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ABSTRACT

Papers were given at a conference sponsored by the National Science Foundation on present and future use of the museum as an educational resource. Science education, media use, museum-community relationships, and museum-school relationships engaged the attention of the speakers. The educational programs of particular museums were reported on by members of their staff. An annotated bibliography is given. The appendices contain suggestions on the possible functions of a science museum and statistical information on museums and precollege science education. (MF)

OPPORTUNITIES FOR EXTENDING MUSEUM CONTRIBUTIONS TO PRE-COLLEGE SCIENCE EDUCATION

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Supported by The National Science Foundation

Belmont Conference Center
January 26-27, 1970

[illegible] Goldman
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Edited by Katherine J. Goldman
Coordinator of Studies in Museum Education
U. S. National Museum

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August 3, 1970

Special thanks are due Mrs. Jo Baker and her staff at Belmont Conference Center for their many unseen ministrations, keeping the conference running smoothly and with grace.

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I.

MUSEUMS AS EDUCATIONAL FACILITIES: GENERAL CONSIDERATIONS

Chairman's Introduction

Alma S. Wittlin (School of Medicine, University of California, La Jolla)

What Science Contributed to the Advancement of Museums -- What Museums Might Contribute to the Advancement of Science

The human yen for knowledge concerning the natural environment was paramount among the forces which led to the foundation of private science collections and of public science museums. Throughout the centuries such establishments have been illustrating two characteristics of man: his concern with utilitarian matters and his curiosity which transcends all regard for utility. A demarcation line between the two propensities cannot always be drawn, and their seeming mutual contradiction may fundamentally be nonexistent.

The study of the attitudes of people toward science collections in the past can, I believe, be of assistance to us in clarifying the services science museums may offer to young people in our age.

Why "Pure" versus "Applied" Science? Why Not Just Science?

For the last ten to 15 years we have been witnessing a crusade for science in schools below college level, and there is little doubt that many of the projects for pupils from the first to the twelfth grade held intellectual enchantment. I know of no overall evaluation of the results of these endeavors, but such spot checking as I had the opportunity to make did not persuade me that what young people gained in information and in interest in science has so far been commensurate with the investment in these programs, with the investment in terms of talent, energy and funds. The introduction of any innovation in schools poses complex problems and a lack of results in the application of a new project does not necessarily reflect any shortcomings in it. It is, however, difficult altogether to ignore the decrease in the number of high school students registering in physics classes in recent years. Had they not had access to updated science instruction in grade and junior high schools? Further, how weighty is the evidence that graduates of new physics classes at high school level did not outrank others in their college physics freshman courses? Such considerations lead up to the question whether many of the innovative science projects for schools under college level did not go too far in emphasizing "pure" science.

Unconsciously many young people may feel what Mr. R. K. Jarvis, a methematics teacher at Groton School, expressed by saying, "Pure mathematics is to applied mathematics as cross-word puzzles are to literature."

I suggest that there is a great opportunity for museums to explore different ways of combining pure and applied science. It would amount to a synchronization of static exhibits with demonstrations and laboratory-style activities for individual students; according to local conditions, museums might take charge of the entire project or share it with school systems, on the premises of the museum or of the schools. If we consistently separate science from technology, we offer incomplete experiences; we have to address ourselves to both the utilitarian and the speculative appetites of human beings.

Such static technological exhibits as I have viewed in museums -- on the refining of oil, on refrigeration, on space flight -- were as a rule attractively handsome but intellectually obscure. They were wrapped-up packages with the contents only partly visible. When a few of the many implied scientific processes are demonstrated, the chance of understanding the entire message goes up. Such combination exists in fact in some institutions, but we need more of them, with strict attention, paid to the synchronization between exhibit and demonstration, and with the realization that flamboyant effects, either in exhibits or in demonstrations, belong to the realm of public relations but not the realm of learning. Further, some technological museum exhibits might be coupled with manipulative materials for individual students, to be used in separate rooms in the museum or sent to schools.

If students, at whatever level below college, engage on experiments related to a very specific area, we run several hazards: the students of limited speculative inclination will not realize the full relevance of the topic and will remain indifferent to it and to science in general; all will be conditioned to seeing a problem as being self-contained instead of being led toward a growing awareness of the warp and woof of life. I met with high school science students intensely interested in their projects for a science fair and yet blissfully unaware of their ignorance of any aspect of science one step beyond their project.

Hardware vs. Software

The listing of topics for this conference is very encouraging: it emphasizes experiences and behaviors of human

beings in museums and allots second place to the hardware of exhibit cases or other technicalities which customarily occupy the place of pride in museums. Obviously, cases or mobile museums, or techniques in freezing bird skins, are important means to an end, but they must not become ends in themselves.

In these sketchy remarks on a very large topic to which several speakers will make their contributions, I would like to mention a few aspects of communication which are of special interest to me. And by communication I mean in this context a successful interaction between people and objects. In planning a message composed of static exhibits only, or of exhibits synchronized with demonstrations (live or mechanical) and laboratory work, let us follow the principles of "systems" which have proved their value in other settings; as Robert Gagné reminded us, a problem cannot be solved in a vacuum and we have to consider how well the component parts fit together. Let us be specific when establishing our goals. Let us pay attention to the hierarchy of concepts we introduce. And let us never forget that our software, the human being with whom we deal, has only one pair of eyes, and of eyes of specific potentialities and limitations, and that he has only a single brain and nervous system. Without thorough information on this software, we are running the danger of dealing mainly with hardware.

It may be that museums, or some museums, should set as their top goal the excitement of scientific curiosity in young people -- of curiosity in general. It is one of the primary human characteristics, akin to hunger, but during the millennia of primitive technology and of scant means of production, actually up to our generation, the curiosity of the masses had to be kept low. As long as the human muscle was a main source of energy on earth, we needed more brawn power than brain power. These conditions are changing radically as we live through the greatest of human revolutions. The cultivation of curiosity is now becoming a utilitarian concern.

About the Individuality of Museum Projects

While schools are harnessed to large organizations museums are comparatively small, independent and flexible establishments. They have much greater scope for experimentation than schools. I shall briefly refer to two science projects which would seem at two opposite ends of the educational spectrum.

The Webb School in Claremont, California, for boys of proven aptitude, has a museum of paleontology which is an integral part of their science center. And the combination of

field work, laboratory, lecture and museum produces remarkable results among boys from the eighth to the twelfth grade. There is an additional learning aid in the form of the teacher who guided the foundation of the program, Mr. Raymond Alf, who professes with passion. The fossil exhibits illustrating footprints, from spiders to dinosaurs, occupy one story of the building and can be viewed by the public by appointment. (See photograph, page 12.)

At the end of the Second World War, I was called as a consultant to a school in the slums of London in England, where an entire class of girls had failed in the dreaded eleven plus examination which opens or shuts the doors to higher education. After several approaches which failed, one approach proved successful with these 11- to 14-year old, thoroughly demoralized and semi-literate girls: a socio-drama in which they acted out the development of spinning and weaving, and of clothing in general. The materials -- garments, samples of cloth, and tools for carding, spinning, and weaving -- were mainly museum specimens which on other occasions served as exhibits in glass cases. They were lent by the Museum of Archaeology and Anthropology of the University of Cambridge and by the Victoria and Albert Museum in London. Some objects used for comparison were supplied by the factories and workshops producing modern textiles and garments.

I sincerely hope that these scanty notes will not be mistaken for all my concerns with museums as means of communication.

Frank Oppenheimer (The Palace of Arts and Science, San Francisco, California)

Schools Are Not for Sightseeing

The concerted attempt of scientists to understand both the living and the inanimate parts of nature has led to the discovery of a rich variety of natural phenomena that surpass any flights of fancy in their beauty and novelty. These miracles of life and nature are wonders of the world that few people have the opportunity to appreciate and observe. As one learns about the inside of a star, the inside of a metal or a crystal, the inside of a brain or an eye, one renews a sense of the miraculous. These wonders of the world are not accessible to the unaided senses. They do not form an obvious part of the familiar world. One needs special instrumentation which extends the range and sensitivity of the senses in order to observe them. They do not fit into the normal patterns of sightseeing, one does not use a ship or airplane or rocket to get to them; yet they can be made accessible. They can become as pleasant and revealing a part of nature study as is a walk through the woods or a stroll on a seashore.

The importance of familiarity with the wonders of nature goes far beyond the instantaneous pleasure it elicits. This familiarity changes the way in which people view themselves and alters their relationships with nature and with other people. The ideas of order and chance, of symmetry and unity, of continuity and discreteness, and of complementarity and reality enlarge and clarify one's understanding of nature, yet these ideas can only become meaningful if one has some form of personal involvement with the details of natural processes. The great gulfs which divide and frighten people can perhaps more easily be bridged as an awareness of the unity of nature becomes more pervasive. The foundation for this sense of unity must begin with appropriate environments for sightseeing. Museums can provide this environment.

Museums have traditionally been a part of sightseeing. People engaged in seeing the sights in a city or a national park invariably visit the museums. However, we can extend the type of sightseeing they now provide. To do so will require much innovation. The innovative task can be made easier both by exploiting the relation between science and technology and by making use of the traditional role which artists have played in making people more aware of and more sensitive to their environment. Most of the newly discovered natural phenomena have provided the raw material for

invention and have been incorporated into the technology. On the other hand, artists are increasingly making use of technological innovations divorced from a technological context. They incorporate them into their aesthetics. Thus new possibilities have opened up for making the wonders of nature accessible to the public and the non-specialist, and these are possibilities that also intrigue the specialist. We are now in a position to develop museums which will enable the public to explore parts of nature and human activity from which they have heretofore been excluded.

Since museums can provide an avenue for sightseeing, they can perform a vital educational role. In performing this role they will relieve the schools and universities of a responsibility which schools are not designed to fulfill. Schools cannot easily provide an adequate vehicle for sightseeing. Sightseeing from a classroom situation usually resembles sightseeing from a train. Courses rush to their destination so that passengers can make their connections. The great vistas that rush by, the people and towns along the way, never become part of the viewer's experience.

But the community has demanded that the schools show the sights to the young. Educators and faculties have been aware of the responsibility they have for not merely training their students to be good at something or to get them to be inventive and thoughtful, but also to survey the broad fields of culture and achievement. The most enlightened and anguish-filled attempts at curriculum development have been involved in developing survey courses, science for the non-scientists, literature for the engineer, humanities for freshmen. Whenever faculty members meet, they list "what the student should know" and the results of these lists invariably lead to the institution of or the modification of a course. The students are graded in these courses, one course is a prerequisite for another one, they are the requirements for graduation.

Museums are very different. No one ever flunks a museum, one museum is not a prerequisite for the next. People do not list the museums they have attended on a job application form. Museums are thus free of many of the tensions which can make education unbearable and ineffective in the schools.

Surely sightseeing is an important part of education. There is so much of nature and history that is inaccessible to people, so many beautiful phenomena of which people are unaware, so many parts of nature and culture which have common threads and inter-connections but which appear as isolated fragments in daily life. In a museum these phenomena can be shown and illuminated. Museum pedagogy can suggest the common threads

through exhibit design, through appropriate juxtaposition, and through multiple examples. The visitor can truly explore, not only by investigating individual exhibits, but by choices in the way he takes in the whole. He can back-track over the same ground, leave out what he chooses, bring his friends back to share the same sights. He can even, on occasion, bring things to the museum to be shown there. In a museum people interact with each other. People watch and overhear each other as they manipulate devices. Groups of people separate and then draw one another together again to focus on specific items. The whole is laid out before the visitor and one part beckons even as he is absorbed in another. Young children will shout with glee and run at full speed from one part of the building to another. People use a museum in different ways. Some will spend an hour before one exhibit, manipulating all its controls and variations, and then leave. On the other extreme I have seen a young couple, out on their Sunday morning jog, enter a museum and jog by every exhibit never once slackening the pace. All manner of people, all ages of people from all parts of town mingle on an obviously equal footing. There are no tensions and no threats.

