organize a Science Fair, which of the following techniques would you use?

CHECK ONE

___1. a highly quantified checklist defining points for each of your criteria

___2. a generalized checklist to permit the judges to arbitrate

___3. permit the judges to give weights to each criterion as they judge each project

___4. some other technique (please fill in)

Judges themselves are vital to the success of a Fair. Among the following, check those whom you would like as judges for your Fair.

ENUMERATE IN ORDER OF PREFERENCE--1 FOR MOST WANTED; 2 FOR SECOND MOST WANTED, AND SO ON.

___science teachers
___professionals in the sciences
___science educators
___college professors of science
___other (please describe)

CHECK THE ORGANIZATION BELOW WHICH BEST SUITS YOUR PURPOSES.

___one judge evaluating a few projects
___several judges evaluating a few projects (team judging)
___one judge evaluating many projects
___several judges evaluating many projects (team judging)

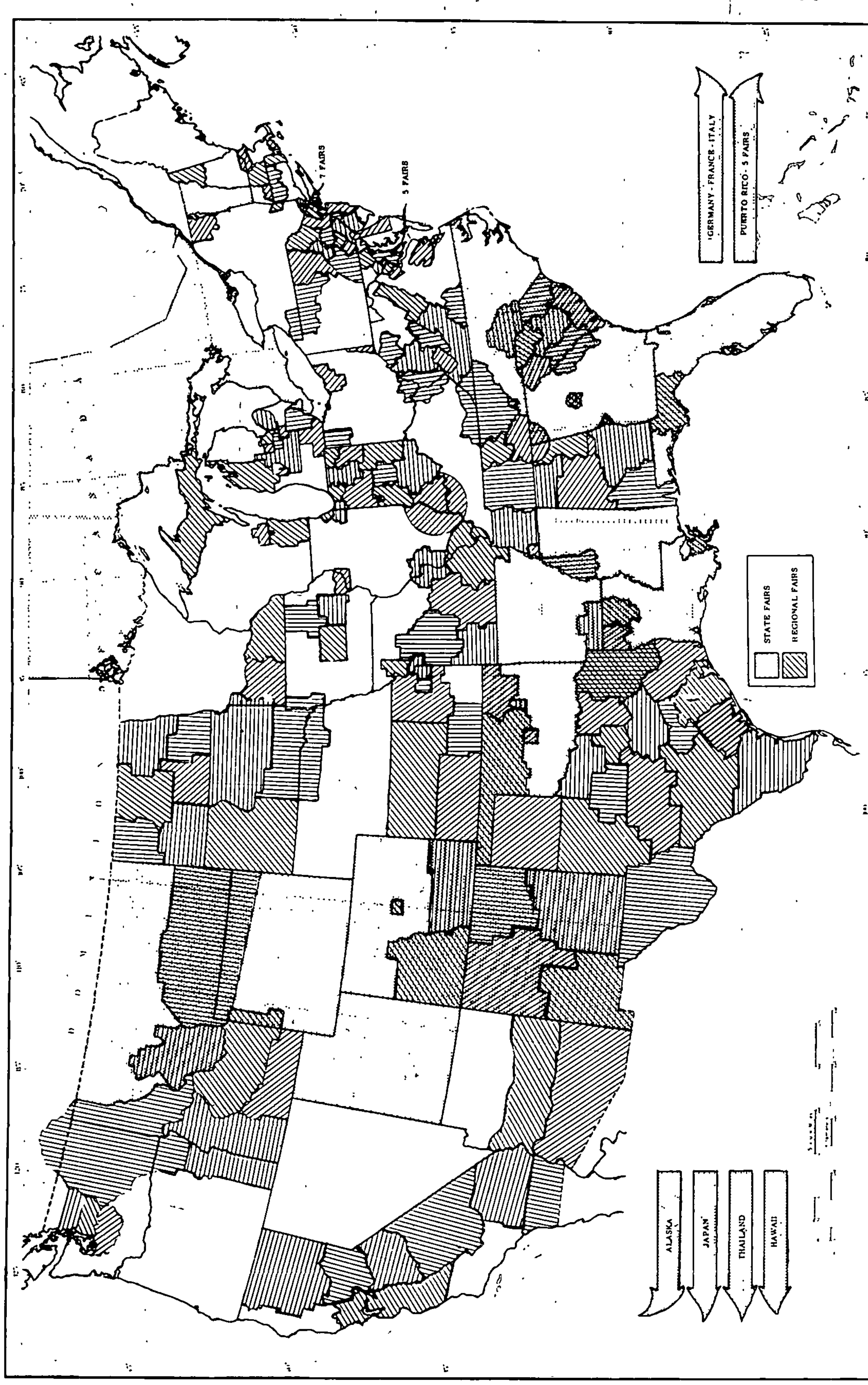
ENUMERATE IN ORDER OF PREFERENCE THE AWARDS YOU THINK BEST SATISFY THE OBJECTIVES OF SCIENCE FAIRS.