In contrast to classrooms, museums provide a reversible, deflectable, three-dimensional form of education. The classroom situation with its blackboard lectures gives a seriatim presentation of material. The classroom lends itself to the non-stoppable two-dimensional type of education that is epitomized in films and television programs. But the classroom situation is essential to many types of learning and especially to those kinds of learning which involve intellectual competence. Free-lance learning of mathematics, physics, philosophy, or economics, for example, is not universally successful. For such disciplines, the classroom appears to be essential. However, the class is not the appropriate environment for sightseeing. Yet sightseeing can lay the background for all other forms of education; it must, however, be done where one can partake of the sights. Films, books, lectures will then take on more significant meaning when they can build on a background of contact with reality. Yet an adequately broad contact with reality is hard to come by in everyday life. Artificially created environments are required. Museums can serve this role.

Why, if museums play this vital role in the educational process, have they been such orphans of the educational endeavor? They are not, for example, considered sufficiently a part of the educational process to be eligible, as are schools, for government surplus property. They are never entirely supported by the educational budgets of cities. As independent institutions, they are

considered not as educational institutions but as tourist attractions. Federal agencies concerned with education are not authorized or funded to support the development of museums.

The lack of public support for museums is derived from several factors. The museums themselves have not uniformly considered themselves as educational institutions and have not creatively developed appropriate forms of pedagogy. They frequently considered themselves primarily as repositories of objects with which scholars could work. Many museums have allowed themselves to be used for glorifying rather than for instructing. Others have become more concerned with things than with people. But on the whole, the trouble is not to be found with the shortcomings of museum management. Their shortcomings are more often the product of financial constraints than of a lack of imagination. The financial constraints, however, are not the whole story. Most museums have been too pristinely audio-visual. They have not stimulated multi-sensory contact with the exhibits which include touch and kinaesthesia. Their aesthetics have gone into expensive diorametry and not into artistry. Yet despite the defects in museums, they nevertheless remain wonderful places in which to learn and to teach.

More important reasons for the lack of educational status for museums stem from deeply based public attitudes. Museums do not involve "work" for the visitor. One goes to a museum on one's time off. When teachers take school children to museums, they are interrupting the serious business of learning (unless of course the students make notes during their tour and take a test or write a paper about the excursion). But museums should be playful. Animals learn about their culture through play, and so do humans. Children become familiar with both the tools and customs of society through play. Play involves using the forms and instruments of society out of context and can thus reduce fear. Acculturation is apparently universally achieved by play. In our era of incessant and rapid cultural change, legitimizing play in the appropriate kind of educational institution is essential for adults as well as children. This aspect of museums, the fact that they appear more as play than as work, should add to rather than detract from their value. It is another difficulty, however, that has tended to slow up support of museums: there is no recognized quantitative measure for the educational effectiveness of a museum. How does one evaluate the educational outcomes of play? How does one determine the social benefits of sightseeing? Should one devise tests, follow-up interviews, or questionnaires? Should one judge by the average daily attendance, the length of stay of the visitors, the admission price that people are willing to pay?

There are some things that we know how to measure, and others that we do not. But the lack of an adequate measure

should not imply that a practice be abandoned if it seems good. People built fires to keep warm long before Galileo invented the thermometer; people take shelter from the wind without requiring a personal anemometer; people have prayed although they had no quantitative measure of the effect of prayer on the outcome. We have no measure for kindness or honesty or wisdom, yet we recognize and revere these qualities. Why do we insist that there must always be a measure for the quantity of learning? By thus insisting, we have limited our teaching to only those aspects of learning for which we have devised a ready measure. More and more we have excluded from the educational processes the teaching and learning of things that we feel good about teaching and about learning but for which we have no measure.

The fact that one cannot quantitatively evaluate the educational benefits of a museum does not imply that one should not do some cost accounting on them. For example, the operating costs per contact hour of the exposure to exhibits for visitors in the Chicago Museum of Science and Industry is about 24 cents. The operating costs per contact hour for pupils in the primary and secondary schools of San Francisco is about 13 cents. How does one evaluate these figures? Clearly museums are not orders of magnitude different in such cost than are schools: But if we insist on a quantitative measure for the effectiveness of museums, we will have to abandon the possibility of making them important.

Discussion Insert

Contributions of Museums
Leading Children to an Interest in Sciences

MR. NAUMER: Frequently students "grow up in a museum." I've tried to find out from a research assistant why it was that he got off to such a good start in a museum. He had been interested in rocks and minerals but it was in a museum that he discovered that others shared his interests. Association with scientists introduces students directly to an awareness about science.

MR. McKINLEY: I had three kids grow up in our museum. They discovered they weren't crazy to have interests in nature. Two are now masters' candidates and one is going after the doctorate. Of 40 former science fair winners whose careers we heard about, most had gone on into the sciences. We give space to local and state professional societies.

DR. NETTING: The Junior Curator Program of the California Academy of Sciences has produced a long succession of scientists. Maybe we should seek extra funds to bring curators in on Saturdays to work with interested youngsters.

MR. NAUMER: You can accomplish fantastic things in a museum framework if you have the right spirit. Salaries may be lower than they should be, but there is a feeling of belonging. The museum must foster an attitude of welcome.

DR. WALKINGTON: The dedicated museum professional will motivate others but you may also use enthusiastic people in the community, as we do in Fullerton, California. We have no difficulty in recruiting volunteer teachers. We've created a science center with the widest imaginable community participation -- now 1,700 members. The schedule of classes (see Appendix B) is extensive.

MR. McKINLEY: Members of our staff are occasionally required to serve on the admissions desk on weekends. We have 50 students in the highest opportunity level program. (They are there every afternoon and involved formally most weekends).

DR. SCHEELE: Our Future Scientists Program is the upper level of a system whose ground floor is attendance and membership in weekend and summer classes. The intermediate level is a museum aide program. Two ecologists and a secretary help to serve the future scientists' needs. In addition to group study, the students pursue individual projects, are exposed to our ranking curators (of whom at least two-thirds work on Saturdays), and experience a high frequency of local field

trips supplemented by others that take them to almost any point in the country. The program can expand indefinitely if we are able to enlist more qualified leaders, whether on our staff or not, and if we can purchase additional equipment of a specialized nature.

[In response to a question from Dr. Netting, it was learned that the Federal Insurance Company has written coverage for volunteer teachers and students.]

DR. WITTLIN: Take advantage of college-level students in working with young people.

MR. NAUMER: The museum has a considerable capacity for pre-school education, and this can be of great importance.

DR. NETTING: Sometimes we are excluded from grant support because we can't cite a large number of students enrolled in a course.

DR. RITTERBUSH: May I offer this statement as a summary? Museums make a distinctive contribution to the education of future scientists by affording them opportunities for direct interaction with and encouragement from professional staff scientists. Learning workshops and field trips to foster creativity can also be an important educational adjunct of the museum. We emphatically reject the typical classroom situation as the model for the museum's educational efforts.

Frank A. Taylor and Katherine J. Goldman (Smithsonian Institution, Washington, D. C.)

Surveys Surveyed

The aim of the Smithsonian's statement to this conference was to ascertain attendance at science museum exhibits (and science exhibits in supplementary facilities such as nature centers, as well as science exhibits in more comprehensive museum complexes) of pre-college visitors: (1) as individuals; (2) in family or peer groups; (3) with school groups organized for visiting the museum but not to attend classes at the museum. We had hoped to relate this information to the size of the museum, the location in relation to metropolitan centers and surrounding areas, and the type of museum facility.

A number of articles and reports have noted that the rate of increase in visitor attendance is growing even faster than the rate of U.S. population increase. Individual museum representatives can testify to the urgency of the need for adequate facilities to handle this increase and to make the museum visit a worthwhile and engaging ("educational") experience.

A survey of the available surveys (and of some of the surveyors) leads us to conclude that very little meaningful information, either quantitative or qualitative, on the nationwide role of museums in pre-college science education can be extracted from existing reports. This impression is confirmed by conversation with individuals in several science museums of various sizes across the U.S. -- directors of museums or of educational offices within the museums -- and with Dr. Duncan Cameron of Janus Museum Consultants, Ltd., in Toronto.

Most surveys have not broken down their data into a pre-college-age category. Such statistics as are available are not readily comparable across surveys. Some museums have found it important to record the numbers of school groups they accommodate per day or per year for tours or classes, but usually without relating these figures to the total visiting population (and without separate figures on the total visiting pre-college population). Even the overall annual attendance figures are not recorded consistently from museum to museum -- some museums include group attendance in the total figure and some do not. Often the extent of inclusion is not indicated by the respondent unless a specific question is asked. The intellectual or socio-economic composition of class, tour, or membership group is often omitted. (See Appendix C for typically available statistics.)

Out of 2,889 museums in the U.S. surveyed in 1966 (Rogers, 1969), 776 (about one-fourth of the total) were science museums and museums

with science exhibits. (This program survey -- the most comprehensive to date -- was conducted by the U.S. Office of Education and the Smithsonian. It has finally been published in the spring of 1970, but by the time the data become widely available they will be out of date, especially if, as reported in one article, a new museum opens every three days. Moreover, if programs and facilities are provided in response to needs found as a result of a survey, the information in the survey is out of date within a year or so by virtue of its own success.)

One-half of the 50 largest cities in the U.S. have within their metropolitan areas one or more science museums at least as large as the Cleveland Museum of Natural Science (annual attendance in 1966, 350,000; annual attendance in 1969, also 350,000). Eleven cities have more than one, some as many as five. At least three cities without science museums are close to building them.

Many museums supplement their role as exhibitors, or visual encyclopaedias, with class instruction of various kinds and purposes. Some museums provide instruction along the same lines as school instruction, with the aim of filling curricular gaps and needs which the overcrowded schools cannot meet or are not meeting. Others aim at introducing children to the excitements of science and mathematics, stimulating interest and motivating them to learn at school about the subject, perhaps also preparing programs for the school to use after the museum visit, not teaching the children any course material at the museum. Some museums are experimenting with curriculum development with the schools, instead of the schools, or perhaps even in spite of the schools. Some are developing programs for use in schools; some for use in museum exhibits. Some are even offering an alternative form of education -- "schools without walls," as Philadelphia's Parkway Program, described by its director later in this report.

On the assumption that there is an observed need -- documented by testimonial even if not yet adequately by statistics -- for museums' participation in, and innovative contributions to, pre-college science education, various museum educators recommend:

(1) more and better exhibits aimed at pre-college visitors --for example, interactive exhibits;

(2) more and better programs for use, either in the museum or in school, in connection with school curricula; including teacher training and teacher and pupil preparation before a visit to the museum, so that the visit will not be simply "An Outing";

(3) subsidiary museums to handle overflow from large metropolitan centers -- e.g., the New York Region large "county museums" discussed by Johnson and Schasberger (1967); special-group museums, such as neighborhood museums; children's museums; suburban museums, either independent or as branch outposts of a large central metropolitan museum complex;

(4) community involvement projects for children not school-affiliated (either the projects or the children, or both);

(5) educational programs for parents corresponding to their children's museum study, to foster an understanding, sharing, encouragement by parents of their children's scientific interest and pursuits; and

(6) programs by large museums for school children not aimed at curriculum enrichment, but rather focused on training the children in the use of a museum -- familiarity with museums in general and how to find their way around a museum and make it an educational experience on their own, independent of a programmed group visit -- much like training in the use of a library.

Can these considerations be incorporated into a survey of museum use by the pre-college museum visitor, to aid in our assessment of the museum's role in his science education before college? Would such a survey actually aid us in this assessment? Is there a good method by which such a survey could be accomplished other than by questionnaire? How can we survey for quality along with quantity?

Questions which might concern us in thinking about educational impact of museums include the following:

Kinds of existing programs, such as exhibits, gallery tours, structured courses, exhibits sent to schools, satellite museums, and other programs. Numbers and levels of students served in each kind of program. Teacher-student ratios. Objectives of each program, such as to teach content or methods in depth, stimulate curiosity, or guide to science careers.

Organization of programs as independent projects or school-related. If school-related, what is the organizational relationship, and what are the contributions made by the school and by the museum? How are museum programs changing established concepts of school classroom teaching?

What are the most innovative research and development programs conducted by museums to determine educational needs of the community, to devise new strategies for museum/school education, to investigate the learning and communication processes, and to test and evaluate programs?

Determine what museum professionals believe to be the original, significant, and innovative contributions that museums can and will make to the organization and content of pre-college science education.