___certificates
___ribbons
___pins

___trophies
___prize money
___scholarships

___apparatus
___other
(please specify)

COMMENTS


GERMANY - FRANCE - ITALY
PUERTO RICO - 5 FAIRS
7 FAIRS
5 FAIRS
STATE FAIRS
REGIONAL FAIRS
ALASKA
JAPAN
THAILAND
HAWAII

APPENDIX C.

CRITERIA FOR EVALUATING EXHIBITS

<u>Criteria in the Handbook of the American Museum of Atomic Energy</u>

1. Scientific Thought:
   How does the exhibit illustrate one or more of the following: completeness of observation, controlled experimentation, theories, analysis, synthesis, cause and effect reasoning, making comparisons by showing likenesses and differences?

2. Creative Ability:
   Does the exhibit show originality in plan and execution? Does it demonstrate new or improved ways of expressing or communicating scientific ideas?

3. Thoroughness:
   Does the exhibit tell a complete and concise story about the project? Is the proper emphasis given to important items?

4. Clarity and Dramatic Value:
   Does the exhibit catch and focus the attention of visitors? Are the labels large, neat, and easy to read and understand? Does the exhibit contribute to the understanding of both laymen and scientists?

5. Technical Skill:
   Is the exhibit sound and durably constructed? Is good craftsmanship shown? Will it stand the wear and tear of transportation and demonstration?

<u>Criteria in the Handbook of Science Service</u>

I. Creative Ability . . . Total 30 points
   How much of the work appears to show originality of approach or handling? Judge that which appears to you to be original regardless of the expense of purchased or borrowed equipment. Give weight to ingenious uses of materials, if present. Consider collections creative if they seem to serve a purpose.

II. Scientific Thought . . . Total 30 points
Does the exhibit disclose organized procedures? Is there a planned system, classification, accurate observation, controlled experiment? Does exhibit show a verification of laws, or a cause and effect, or present by models or other methods a better understanding of scientific facts or theories? Give weight to probable amount of real study and effort which is represented in the exhibit. Guard against discounting for what might have been added, included, or improved.

III. Thoroughness . . . Total 10 points
Score here for how completely the story is told. It is not essential that step by step elucidation of construction details be given in working models.

IV. Skill . . . Total 10 points
Is the workmanship good? Under normal working condition, is the exhibit likely to demand frequent repairs? In collections, how skilled is the handling, preparation, mounting or other treatment?

V. Clarity . . . Total 10 points
In your opinion will the average person understand what is being displayed? Are guide marks, labels, descriptions neatly yet briefly presented? Is there sensible progression of the attention of the spectator across or through the exhibit?

VI. Dramatic Value . . . Total 10 points
Is this exhibit more attractive than others in the same field? Do not be influenced by "cute" things, lights, buttons, switches, cranks, or other gadgets which contribute nothing to the exhibit.