A survey was suggested to determine the quality and the quantity of existing pre-college science education programs and activities of museums in the United States, and to make known the most innovative of museum programs and prospects. The consensus of conferees was that such a survey would serve no useful purpose and that the time, money, personnel and thought would be better spent on attacking the problems of space, financing, communication with visitors, and accommodation of school classes -- problems which are already known and do not need further statistics to substantiate their existence.

References Consulted

Abbey, D. S. and Duncan F. Cameron. The Museum Visitor (referred to as "ROM Survey" 1958.) Toronto: Royal Ontario Museum, 1959, 1960, 1961.

America's Museums: The Belmont Report. Washington D.C.: American Association of Museums, October, 1968.

The Diversity of Life ("The Steere Report"). Report to the National Science Foundation on Resources and Needs of the Major Systematic Biology Collections of the U. S. July, 1969. (Unpublished?)

Janus Museum Consultants, Ltd. [David S. Abbey and Duncan F. Cameron]. Museum Education and School Services at the New York State Museum in the South Mall Cultural Center. Final Report, 1967. (Unpublished?)

Janus Museum Consultants, Ltd. and New York State Education Department. The 1966 Audience of the New York State Museum: An Evaluation of the Museum's Visitors Program. Albany, New York: January, 1968.

Johnson, David A. and Richard F. Schasberger. Museum Attendance in the New York Metropolitan Region: A Survey of Patterns of Attendance at Six Selected Museums. Regional Plan Association, Supplementary Report, May 1967. (Mimeo.)

Milwaukee Public Museum Publications in Museology:

(1) de Borhegyi, Stephan F. and Elba A. Dodson. A Bibliography of Museums and Museum Work, 1900-1960 (pub. 1960), especially section I-J, "Museum Visitors," pp. 16-17. (See also section VI, "Educational Work of Museums," pp. 23-28.)

(2) de Borhegyi, Stephan F., Elba A. Dodson, and Irene Hanson. Bibliography Supplement, 1900-1961, especially section I-J, "Museum Visitors," p. 22. (See also section VI, "Educational Work of Museums," pp. 31-32.)

(3) de Borhegyi, Stephan and Irene Hanson (eds.). The Museum Visitor: Selected Essays and Surveys of Visitor Reaction to Exhibits in the Milwaukee Public Museum, 1968.

Report of the Commissioner's Committee on Museum Resources, 1962 ("The Hochschild Report"). Albany, New York: University of State of New York, State Education Department, New York State Museum Science Service, 1962.

Rogers, Lola Eriksen. Museums and Related Institutions: A Basic Program Survey. Washington, D. C.: U. S. Department of Health, Education and Welfare, Office of Education, 1969.

A Statistical Survey Of Museums in the United States and Canada. Washington, D. C.: American Association of Museums, 1965.

Taylor, James B. et al. Science on Display: A Study of the U. S. Science Exhibit, Seattle World's Fair, 1962. Seattle: University of Washington, Institute for Sociological Research. March, 1963. (Mimeo.)

Weiss, Robert and Serge Boutourline. Fairs, Pavilions, Exhibits, and Their Audiences. 1962. (Unpublished?)

Wells, Carolyn H. "Comparison of Smithsonian Visitor Survey (1968-69) and the Evaluation of the Museum's Visitor Program of the New York State Museum [1966, published 1968]." September, 1969. (Mimeo.) Paper written in connection with Smithsonian Institution Visitor Survey conducted 1968-1969, the data from which is in the process of being analyzed.

John R. Kinard (Anacostia Neighborhood Museum, Washington, D.C.)

Science education in the schools as well as in the community must start with a study of the community itself, with parents and children as the designers and teachers and museum administrators as the interpreters.

The museum's involvement as a teaching mechanism should be that of an innovative pace-setter, experimenter, and expert on local conditions. Education in all disciplines of science must relate to the immediate environment to the degree that the actual teaching of science becomes incidental to the task of enhancing the quality of life in the area. The research capability of the museum to analyze current problems and provide the solutions must be developed on that basis.

After community needs have been isolated, local groups with particular interests -- schools, health centers, conservationists, etc. -- can then help to plan programs and exhibits that will be demonstration models of what can be done to meet those needs. An example of this is the Rat Exhibit presented at the Anacostia Neighborhood Museum. In addition to the scientific data related to the overall problem, such exhibits may be supplemented with historical information.

We will be unable to solve any of these problems -- science education, museum education, or education in general -- until the lethargy and seeming hopelessness with which museum adminstrators view themselves, the schools, and their community are overcome. Thus far they have been content to "do their own thing" regardless of whether it is relevant to life -- past, present, or future. Museums can provide the creative enthusiasm that is needed by involving people on every level in the practical application of science to the urgent problems of the inner city.

Carol A. Saslow (Oregon State University, Corvallis)

The Potential of the Museum for Research on Pre-College Learning

In order to organize my thoughts about research on pre-college learning in the museum, I will begin by describing a paradigm which has proven to be highly effective in studying other kinds of instructional situations. The key seems to be to specify instructional objectives in words in such a way that evaluation is possible and that techniques of evaluation are obvious. Paulson (1968) has spoken of the ABCDs of instructional objectives: Audience, Behavior, Conditions, and Degree. Once you have specified (A) what the relevant properties of the learners are, (B) what learning is to be demonstrated, and (C) under what conditions it is to be demonstrated, it is not difficult to specify (D) what sorts of measures of degree of success are appropriate. Having performed these preliminaries, then, with a commitment to results, you create instructional materials, and design experiments to see how well the learners perform on the measures. In the light of that evaluation, you then revise the learning materials, and try again. The commitment is to demonstrated performance results. The evaluation and revision process may, of course, extend to tighter specifications for objectives and for learners as well as to changes in the learning materials. The evaluation and revision process is not possible, in any meaningful sense, without well-specified, measurable objectives.

Examination of the preliminary statements of other participants at this conference shows that, in many cases, admirable commitment to and enthusiasm for programs has yet to be supplemented with the presentation of proven results. An instructive exercise would be to attempt to write down the ABCDs for each paper. There are a lot of testimonials, but testimonials are not hard results. In the absence of hard results, it is unreasonable to expect either progress in museum instruction, or substantial success in securing scarce federal or foundation funds. An evaluation of current museum instructional programs would turn up some real problems which would have to be addressed, in this context. Most of the programs seem to be "creaming" -- that is, reaching the people who already have advantages. First-time visitors from lower socioeconomic groups, for example, are not likely to be attracted or sustained by conventional schoolroom classes located in a museum, or by sophisticated scientific or hobby classes. The visitor who comes once and passes through needs something more immediate in the way of results of his visit than is now provided. Steve Saslow's survey at Adams high school gives some relevant evidence.

If the focus is on attracting the first-time or occasional visitor to learning about science in the museum, the type of instructional development needed is easily identified. It is the production of short, effective, small learning packages, with limited or single objectives, which involve the chance to view and manipulate objects not readily available in schools or elsewhere. If the purpose is teaching science, then it seems appropriate to attract students by providing effective, attractive experiences, which you can prove do teach science. It does not seem appropriate nor effective for this purpose to attract students by "motivating" them with a slick, flashy, promotional approach. No one has ever shown that this teaches science, or anything else. Nor is it appropriate to have just a bunch of unrelated short sequences. "Getting somewhere" has to be facilitated.

Why is the museum a good place to do research and development on this kind of pre-college science instruction? What are the unique characteristics of its visitors and its resources which indicate this potential? How is it more appropriate than the classroom in the school? First, the museum contains special objects not available in the classroom and presents an opportunity to evaluate the effectiveness of display methods and procedures which seem appropriate to a given objective but would simply not be feasible in a classroom or a laboratory. Second, there is the opportunity to examine the results of many variations in materials, because of the continuing access to new learners pointed out in the contribution by Mr. Gerald Dotson from the Pacific Science Center. Third, the learners are probably more relaxed and cooperative than captive students who have made no active choice. Finally, to test the effectiveness of a one-shot procedure in a school setting involves a great deal of arranging, interruption of on-going activities, administrative clearances, moving of objects and equipment, and work with a fairly homogeneous group of learners of like age. In a museum, on the other hand, much replication, in place, on a large and varied group is possible, so that a more robust instructional package should result, since the audience requires packages appropriate for a wide range of age levels. Instructional research and development in classrooms and laboratories have not solved this problem; their settings have not required its solution; yet, if education is to really work and be attractive with a heterogeneous population, the problem of breadth has to be solved.

Some instructional problems for which the setting described would provide unique research opportunities may be mentioned. The visual and physical emphases of museum materials may provide results applicable to better guidance of attention and learning with the similarly complex but abstract materials and displays used in classroom settings. The effects of

instructional feedback could be appropriately studied in the museum setting because the people come to the materials and equipment, which therefore do not have to be replicated and transported. Techniques requiring learners to demonstrate performance of intermediate criteria before the next display can be presented could be more easily studied in museums. And, of special interest, the museum presents a unique chance to learn how to use techniques of successive elaboration or variation of materials to build concepts. A display on the Pythagorean Theorem, for example, could involve successive, more and more abstract, performances. Now, however, such displays are single-item "gee-whiz" shows, and are as likely as not to be placed next to a rather sexless model cow giving artificial milk.

The prerequisite to using the unique potential of the museum for research in pre-college science education is the collection of real data about who comes; and who elects to do what, under various conditions; and what learning results. There is no point to spending time and money on instructional research unless enthusiasm is coupled with workable strategies for the demonstration of specified, worthwhile results. The skills which are needed include:

(1) to be able to design good, inexpensive experiments permitting rapid and clear evaluation of instructional results;

(2) to be able to specify worthwhile, measurable, objectives, in advance, and to place more value on their achievement then on the teacher's initial personal predilections for particular media or procedures;

(3) to be able to gather easily available data on the population of learners, and on the individuals.

The main barrier to implementation of this effort is the absence of persons with these skills on the staffs of museums. There are a number of ways to solve this. One might try to hire a statistician or an educational researcher or a psychologist. This is not likely to work out, because these specialists are scarce and can earn more money and satisfaction in other places. One might send a staff member out to spend several years getting a degree in a school of education. This is apt to be costly, and to result in the staff member's frustration (because the training would be rather abstract and of low relevance to the settings and problems discussed here) or his going into educational research elsewhere. The preferable alternative is to teach the specific competencies identified, to members

of museum staffs who want to learn them, in an intensive workshop approach. Materials exist, for example, which permit enough teaching in one week of setting-specific, non-mathematical, experimental design procedures. Similar materials exist for the preparation of instructional objectives (for example, materials prepared by and available from Teaching Research Division, Oregon State System of Higher Education, Monmouth, Oregon 97361). Materials could be easily developed for teaching other specific competencies that museum staff members need in order to do competent experimental work. An investment in such training of museum staff would be less costly, and more effective, than the same number of dollars spent on poorly planned "research," or spent on gilt and media. (See references to education research materials in report Bibliography.)

References

Paulson, C. F., Jr. "Behavioral Objectives," in National Research, Evaluation, and Development Training Manual, 1st ed. Monmouth, Oregon: Teaching Research Division of the Oregon State System of Higher Education, 1968.

Crawford, J., and C. Kielsmeier. The Prudent Pea-Picker's Guide to Experimental Design. Albany, Oregon: Albany Printing Co., 1970.

Steven Saslow (John Adams High School, Portland, Oregon)

Survey of Science Museum Use and Attitudes in a Northwest Inner City High School

John Adams is a new, fairly autonomous, experimental public school, emphasizing teacher training and research, planned by seven Harvard Ph.D. candidates, one of whom is the principal. Although it is not a classical deteriorating inner city school, it has most of the problems. The boundaries were drawn so that its 1,376 students are about half in the lower and half in the middle socioeconomic class. About one-fourth are non-white, mostly black. In Portland, this is an appreciable proportion.

In response to the Smithsonian's invitation to present a statement about museums and the teaching of science in the inner city, it seemed best to find out what a representative group (about ten percent) of Adams students had to say. A one-page survey form was prepared, and was administered by the author to two-thirds of the 130 students, and by other teachers, using the same procedure, to the remainder. All of the students were in "General Education" classes, in which ninth, tenth, and eleventh graders, boys and girls, white and black, are mixed up together, in proportions roughly representative of the school.

The procedure included explaining exactly what the questionnaire was for; suggesting that people at the conference should know exactly what students think; that I would like to represent their views in my statement, and that I hoped to be at the conference in person, and possibly bring a student if funds allowed. The questions could be answered in any way, or left blank; students were asked not to consult with each other.

The hypotheses around which the questions were designed were these:

(1) Students don't know much about, and aren't very concerned about, museums as they exist in Portland.

(2) Under certain altered conditions, students could be quite interested.

(3) Students have much larger, more consuming concerns than museums. The concerns are those of adults who are involuntarily restricted and who have no adult privileges. A museum program which merely supplemented school would be a poor learning investment; one which provided a quite different, voluntary atmosphere might be a better investment. Maybe the best direct federal investment, however, would be in changing some of the

aspects of the larger society, especially the schools themselves.

This last hypothesis could not, of course, be really tested directly by a simple survey. All that a survey might do would be to provide information consistent or inconsistent with it. The first two hypotheses (present degree of knowledge and concern; possible altered degree of concern) could be tested. Some of the data are summarized here, in terms of the principal questions conveyed by the preliminary conference materials from the Smithsonian.

Three-fourths (100) of the students surveyed had been, at last once, to either the art museum (18), the science museum (25), or both (57). However, of the 130 students, only about one-fifth evidenced a more than superficial acquaintance with either of these two museums, or knowledge of other museums.

Although about the same proportion of students had been to the Art Museum (58 percent) and the Oregon Museum of Science and Industry (63 percent), only one-third of those who had been to the Art Museum had been three or more times, but three-fourths of those who had been to OMSI had been three or more times. This difference is in spite of the relatively central location of the Art Museum compared to OMSI's location a fair distance west of town on a freeway. Aside from program features and subject-matter preferences, OMSI has two things going for it: It is next to the zoo, and it has a heavy program of museum tours or field trips for pre-college school classes. However, less than five percent of the students evidenced awareness of OMSI's program of museum-sponsored classes in special science topics, or of the extensive high school science fair activities. These students are not being reached by those programs. Transportation is much more of a barrier to participation in those programs than it is to family visits, zoo drop-ins, or tours involving captive school classes. When students were asked where they would put a museum, they emphasized easy access, especially neighborhood or school. When the students made spontaneous comments, it was about OMSI, not about the Art Museum: things moved; things were arranged in an intelligible, explanatory form; there was action.

Forty-four percent of the students mention going by bus; 58 percent by car. An insignificant number claim to have walked. There are many comments about transportation being a barrier. Of the 100 students who had been at least once, only ten percent had been there at least once by themselves. Most visits are in general tours held for school classes. Some are with family. Few are with peers, and few are for museum classes.

About 55 percent of the 130 students were interested in making a museum; 59 percent were interested in collecting things;

75 percent would take field trips to collect (anything to get away from school?). The kinds of things they say should be put in museums are current or recent, immediately relevant, comprehensible things, especially relics, man-made objects, arts and crafts. They would like exhibits or demonstrations showing how displayed objects (wax figures, for example) are made. They don't have a well-formulated idea of what should be in a museum; museums, to them, seem to be hodge-podge collections of old things. However, when asked where they'd go to collect, and what they'd collect, they talk about natural history types of things, with man-made relics second -- perhaps because these answers reflect not a clear or consistent feeling of where things are really collected, but a simple preference to get away from school, especially outdoors (a large vote for Eastern Oregon).

In conclusion, the hypotheses are supported. These inner-city students aren't terribly concerned or involved; the museum isn't really accessible; it doesn't provide them with a real, participatory, voluntary learning experience which leads to a self-sustaining interest. These conditions need not prevail; but until administrative decisions are made, with the participation of students, defining an appropriate environment with specific instructional objectives for individual students, the situation will not change.

Jonathan Karas (Science House, Manchester, Massachusetts)

Education by Involvement

I have tried to understand the reason so many museums are "dullsville" and I suppose the main reason is lack of competition. Only the larger cities can afford more than one museum, and even then the museum collections don't usually overlap.

The attitude seems to be, "We've got the only 15th century marble Tibetan lama in the world and we'll let you see it when we're open." My concern is that people may not know you have such a treasure. And even if they did, why should they bother to see it?

A realistic national rating system is needed and a reasonable start might be based on cost per visitor. How much does it cost the community in investment, dues, and tax benefits to support a structure for a few scholars? The scholars should be funded, but how about the education of the majority?

All members of a community contribute to a museum's financing by the simple expedient of allowing a tax-free status. Should such an institution then not be expected to provide a modicum of information for the non-scholar?

As a repository of priceless articles today's traditional museum does its job well. As an educational institution it has a long way to go.

Such a comment will (and should) disturb the typical museum curator. If education is the purpose of these institutions, why is it that:

> Most museums are open from 9-4, precisely the hours that most people work or that students are in school?
>
> Exhibits of even indestructible mementos like locomotives and slabs of granite are kept under lock and key?
>
> Audiovisual techniques, powerful in communicating ideas, are rarely used? A few slide projectors are beginning to show up, but even then the quality and age of the slides is lamentable.
>
> Sound is taboo?

The museum definition of "education" is evidently based on providing artifacts arranged in some reasonable order for serious study. Clearly this may not be a responsible position to maintain when you really study the nature of your museum visitor.

If we further limit our consideration to the education of children, then we need to develop some techniques to entice them to learn. The most powerful technique I know is involvement.

The traditional museum involves people primarily by sight. The visitor is allowed to look at objects, paintings, prints, and devices. Unfortunately, little effort is made to make him want to see.

Although sight is perhaps the most powerful sense there is, there are four other senses which are usually ignored. In fact, as mentioned earlier, sound and touch are often taboo and few visitors have ever tasted or smelled an exhibit. Some efforts have been made to exploit the senses. We've used strange sounds as visitor bait and in actuality the sounds they heard were the message. We've developed devices which required the sense of touch. Without touch the exhibit simply didn't exist. You can be transported to an open field or a steel mill through your nostrils. And the sense of taste can be marshalled by giving away lollipops that tell a taste story.

But the expanding use of the senses will not guarantee involvement. Involvement requires that the person himself provide the connecting link to an exhibit.

Traditionally, this has been done by requiring him to push a button. At the time this concept was introduced it probably was a radical departure. What is disturbing is that even this miniscule perturbation is still considered too radical an approach by many curators. The trouble with many push-button displays is that they're so inert that no one is tempted to push the button -- or even realizes that there is a button to be pushed! The "Out of Order" sign is a vivid indication that youngsters want to get involved. So much so that they continually outwit the designers by thwarting the push-button and stalling the entire machine!

One of the most impressive visual involvement devices available is a planetarium projector. Here is an opportunity to control the heavens, move back into the past, and step into the future. But have you ever pondered over the schedule of planetarium shows?

Christmas finds us explaining the "Star of Bethlehem." Year after year after year. Spring brings the "Reasons for the Seasons." Year after year after year. In the fall it's the "Giant Planets of the Solar System." Year after year after year. You would expect that those who control these million-dollar projectors would exercise a bit more imagination. But why should they? Their jobs are secure and they have no critics to prod them.

And if lack of funds is the plea, then we should ask who was foolish enough to build a planetarium with insufficient funds to

make it effective. I'd like to see a show producer get a chance to build a planetarium program -- just once. I'm afraid it would be terribly embarrassing to most planetarium staffs.

What museums need is a change in attitude and a measure of risk imposed on their managements. The Federal Communications Commission keeps radio and television stations on their toes by requiring proof of efficient use of the public airways. Stations continually have their licenses challenged by groups who feel they can do better with the allocation . . . and often get the chance to prove it. Corporations lop off corporate heads when profit and loss statements are shaky. It would be interesting to ask what measure of success is imposed on a museum staff by the august boards of directors.

What, in truth, is the proof of the pudding?

References Suggested

Karas, Jonathan. "A Physicist Looks at Exhibits." Manchester, Mass.: Science House, 1967. Paper presented to Exhibit Designers & Producers Association Seminar.

_____. "Science and Engineering -- Drab or Dramatic?" Manchester, Mass.: Science House, 1967. Paper presented to American Society of Enginerring Education, Worcester Polytechnic Institute.

_____. "Science and Technology -- Who Needs It?" Manchester, Mass.: Science House, 1968. Paper presented to Rochester Advertisers, Rochester, New York.

_____. "The Fight for Men's Minds under Ridiculous Conditions." Manchester, Mass.: Science House, 1969. Paper presented to Association of Industrial Advertisers, Boston.

Michael G. Saslow (Teaching Research Division, Oregon State System of Higher Education)

Must the Museum Mutilate Its Mission by Means of a Media Mish-Mash?

I write this commentary on the basis of what I have learned on my job in an organization which specializes in instructional research, evaluation, and development, with an emphasis on educational technology and media. What I have learned is that, if one wants friends and funds, one had better have a mission; and that, if one wants to succeed in that mission, that is, if one wants to accomplish some results that would justify more friends and more funds, one had better let the mission determine the media. That is, media may be useful as means to an end. It would be unwise to behave as though media were ends in themselves. This is the mistake which we must manage to mute, lest it mutilate the museum as it has mutilated other institutionalized centers of educational endeavor. The sentence that you just read did have a mission. Did the media device, the extensive use of words beginning with M, clarify or obscure the point?

What I was trying to convey behind that marvelous media screen was this. With the help of audiovisual salesmen, some of whom are my good friends, many of the elementary and secondary schools bought projectors, recorders, and other machines, and then and only then realized that it might take some mental time and effort to do anything with the machines . . . but all the money in the budget had been spent on the malevolent machinery. So the schools waited for more money. With the money, they hired technicians who could make movies and manipulate microphones. And what happened? The students liked the flashy stuff, sure. But most of the time -- and more and more, after the novelty wore off -- they were titillated by the media and didn't learn any more content material than they used to learn -- maybe less.

After years of this ineffective flailing about, a few professional individuals caught on to the thing that I want to teach in this commentary: If you want to teach effectively, you have to specify precisely and measurably what it is you want the learner actually to do when you are through with him and he is through with you. And then -- and only then -- when you know your objectives and your evaluation procedure, is it time to open the media box and find, by hunch and by trial and error, that combination of media and materials which leads most effectively, and reasonably efficiently, to the performance of the instructional objectives of all of the learners.

Let me close by providing two contrasting examples of simple media use, illustrative of the potential use of complex things such

as interactive displays, teaching machines, and sensory enhancement.

(1) Your museum hires a media specialist. He marches out into your museum with his malignant microphone and announces the complete contents and minutest minutiae of every label on every case. Then, he tears off all the labels; puts the tape recordings on cartridges into little boxes; and stands at the door and sells each visitor a metal key, for 25 cents, so that each visitor can turn himself on by using his key to turn on each box, in turn, and hear its mawkish squawk.

(2) Your museum, together with local science teachers, develops some instructional objectives -- some specific competencies which, it is agreed, students can, could, and should learn in the museum. Then, with the help of consultants who understand the use of -- not the circuits and connections of -- instructional systems, materials are prepared, media approaches are tried out, programmed and other formats are investigated, and the system is developed, and revised, and revised some more, until the students learn to do what we said we were going to get them to learn to do when we sent them to the museum.

Which approach will accomplish your museum's educational mission? Magnificent manipulations of media? Or just plain results, obtained through wise use of media as tools by which to achieve demonstrable objectives?

Discussion Insert

Using Media

DR. M. SASLOW: Before we can succeed in our discussion of how to evaluate media we must refine our understanding of the fundamentals of the learning process. We might try to compile in the aggregate what children's own learning agendas actually are. Successful learning experiences lead children toward greater specificity in stating their agendas. Such improvements in specificity may be a gauge by which to measure success.

MR. DIXON noted the need to maintain a steady rate of advance in the acquisition of basic skills, to which Dr. Saslow replied that even here schools should try to meet defined objectives and in the most flexible and imaginative manner. Mr. Dixon described a Bell & Howell/Encyclopedia Britannica project called Project Discovery whereby they made available large media libraries in selected schools and found genuine improvement, especially where children had not received frequent exposure to varied or natural environments. The Scott-Montgomery Elementary School in Washington, D.C., showed marked improvement in reading and mathematical skills relative to other schools, despite acute disadvantages in its physical and social setting.

MR. GLOBUS maintained that schools lack a standard display format capable of carrying media offerings from many different museums. Without such a format in the schools each individual museum will be at a crippling disadvantage. He used the analogy of a television set which can receive different channels. Individual museums are at a disadvantage in trying to create exhibits for schools because a setting must be created for a given exhibit within a given school, but that setting cannot then be used again.

MISS BENNETT related the story of a nine-year-old pupil who had a bad day at school because he "put his hand over the lens of the movie projector." Why? "Because she [the teacher] was showing a movie that she'd never seen before, she hadn't read any of the instructions, and she couldn't tell us anything about it. So I just thought it was useless."

[At EPOCH] we try to take an enrichment approach, regarding ours as an instruction center, not a "multi-media" gimmick. We take the curriculum as our point of departure but go far beyond it. We also have a five-screen travelling unit which has been to 50 schools. We take pride in being replicable.

MR. KARAS: I think that teachers and educators are afraid of media. As an example let me cite the fact that the Smithsonian has made such poor provision for showing slides and films right here in what is meant to be a conference center. The media apparently threaten to displace the teacher.

Gertrude L. Ward (Joseph Moore Museum, Earlham College)

Will the day come when all science and nature field trips have to be "conducted?" Will the "wild" areas be so reduced that they will be surrounded by fences and the gates be padlocked? Perhaps the only way to insure that this won't happen is to make young people aware of their heritage of plants, animals, soils, rocks and water, and of history. These concerns should not be merely a veneer, but a basic, functioning part of each individual.

Museums and nature centers have a freedom to teach with new and unique methods which are often denied to school systems. Often a museum's methods include a self-teaching, progress-at-one's-own-speed system which is eminently adaptable to a varied audience. It seems to me that it is especially important to stretch the imagination of the young, who are in the ideal physiological state for learning. Their elders, however, should not be ignored, because it is important that parents at least have an interest in their children's projects, and better yet, can encourage their projects. And often a visit to a museum is the stimulus for a project. I hope that we could educate the mother, for example, who sees a growing collection as just a pile of dirty rocks. The junior science clubs which we have had at Earlham College often introduced parents to our museum, because that is where we asked them to pick up their children. Mothers would exchange comments about their problems, and discover that other mothers were dusting around leaf collections or stumbling over fossils, and that their offspring were not peculiar after all.

I believe that people learn best when they explore individually but getting them started as a group is probably the most efficient method. Our junior science clubs were not just listening groups, but included such activities as physics and chemistry experiments, use of microscopes, rock hunting trips, and dissection sessions. We intend these group sessions to be introductions to subjects, and hope they serve as springboards to additional study. They are taught by college students who are qualified in their subjects and who volunteer for the experience. Ancillary gains have been the students who found that they enjoy teaching but had not previously considered it as a career because they had never experienced it from a teacher's point of view.

It seems to me that too often we answer all possible questions in our museum exhibits. Why not leave some questions unanswered, or point out the things that remain to be discovered or explained? As the geographical frontiers close, and the space frontiers require elaborate equipment for their exploration, we are forced to rely on intellectual frontiers to overcome a common disease of civilization, and that is boredom.

There are tremendous things to be done in the world, and yet millions of people are sitting in living rooms, family rooms, play rooms, redecorated basements, and converted garages enthralled by the excitement of someone else's imaginary problems, because they are bored with their own lives.

However, I certainly don't want everyone out in the woodlands, crushing the hepatica and picking the bloodroot. But I do want people to be aware of what is around them, to treasure it, and to try to prevent its disappearance.

It may seem incongruous at first glance, but I think that history has an important place in a study of science and of natural resources. We don't need to build a cult around our ancestors, but I believe that we do need an appreciation of the people who have made history. This sort of respect can be built in several ways. One is to show the conditions that prevailed in earlier times. Another is to have people take part in the activities at an historical center. I believe that some of the current interest in pottery and weaving is due to the rewarding sensation from creating an attractive and/or useful article. Museums need not be static exhibits, but should be able to offer activities, and not just of the spectator type.

I believe that we have a huge potential for the use of museums. We have leisure time, we have a wealth of natural and historical resources, we have more people traveling farther on their vacations, and we can have people clamoring to see, touch, and take part in our museums. Learning more about our environment and our history, actually participating in museums and nature centers, could be an impetus to take better care of our heritage.

Lola Eriksen Rogers (Arlington, Virginia)

Museum Resources (Science) for the Classroom

Among the values underlying science, according to the National Education Association's Educational Policies Commission (1966, p. 15), are the search for data and their meaning, and the demand for verification. In both of these areas museums are in a unique position to make special contributions to science education. For too many youngsters, first-hand experience is negated in the classroom. Although many of the national curriculum developments of the last decade have helped to turn this tide, a great many school children are dependent upon local materials that can be obtained by a creative teacher to make their work in science -- and in other areas -- truly meaningful. Here is an unparalleled mission for museums!

Museums need to be aware of some basic grade-level differences in instruction if they are to make their most effective contributions. The general pattern for elementary schools is a self-contained classroom in which the harried instructor must teach all subjects, including science, even though his formal preparation may never have included a college-level course in the field. Thus, if good materials are readily available to him, he probably will use them, but he is not in a position to evaluate their scientific significance, nor does he usually have time to seek them out. This implies that the museum performs a key role in having its curators select material appropriate for the curriculum (preferably in cooperation with teachers), along with developing related interpretive material for both children and teachers. It also suggests that effective means are needed for publicizing such resources and distributing them.

Although the secondary-school science instructor supposedly is well trained in his field, and hence is better able to evaluate the scientific relevance of available resources, he is working with more critical young people who should have the opportunity to use scientific materials which are beyond the limited resources of most secondary schools. Museums are in a prime position to help fill this void. Their collections often can supply objects not otherwise obtainable. They generally have available technical assistance and facilities for preparing displays, and they also have well-trained subject-matter specialists who in themselves are resources.

The key to extending the museum effectively into the classroom is to be well acquainted with curriculum and to recognize areas where museum resources parallel it. The museum often needs to take the initiative in establishing regular channels of communication that include not only administrators but innovative teachers as

well. Cooperative planning can result in a complementing of functions. Furthermore, the museum may be in a key position to make curricular modifications by offering the services of its curators as subject consultants to local curriculum committees.

Taking the museum to the classroom is nothing new; some museums have been doing this for several decades. According to Museums and Related Institutions: A Basic Program Survey (Rogers, 1969, pp. 90, 91), 20 percent of all museums and 35 percent of those in science are making presentations at schools. An organized school loan service was reported by 16 percent of the science museums. Ten percent of them reported the production of television programs -- the greatest percentage by any subject or combination of subjects. Thus it appears that science museums are indeed taking their institutions to the schools.

Museum loans to schools range from a few individual items to sizable collections of prepared exhibits. In at least one community the museum operates the audiovisual loan service for the school district, including science equipment purchased with NDEA funds and other items owned by the schools, in addition to special displays assembled by the museum itself.

Several different types of loan items are available from museums. In addition to the films, slides, records, and pictures, there are the all-important displays, which can be variously categorized. One is the static type in a mobile case -- a single item, a collection of related objects, or even a diorama, with appropriate legend(s). Another category consists of related items from the museum's collections which children may handle and examine under supervision. A third, developed at the Boston Children's Museum, contains materials, equipment, supplies, and instructions for activities where the teacher and children work together for a few weeks on a particular subject. A fourth type, exemplified in the Lawrence Hall of Science, is designed to stimulate interest in and facilitate learning of some of the basic fundamentals of physical science by viewer participation (problem solving).

The development of supplementary curriculum materials for children and for teachers is featured in some museum programs. In the case of institutions that develop field trip and other study guides for use in the classroom, as well as at the museum, the direction of such materials may almost channel the nature of what is taught, particularly for the weaker teacher who relies more heavily upon such assistance. Programmed instruction booklets designed by the museum for self-learning also may have great potential for the classroom.

Thus, not only the nature of the museum offerings -- a particularly good mammal hall, for example -- may have an impact upon the curriculum, but also the availability of loan materials themselves.

If loan displays and films in certain areas of study are available readily to local teachers, the teachers will tend to emphasize those topics for which the supplementary teaching aids are at hand. Furthermore, the concepts developed by the nature of such displays will affect also the nature of the learning situation. In one western U.S. community, the availability of museum materials relating to the natural history of the region facilitated a synthesis of science and social studies when the teachers recognized that the local ecology had a direct bearing upon the area's historical development.

References

The Educational Policies Commission of the National Education Association and the American Association of School Administrators. Education and the Spirit of Science. Washington, D. C.: The National Education Association, 1966.

Rogers, Lola Eriksen. Museums and Related Institutions: A Basic Program Survey. Washington, D. C.: U.S. Department of Health, Education, and Welfare, Office of Education, 1969.

II.

PARTICULAR EDUCATIONAL PROGRAMS IN OPERATION AND COOPERATION

John Bremer (Parkway School Program, Philadelphia, Pennsylvania)

Some Thoughts on Education and the Parkway Program

America has never had an educational system worthy of itself. After pioneering a continent, developing new forms of social and political organization, absorbing countless immigrants and bringing technology into a close relationship with human life, it is nevertheless true that Americans have adopted principles and practices of education belonging to another age and imported from another society. The Parkway Program tries to provide a mode of education in keeping with the major traditions of American life.

From an examination of our high schools, who would ever suppose that bold and adventurous exploration was a major part of the American heritage? Who would realize that American society has given new meaning to self-reliance and individualism; that communities, founded for survival, have made internal cooperation a way of life and yet have been able to incorporate the rich and varied customs brought by those seeking new homes? Who would ever conclude that American society has been compelled to test its knowledge against the realities of the world? Why is the American high school so out of touch with American life? Why is the American high school so out of touch with life? It is because the boundaries of education are no longer correctly drawn.

Our schools imagine that students learn best in a special building separated from the larger community. This has created a refuge in which students and teachers do not need to explore but only accept. Within this separated refuge, students are expected to learn in so-called homogeneous groups known as classes, and within these classes students are isolated, separated from each other by the seating arrangement and by the competition for approval. It is seldom that they are allowed to cooperate in a systematic, friendly manner. Finally, within these "boxes," the school houses and the classrooms, life is self-reflecting, with no relation to anything outside of itself, and so it becomes a fantasy, it becomes unreal. The students' learning is evaluated within the "boxes," and it is never tested against the realities of life. It is a common feeling (particularly on the part of the students) that what is learned in school is learned only for the purposes of the school. This is the well-known irrelevance of education.

Everyone has a stake in education, everyone has a right and a duty to be involved, to participate. The complexity of social life today is immeasurably greater than that of social life in 1900 or even in 1940. Education must respond to this complexity, this

heterogeneity; must accept it and put it to educational use. It used to be that the ideal teaching situation was thought to be a teacher (who knew what was to be learned by the student) telling a homogeneous group (as similar as possible in age, background and presumed ability) what they ought to know, with emphasis on that aspect of knowing which we call remembering. All that has changed. The standards by which these homogeneous groups were formed are no longer useful or relevant; the teacher does not know, cannot know in many cases, what the students should be learning; and you cannot memorize the future.

Our students have to learn to be responsible for their own education, to make choices and to face the consequences of those choices. It is difficult, and many people at the beginning thought that it would not work, but it is working and the demand is so great that we shall expand rapidly. It is our intention to set up a series of units of about 130 students, ten faculty members, and ten university interns, in various parts of the city, because this unit enables the students to have a human relationship with each other and with the faculty. The educational community should really be small enough so that everyone can know everyone else. Our present unit of 143 students is a little too large. It is also true that above that number the group can no longer control itself. Although our community unit should not exceed 150, there is no reason why we could not set up 100 such units in Philadelphia. In the first place, we do not require large capital expenditure and school buildings, and in the second place, our operating costs are approximately the same as those in an ordinary school. What could be more practical?

The Philadelphia Board of Education, in cooperation with the cultural, scientific and business institutions along and around the Benjamin Franklin Parkway, has initiated a four-year educational program for students of high school age. The Parkway Program, as it is called, has starting points which differ from those of conventional high school education in at least two basic respects. In the first place, the Parkway Program does not have a school-house, a building of its own -- it is a school without walls; in the second place, the institutions and organizations along and near the Parkway constitute a learning laboratory of unlimited resource.

The adoption of these two starting points opens the way for a complete reformulation of what education means for the present day urban student. There is little doubt that such a reformulation has far-reaching consequences for both the theory and the practice of education since it indicates reformation in every aspect of the student's activity.

Responsibility for educational planning carries with it the incentive to think more deeply about educational purposes. By sharing responsibility among students, parents and teachers, a continuing dialogue on education has developed which must have a beneficial effect on the people involved. Through this dialogue, students, particularly, have come to reflect on, to understand, and to control more effectively their own lives.

The facilities of the institutions along and near the Parkway are available, to a greater or lesser extent, to the students in the Program. They choose their activities from offerings made by such scientific centers as the Franklin Institute, by such humanistic centers as the Museum of Art, by such business centers as the Insurance Company of North America, by such manufacturing centers as Smith, Kline and French, and by such communications centers as KYW and the Philadelphia Bulletin and Inquirer. By choice and with encouragement and support, the student goes beyond the restrictions of his present life, and by furthering his experience he will further his capacity to have an experience.

By adopting new spatial and temporal boundaries, determined by the view of education as a mode of life and by the learning needs of a particular student, school has ceased to be a building and has become a process, an activity, in which the student participates, or more properly, which is nothing other than the life of the community of learning. The fundamental teaching problem is how to help the student enter the process.

Since learning is a human activity -- and, in a sense, the characteristic human activity -- it is intimately bound up with the human group. The problem of how to enter into the learning process, or to be a learner, can be restated in terms of group membership -- how to be a member of a learning community. It is for this reason that the social structure within the Parkway Program is of utmost importance. What are the characteristics of a community which has as its purpose the learning of its members? To frame the question in this way -- and it is the appropriate way -- indicates that the community is concerned with the learning of all, and not merely some of its members. This acknowledges frankly the need of everyone for more learning -- it is not something appropriate only for people cast in the role of "student" -- and it makes easier the possibility of cooperation, of partnership, of a true sharing in a common enterprise. This view is in strong contrast to the conventional view of education in which there are teachers and learners -- that is, superiors and inferiors -- and in which knowledge is treated as alien and self-subsisting to be imposed on the student from without by the exercise of authority. In the Parkway Program, energies are not tied up in maintaining the conventional social system of the school, which is under considerable tension from the conflict arising from declared inequality, and which has little or no

relation to learning; students' energies are enlisted on behalf of their own education, individually and in formal and informal groups.

The appropriate model for the Parkway Program is the kind of working together seen in space exploration teams, or in medical teams engaged in transplant surgery. With differentiation of function, there is an intricate pattern of interdependences in such teams dictated by the complexity of the means necessary to achieve the end and by the variations in functional responsibility, generated as the situation changes. The activity of the Parkway Program is not essentially different. The hierarchical ordering of the roles in such teams is determined and re-determined as one stage of operation succeeds another, as crises and emergencies come and go. This has its counterpart in the Parkway Program but, in addition, the people change their roles as the learning needs require it. Members of the learning community are acquiring adaptability and flexibility as they respond to the potentialities of the Program, learning how to play new roles and, by so doing, achieving new satisfactions.

It has already been stated that by using the institutions along the Parkway, students extend their life space and increase their capacity for experience. This is a very real function but it is one which any area -- urban or rural -- could perform. The unique and specific importance of the Parkway institutions lies in the unparalleled wealth of material and human resources which they bring to a very small area of the city. Within a few short blocks there can be found some of the best museums and collections in the world, and the research work that is conducted along the Parkway is of civic, national and even international importance. To have easy and continuous access to the fine collections of paintings, sculpture, scientific instruments and books available along the Parkway would enhance any educational program. Beyond this, however, business, industrial and communications organizations -- again of national and international reputation -- have expressed interest in providing opportunities for students to study intensively with them, and to pursue work-study programs.

There are two further advantages for Parkway Program students. First, in addition to the material resources of these institutions, there is the possibility of intense and varied contact with the highly skilled professional personnel who are responsible for their continuing life; to have such people as, in a sense, faculty members, is to provide specialist teachers of the highest possible caliber. Second, as an optional and additional activity, there is the possibility of participating in the work of these institutions, and, particularly, in their research work; this is an opportunity for sharing in exciting, creative and original work denied even to most college students.

Dorothy A. Bennett (EPOCH: Educational Programming for Cultural Heritage, Berkeley, California)

No longer content to be merely repositories of treasures and artifacts, museums have been broadening this primary function beyond research and exposition into the development of more effective environments for many aspects of learning and teaching. New approaches are evolving in museums, and innovative strategies developed elsewhere can enrich the museum's climate.

EPOCH (Educational Programming of Cultural Heritage) in Berkeley is a supplementary center developed under a United States Office of Education Title III PL 89-10 grant to the Berkeley Unified School District in California. Among the cooperating institutions are the University of California, Hayward State College, the Latin American Library, the American Society for Eastern Arts, and La Causa. EPOCH offers a total environment for learning with a new kind of instructional approach that challenges the whole person -- eye, ear, hand, mind and heart.

An organized diversity of learning structures includes: a demonstration room for group instruction, a resource room with open shelving of resources and equipment for self-instruction, and a "hands-on" museum for discovery and exploration.

In the specially constructed demonstration room, curriculum-related programs make discriminating use of slide, films, records, books and graphics, tapes and artifacts, in a multisensory experience that increases motivation and receptivity to the factual content.

Easily adaptable to museum needs for all kinds of instructional purposes, the demonstration room (32 feet in diameter) employs 20 projectors for rear and front projection. It is possible to simulate the interior of a rocket capsule or an Egyptian tomb through 1,100 square feet of encircling, life-size images. It is equally possible to view in succession and retain all of 12 steps in the development of any process (through rear projection of images of 20 square feet). Thus the concept is clearly built and formed in toto. These rear projectors can also be used for comparison and survey. Of course, motion pictures can be combined, as well as film strips, overhead projection, etc., with varied uses of sound.

A special feature of the demonstration room is the World History Time Table (11 feet in diameter), with the world's countries named around the edge. The continents are represented by pie-shaped segments crossed by concentric circles measuring off time from the remote past (at the center) to the present (at the outer edge). Artifacts on the table represent certain high points in human achievement and significant crossroads of time and

place in history.

The "hands-on" museum offers all kinds of displays to attract the eye, tempt the touch, stretch the mind and expand appreciation. Frequent changes relate to the changing subjects of the multi-media programs. Students are encouraged to handle and examine the displays, to try on the garments and jewelry of different cultures, to play the musical instruments, to grind corn or acorns, etc. Museum legends are in English, Spanish, and Chinese to relate to the ethnic programs, attended by more than 5,000 students in the last year.

The resource room has 36 learning stations equipped with automatic or easy-to-operate viewers and projectors, tape decks, and record players. These are "loaded" to relate to the subject of current demonstrations, but students may select other materials from carefully arranged areas of related resources. Open shelving permits easy finding and free choice of materials which are grouped first by continent, then country, then subject.

Pilot programs have been primarily concerned with creating new techniques for enriched teaching of any subject at any academic level, but the focus was on elementary teaching in this pilot period. Subjects have included ethnic studies (American Indian heritage, Chinese-American, Japanese-American, Mexican-American and Afro-American heritages), Shakespeare, art history, and opera. Programs in work include ecology, health, and language studies. Emphasis has been on interdisciplinary relationships, and the humanities have been used as vehicles for instruction in social studies. A cross-cultural view is applied to the planning of programs, and the fellowship as well as the continuity of history is stressed.

Science has had less emphasis in this early period, but was included in its social aspects (i.e., astronomical observation, calendar, selective plant breeding, pollen and carbon dating in the Mexican-American heritage program). Of course, the whole method applies excellently to the fields of science, especially natural history.

An extension of the approach to the classroom has been explored with the use of a portable multi-media unit. A three-leaf and a five-leaf screen using three and five projectors with accompanying tapes or records, artifacts, and models, have been used in many demonstrations with considerable success. Five schools in Berkeley will have their own units early in 1970.

The several other school districts associated with EPOCH have adopted our approach, and EPOCH-type installations now are in use (in Fremont, California) or being developed (San Francisco, California). More than a dozen districts are working on

plans for some adaptation of the EPOCH idea.

Teacher training has been carried on with Berkeley School District teachers, and EPOCH presentations have been a part of the in-service programs of numerous other districts. More than 100 teachers have attended courses in the EPOCH method given at EPOCH for the University of California and Hayward State College.

Development of parent-child use of community resources is encouraged by the EPOCH Passport-to-Discovery, now being adopted by Follow Through projects throughout the United States.

As a learning situation in which group and individual instruction is aided by carefully evaluated resources and the use of modern technology, EPOCH offers an exceptional potential for study of the learning process.

Courtland S. Randall and John R. Butler (Oak Ridge Associated Universities, Oak Ridge, Tennessee)

A Description of Two Kinds of Exhibit-Demonstration-Laboratories for Presenting Scientific Principles

Experimentation is taking place in nearly all academic areas -- searching for better methods, materials, techniques, and curricula to improve the educational product. Most museums have only recently begun to play a role in this process. We may have been delayed by the tenacity of the store-house stereotype -- big dark places where you have to be quiet and can't touch anything.

One museum that is not a storehouse, is not big, does allow noise, and insists that its visitors become involved, is the American Museum of Atomic Energy in Oak Ridge, Tennessee. We mean more than pushing a button and then watching what happens. We mean jumping in with both feet -- twisting knobs, working tape recorders, building geiger counters, and measuring radioactivity.

This museum is unusual for a number of reasons. Our story is restricted to one rather limited facet of science. However, let us hasten to add, the concepts and applications of nuclear energy allow us to probe many different scientific disciplines. We are new as museums go -- a mere 25 years old. Our origin and support are also unusual. We are home base for the AEC's nationwide (and world-wide) exhibit program. This allows us to draw upon the talents and enthusiasm of a sizeable group of highly trained young men whom we call Teacher-Demonstrators. It is their enthusiasm that motivates the museum to experiment with new and different modes of reaching young people.

We have equipped two new laboratories on the museum floor with audiovisual devices. Student (and adult) visitors learn about atomic energy by assembling a geiger counter, an electroscope, measuring radiation, testing shielding materials, and performing radiography experiments. They may get all their instructions from listening to tapes or watching films.

In addition, the general public is testing an audiovisual library system. The museum visitor can see and hear details of the nuclear topic of his choice on film and tape, operating audiovisual equipment himself in an individual booth.

We expect to learn as much about automated learning as applied to exhibits and science, as the visitors learn about nuclear energy. The youngsters work and learn at their own pace behind laboratory doors of one-way glass. The students at work and their equipment comprise an important exhibit.

The larger of the two labs is a twenty-station setup, each station identically equipped. Projects are designed primarily for sixth, seventh, and eighth graders. A set of instructions on film is screened in the laboratory. If a student runs into a snag during his experiment, he operates a convenient individual slide film projector or tape recorder which gives him another version of the instructions or more details. Not far in the background, working behind rather than before the students, is a live teacher.

The program, designed to run about 25 minutes, includes such projects as building a geiger counter using the speaker of a tiny transistor radio, making an electroscope from a coffee can, using a clock face with radium numerals to develop an autoradiograph with packaged polaroid film, and planting a varied set of irradiated bean seeds. Except for the seed project, which he keeps, each student's project is disassembled and redistributed for the next session. The student takes the seed project home and records results on a data sheet which is returned to the museum a month later when the project is completed. By regularly recording the bean growth, the student plots a curve showing the effects of radiation on growth rate. This record extends the benefits of the lab lesson long after the museum visit.

The second lab, designed for junior and senior high school students, has been focused on individualized instruction. Four sound-insulated booths contain tape recorders, a ratemeter, and various small items of equipment including radioactive materials. Each recorder and ratemeter is of a different commercial origin, providing a test of equipment as well as experiments. The general visitor unknowingly performs the same service on various brands and models of equipment used in the audiovisual libraries.

The students, who wear headphones throughout the half-hour session, perform simple experiments showing characteristics of radiation including measurements and shielding, while listening to recorded instructions. If he falls behind or misunderstands, a student stops his tape and repeats it as necessary. Visiting teachers and our own Teacher-Demonstrators collect data on each student's work in a continual evaluation of the projects, the instructions, and the equipment.

School groups on museum tours use the labs, invariably to the delight of their science teachers. Teachers familiar with the equipment and program are invited to conduct the session. Boy Scouts working for an Atomic Energy Merit Badge find the labs ideal. Youngsters touring the museum with their families are also invited to laboratory sessions. Teachers report that most young students are already familiar with such equipment as tape recorders and film projectors. The cost of the audio-

visual autotutorial equipment, all of which is available commercially, is at least comparable to other types of museum exhibits.

Special efforts have been made to keep the system from becoming mechanical and impersonal. One mode is a post-lab session in which students work additional problems by discussing them together, using the information and terms learned in the lab experiments. Another is the requirement that each student, after completing his lab work, write a paragraph about what he has learned. Typically, the report is a well written summary of the highlights and results of the experiments, indicating a successful lesson. But not always. One ninth grader wrote: "I learned how lead, aluminum, and plastic worked differently in producing different results on film. Other than that, the experiment was interesting and fun." Another said only: "I learned radiation runs uphill." Need we stress how important it is not to "correct" such marvelous misconceptions?

The success of the lab's techniques and experiments is shown by the reception they have received in an Oak Ridge elementary school. One of our teachers made a preliminary evaluation of the experiments in a programmed booklet format with a group of fifth graders in a nearby school. Several teachers have also incorporated these experiments into workshops conducted as a supplementary activity of their field assignments on traveling exhibits.

From our experience there is no doubt about a museum being able to contribute to improving the educational product -- if we let the student get involved.

Another effective method of presenting science to a wide audience is to load the exhibits and demonstrations onto wheels and drive them to the audience rather than presenting them to visitors in a stationary museum building. Oak Ridge Associated Universities, a non-profit membership corporation of 41 southern universities, has for nearly 20 years developed and operated a number of traveling exhibit and mobile laboratory programs for the U. S. Atomic Energy Commission. Although rigorous statistical evaluations are lacking, there is much evidence of the effectiveness of these programs in both institutional and public education. Typical are statements by engineering departments of the University of North Carolina and Texas A & M which attribute increased enrollment in engineering courses to the traveling high school program, "This Atomic World." Meaningful increases were noted at a time when the general enrollment trend was down.

The opinion has been expressed by behaviorists and testing specialists that present instruments of evaluation are too crude to reveal the incremental progress in learning due to any single exposure as short as one class period, one film, one lecture demonstration, or the like. These people appear to agree that there are probably meaningful attitude changes associated with a single exposure of the right kind. There is a disagreement on the relationship between an attitude change and a behavioral change, and most of us have come to accept the practical importance of being able to witness some change in behavior as evidence of learning. But as we in museum and exhibits work accept this dictum, we embarrass ourselves, because much of what we do falls in the very short exposure period. Our institutions, our common sense, and our basic survival instincts insist that what we do has value, but we take heart when we find real evidence such as an increase in enrollment from a short-exposure, exhibit-type program specifically designed for career motivation.

Before describing the high school program, and some others, a statement of outlook or style may be useful. We feel that the word exhibit is less significant as a noun than as a transitive verb. It thus requires (a) a human subject, whom we term a teacher-demonstrator; (b) a direct object, which should be stimulating, memorable, dramatic, and if possible, real or phenomenological; and (c) an indirect object, the audience, which should be appropriately constituted and of efficient size. We recognize that this outlook puts us in a different category from the curator of a valuable collection which exists for scholarly purposes but can be judiciously offered for its general educational or entertainment value. Our mode is to use the thing, the exhibit, as the feature or the occasion for a lecture demonstration by a master teacher who encourages direct participation with the exhibit or phenomena by his audience.

Last year the AEC invested $800,000 on a set of these traveling and mobile programs which permitted teacher demonstrators to interact at some length with at least seven million persons. A large portion of these people received their first direct contact with the phenomena of nuclear energy.

One program called "This Atomic World" is comprised of 23 trucks, small "Econoline" vans, loaded with demonstrations and exhibits, which are driven from school to school by specially trained teachers. These vans visit a new school each day, covering some 150 schools each per year, on a schedule developed a year in advance. At each school the teacher conducts five or six activities, including general assembly programs for large numbers of students, laboratory experiments for physics, chemistry, or biology classes, teacher workshops, and career guidance sessions. The exhibits and demonstrations are removed from the van, with help from students, and are set up on the auditorium

stage, in a gym or cafeteria, or in the classroom. This arrangement evolved from an earlier program with larger exhibit vans, through which students circulated. This was proved less efficient in terms of exposure time per student, and lacked the capacity for in-depth participation by an entire class in a laboratory exercise.

A typical exhibit is a four-foot-high Van de Graaff generator which produces an electrostatic field of 300,000 volts. This is enough to make a participant's hair stand on end, literally, and is a favorite item. It relates to learning goals by being a scaled down part of an atomic accelerator or atom smasher. The teacher so relates it, once the laughter dies down after a hair-raising episode.

Purists of a number of points of view fault this exhibit. It is corny, having been done time and time again. It relates less precisely to subject matter than would a complex light-animated model of an accelerator which portrayed target areas, synchronization stages, control rooms, and overall geometry. It would be easier to mouth facts about the complexity and cost of high energy machines using such a model. But we've come to appreciate after several thousand trials that our presentations reach peak effectiveness when three things happen simultaneously: (1) there is direct participation by the learner (which is perhaps not greatly less effective when vicarious), (2) real phenomena (such as a high energy field of force) are made obvious, and (3) there is enthusiastic exposition on the part of an inspired teacher. The Van de Graaff allows all three. An animated exhibit model of an accelerator, which would cost three or four times as much as the Van de Graaff, is of relatively limited usefulness.

Other evidence of effectiveness comes in daily reports from teachers who are nearly unanimous in placing high value on a visiting program which casts a new entertaining light on science and technology. Students often express surprise that a science program can be fun. The values of a new face, a different teaching technique, and a set of devices unavailable in the school jar preconceptions and are often related to us in unsolicited letters from educators and administrators. We even receive letters from students! The program is over-subscribed after several return visits in each state.

A further measure of effectiveness is seen in the fact that a dozen universities and 35 private corporations, mostly public utilities, have joined with the AEC to support the program. It has grown from ten units to 23 units in a three-year period. We have just received a national award for its contribution to public education in nuclear science from the Atomic Industrial Forum.

Other traveling programs at ORAU include large demonstration centers which circulate among major science museums for visits of several months. These also are manned by teachers

who use the exhibits as "platforms" for extensive community and school-service activities. These programs generally create and strengthen museum ties with schools, civic organizations, and television and publications media.

A third traveling program visits state agricultural fairs with its own geodesic building which packs, together with exhibits and a motor-generator power supply, into a large semi-trailer. This exhibit is a popular attraction with fair audiences, again because of its live lecture-demonstration format.

Another AEC-ORAU program is a mobile laboratory with equipment for work with radioisotopes which visits small colleges where these labs are in short supply. Students and teachers work in the van, eight at a time, for periods of hours and days. It thus serves a small number of near-professional persons with an educational program of considerable depth.

Some educational goals are best served by a walk-through or "work-in" van. But our experience indicates that traveling exhibits which unpack and set up easily in local buildings are generally more efficient. Trade-offs include the intrinsic value and uniqueness of the exhibit or equipment, and the level and size of the audience.

John G. Colson, Jr. (Prince William County Schools, Manassas, Virginia)

The Experimental Educational Exhibit

What and How Much
-can pre-college students learn?
-should they learn?
-should they be exposed to learning?
-can their teachers teach them?
-should they teach them?
-should they try to teach?

Answers -
-
-
-
-
-
-

One Search for Answers: Assume
-can learn # more #
-should learn # more #
-should be exposed # more #
-can't teach # more #
-shouldn't teach # more #
-shouldn't try # more #

Put Descriptors on # more # by the Experimental Educational Exhibit
-sample content Science Of Light
-organize Facts, Fancies, Theories
-build Movable Cases, Removable Guts
-install Cases In Classrooms
- In Libraries
- In Storerooms
-rotate Guts Sequentially Thru Cases
-viewers in spare time Work With, Play With
-problems Yes, Some Even Solvable
-results Yes, Some Even Satisfactory
-data collected Some Pre-Test
- Much At-The-Exhibit
- Sample Post-Test
-indications: Each Behavioral Objective Given Two Chances
- pre-test Almost Zero Performance Ability
- at-the-exhibit 49% Successful On At Least One Try
- post-test 38% Successful On At Least One Try

more # = performance not previously possible in manipulating
Facts Fancies Theories
About Light

sans Teacher via Exhibit

Stephen E. Globus (Museum of the Media, New York)

Museum Technology and Standardization of Museum Transmitters

Grave problems exist in the museum's role in contemporary America. The museums are no different than other established institutions in our society -- they are under constant criticism from youth, the impoverished, and intellectuals. Museums are often cynically pictured as "mausoleums" of objects, not as stimulating educational environments. It is therefore extremely urgent that we as a group should attempt to bridge our past roots and seek a constructive road into the age of technology.

The most considerable problem is that of economy. It is very expensive to create, furnish, and display quality exhibits. This situation is caused by the harsh reality of supply and demand. The art and artifact competition favors the urban areas. Objects become centralized in the areas of great wealth, the large cities, such as New York, Washington, Boston, Chicago, San Francisco, and Los Angeles. Prices of precious objects are indeed prohibitive for the museums with small budgets. As a result, as one leaves these urban areas, he finds serious "cultural gaps." The non-urban areas do not have the resources to expose their residents to the important and comprehensive visual experiences contained in the central cities. The distribution of objects and the information they yield is limited. Small city and town museums can normally present competent exhibits only on specific, local topics such as local history, folklore, architectural remains, and regional art.

Moreover, the organization in the great museums is categorical -- that is to say, each subject is sectioned off into a suite of rooms in which the viewer is left to wander and make some sort of connection. The difficulties of this approach have made it necessary to use walkie-talkie lecture devices to give the inexperienced some feeling for the development of a work, and some idea of its place in society or nature. Objects are separated into a specific, linear approach -- for example, art museums segregate paintings from architecture, architecture from sculpture, sculpture from environment.

The cry for relevance is a valid one; the scholarly, categorical approach often appears to be unexciting, dry, and passive. This method does not exploit the full potentialities of communication. For many, especially the uneducated and the very young, this approach creates more educational barriers than it eliminates.

What are some solutions for the problem of economy, centralization, and organization? I think the evidence presented through

the research of the neighborhood museums demonstrates the need for the decentralization of the museum's role and contact with its society. It brings the museum's educational experience to an intimate relationship between visitor and object. But again, there is the nagging problem of economy; the subject matter is often limited because of inadequate funds.

I think that by employing contemporary means of communications we can start to see the solutions to some of these problems. Films, slides, and audio-tapes, when well synchronized, can make the educational process both comprehensive and invigorating. These tools can be duplicated rapidly and inexpensively. Since we are dealing with images, not precious objects, any loss or damage is not irreversible. But the great asset of a media exhibit is its amazing flexibility -- the many photographic techniques, such as split screen, close-up, time lapse, etc., can give the museum programmer a vast range of subjects and variety in exposition. Some day, I hope that the museums of this country, and indeed the world, will create a systematic procedure in which museums of all sizes, and purposes, can rapidly exchange audio-visual information.

The Museum of the Media has been researching the problems of the development and implementation of the museum system described above. I would briefly like to discuss our results. We believe that one method of eliminating the complexity of technologically grounded exhibits is a standardization process. We have designed the basic building blocks that would serve, when assembled, as a complete educational environment. I would like to refer to these as the "museum modules." I cannot stress too much the urgency for standardization, for it not only increases the efficiency of the transmitter, brings down the cost of the module (through mass production), but most important, I think, it unifies a procedure in which all museums can rapidly communicate among themselves. Each standardized module consists of a two-way polarized rear screen about eight foot square. Over each screen is placed a system of sound speakers. On these screens will be projected visual materials dealing with a specific subject accompanied by a synchronized sound presentation. All information in the modules will be synchronized. Each module is designed to function independently and collectively. Any number of modules can be joined together to form a total unit. For example, they can be placed, much like bricks, into different compositions: circular, horizontal, and vertical.

A number of inherent problems have plagued multi-screen and multi-projection systems of the past. The Museum of the Media believes that it has circumnavigated the usual difficulties of economy, power requirements, equipment compatibility, reliability, and coordination by developing this modular construction and a corresponding programming technique. Each module is

portable and can be assembled, because of its pre-packaged design, in less than one hour. When disassembled, a complete exhibit can fit easily into a flat truck.

All the software (the information conveyed in the exhibit) is designed and pre-programmed to fit into these modules. The standardization of the projection equipment, either movies or slides, enables the institutions to rapidly change their exhibits without elaborate cost development. By plugging in new software, small museums can expose their visitors to a great variety of exhibits from art, natural history, and science. Large museums can both disseminate their information more efficiently, and interrelate their objects in a more complete, organic synthesis.

The Museum of the Media's first exhibit, "The Human Head," is an exploration of the architecture of the face. It is accompanied with a non-narrative sound track, so that all communication will be completely sensory and therefore universally understandable.

Our museum, a non-profit institution chartered by the New York State Board of Regents, is basically an editing facility for modulated audio-visual exhibits. In New York City, we have constructed a sophisticated control system to pre-program our exhibits. We have installed a three-screen rear projection system. Behind each screen is an adjustable projection scaffolding, which is used to align our multiple images. In our laboratory we edit, collate and juxtapose large amounts of visual information and unify them into a meaningful educational experience.

Finally, I would like to open our doors to those who are researching new exhibition techniques, and also express a desire to work with the museum community to help find solutions to the nagging problems of our industry.

Nathaniel R. Dixon (Smithsonian Institution, Washington, D.C.)

Museum Resources to Classrooms

There has always been very high regard for the role that museums play as institutions fostering public education. Certainly the "educational" goals of some of museums' several "publics" are very well served. The casual sightseer, with no conscious learning goal, comes away pleased if he learns anything he did not know or satisfies some curiosity. For these people attractive exhibits with reasonably clear labels seem to suffice. The serious student or scholar with firmly set objectives combined with research capability encounters little trouble in his forays into museums because of his background of preparation his capacity for reading the language of objects and his ability to gain the empathy of scholars on the museum staff who often allow access to collections not on public display. In the same way, lecture attenders, individual collectors and other "museum buffs" enjoy certain contrived mechanisms which give access to museum facilities, resources, or expertise necessary for realization of learning objectives. Therefore, to many of its "publics," the museum does fulfill its role in implementation of public education.

Somewhere between the extremes formed by the sightseer and the researcher falls the huge "public" made up of millions of precollege level school children who visit museums as organized school groups -- those who come on learning excursions ostensibly planned to implement learning in some curriculum area. Although some of the same youngsters who visit the museum independently or with parents come again as members of school groups, the teacher must strive to effect a more purposeful utilization of resources from the student-visitor as contrasted to the sightseer-visitor.

Certainly there is very little hard data available which would feed back to museums reliable measures of the extent to which teachers are actually able to make the museum lesson a viable part of the course of study. However, we must agree that while museums contain an abundance of challenging verbal and nonverbal materials, very little effort has been put forth to give schools access to these materials except through visible but untouchable non-involving exhibits or tours often in crowded halls and galleries. We know that the effective learning environment should be one that combines student involvement with challenging materials in a setting conducive to study, discussion, discovery and exploration. Even in the absence of hard data we can see that we do not provide opportunities for purposeful involvement in a suitable environment. Nor have we seriously considered mechanisms for access to our huge lodes of unexhibited objects to school children.

The Smithsonian Institution through its Division of Elementary and Secondary Education is engaged in several coordinated programs to increase its viability as an auxiliary resource to schools. Program components include: teacher education, improvement of in-museum teaching environments, and production of classroom teaching materials.

Teacher Education

For the past three summers, teams of teachers have been invited to the Smithsonian to work with museum education staff, curatorial and exhibits staff, and outside consultants to explore areas in which the museum can best supplement school curricula. Products of these efforts are five teaching units adopted by the Washington, D.C. Board of Education, six teacher guides for in-school preparation of students for museum study tours, and instruction to 15 teachers for the introduction of "Man: A Course of Study," an innovative Education Development Center science curriculum, into classrooms. (Plans for summer 1970 were to train 15 teachers of high school science and social studies to develop audiovisual media for classroom use from museum exhibits and collections. These plans have had to be cancelled for the current year because of lack of funds.)

Throughout the school year education staff members are available to plan with teachers wishing to tailor museum visits directly to needs of school groups. Making use of museum classrooms, objects obtained from curators, films and other media, as well as concept modules designed from selected exhibit cases, the tailored visit provides a setting in which pupils may become involved with museum material and human resources. Our experience has been that once a teacher participates in the planning of this kind of school-museum experience future use of the museum becomes more imaginative with resulting benefits to students.

Improvement of the Museum Teaching Environment

With the cooperation of curators, conservators, exhibits staff and private donors, baskets of objects for close inspection and handling by students have become a part of the school tour at the Smithsonian. Pupils and teachers are able to feel, smell, taste, and in some cases hear the things they are studying, as well as see them. Classrooms are available for discussions and other learning activities.

Under construction at present are several experimental "teaching stations" which will be mobile media-loaded modules with general dimensions slightly larger than a telephone booth. These stations placed in retreat areas near appropriate museum halls will contain color slides, filmstrips, single concept films, objects, charts, diagrams and other materials which may supplement viewing in exhibit halls. Materials will be programmed into easily operated equipment for use by the docent and classroom teacher in an environment much better suited to reinforcement of learning than the crowded open gallery.

Two "teaching rooms" have been recently opened at the Smithsonian's National Portrait Gallery. In each of the rooms, presently devoted to Thomas Edison and Elijah Kent Kane, a multi-media approach is made to a comprehensive treatment of the man, the influences on him of the times in which he lived, and his impact on his and future times. Artifacts, photographs, color slides, music, documents, films all combine to give life and substance to an otherwise dull portrait of a great person. "Teaching rooms" will be changed periodically to present in-depth studies of other portraits.

Audiovisual Materials for Classroom Use

While it is certainly impractical to consider that large groups of school children will ever be able to rummage among catalogued and stored artifacts in the Smithsonian, an effort is under way to use these objects in the production of mediated packages for classroom use. Work is in progress to produce several sound filmstrip series and a possible study print package, all of which will utilize unexhibited collections in the development of themes of interest to teachers. In an open-ended, non-didactic approach, themes will include: "The Great Silk Road," "Gift-giving," "Poverty and Affluence," "Man's Rapport with Animals," and "The History of Racial Stereotyping in America." These media packages will be made available through major distributors.

We have only begun to unleash museums' enormous capacity to support pre-college educational goals in science and the humanities. I sincerely hope that this conference will escalate a growing acceptance of responsibility by the museum community with resulting benefits to elementary and secondary school learners.

Marie Svoboda (Field Museum of Natural History, Chicago)

The Museum as a Supplementary Learning Center

The Department of Education created in June of 1969 at Field Museum proposes to expand and modify its on-going school programs in order to ensure greater educational benefits and maximum retention of learning by school children.

In order to do this, it is necessary to know as much as possible about each school group before the visit is scheduled. It is therefore proposed that every group requesting staff assistance receive a pre-visit packet of materials which will include a number of key questions to determine the level of competence already established by the group, a summary of what the museum visit will involve, a statement suggesting classroom activities and sample lessons, and a list of instructional objective options including ideas or concepts which the visit could develop.

Obviously a group will get out of their museum visit only what they bring to it. By pre-determining the group's level of attainment, the museum teacher is better able to prepare her materials in a meaningful way, wasting a minimum amount of time either in needless review or in presenting material beyond the grasp of the students. Pre-test data of some sort must be available to the museum teacher. Post-test data are the only way to evaluate our program effectively. Research in this area is inadequate at the very least.

Museum teaching differs greatly from classroom teaching in that objects are the primary teaching tools and are more accessible to the students there in the museum than in the classroom. This was not always the case, however, for traditional museum visits consist of groups being escorted through the exhibition halls with "guides" or "docents" explaining the various exhibits. Actual handling of objects is either minimal or nonexistent.

Museum teaching offers innumerable opportunities for teaching students how to observe and how to organize their observations so as to draw inferences -- inferences which eventually could be applied to other situations. Many museum teachers have, at least in principle, attempted to accomplish this through their own interpretation of an exhibit. Admittedly, this is a poor substitute for the ideal "one-to-one" teaching situation, in which the student interacts directly with an object in hand, making his own observations and inferences. Perhaps the "one-to-one" relationship I have in mind is unrealistic and will never materialize, but we at Field Museum propose to determine if it is, in fact, unrealistic.

To accomplish this, it is proposed that more time be spent in a workshop setting (keeping in mind always that this is a museum workshop whose educational benefits depend greatly on the background work done previously in the classroom), with objects or models available for handling, comparing, sorting, etc. Following the workshop period, the students would be sent with specific questions to the exhibit halls where they would put into practice new competencies in observation and in constructing inferences learned in the workshop or by pre-visit instruction. Again, the emphasis is on the "one-to-one" relationship -- the student and the object; the student competes with himself, not with the group. Both the classroom teacher and the museum teacher would be available as consultants but not as active dispensers of information.

Following the museum trip, post-visit materials would be sent to the teacher to determine the success of the visit, with data being sent back to the museum. Hopefully, this kind of program would result in a long-term relationship between the school and the museum, so that museum visits become an integral part of the teaching sequence. Instituting such a program will involve much thought and work and many revisions to make it a mutually beneficial undertaking.

I feel that as this system becomes operative, all data (both successes and failures) should be pooled in a central location and made available to all museums interested in starting similar programs, with the understanding that those museums also would contribute their successes and failures to the central pool. Thus, all of us would be better able to produce valid analyses of our programs.

One problem that would preclude the setting up of such a program is the fact that no museum, however large, will ever be able to provide enough staff to service this kind of education. The only practical solution is to train teachers to use the museum on their own.

A six-week pilot in-service program is presently being developed by the Field Museum to train teachers in using the museum, with basic staff provided by the museum and additional staff from participating universities. This program is a research project to test a model of instruction. The course includes some subject content, but the emphasis is placed on museum materials and their utilization as illustrative aids to existing curricula. Practice in writing pre- and post-visit instruction based upon sequenced behavioral objectives will form the major portion of the course. Observation of professional staff at work with school groups will demonstrate the practical application of the teaching principles being discussed. It is hoped that the course will be conducted during the summer of 1970.

By training teachers to use the museum's resources, our professional museum staff will be free to train other teachers, to prepare pre- and post-testing materials, to correlate resulting data, and to act as consultants to schools and teachers requesting specialized help.

Statistics tell us that it is impossible for a staff of five professional museum teachers (as we have at Field Museum) to reach more than twenty-twenty-five percent of the 6,800 groups of nearly 400,000 students who visit the museum annually. Good sense does tell us, however, that if we could train the 6,800 teachers, at least 400,000 children would receive the kind of education we believe would be most beneficial to them.

We must not forget that school children visit a museum for a variety of reasons. For some it may be:

(1) a first visit;

(2) only visit because of distance or finances;

(3) one of several visits made annually;

(4) a visit to pursue a highly specialized interest.

In order to meet these varied and entirely valid reasons for visiting a museum, a flexible program is necessary. Well-trained volunteers could handle many groups whose needs are less complex, thereby releasing professional staff for programs requiring particular assistance.

A more intensive program of adult education than we have had is also being considered. Although the museum is open on weekends and occasionally in the evenings, the adult visitor is often very much on his own. Why not offer classes or seminars for professional groups, for laymen, for students, and for family groups? Any number of natural history topics could be presented by the museum's staff or by speakers invited from other institutions or from the community. This would be a different way of using the untapped resources of the museum. For example, why not a series of discussions on the evolution of law, medicine, communication, language, writing, transportation, art, music, etc.? The museum is filled with objects that could be put to real use in such learning situations. Outstanding individuals in various fields could be invited to contribute their ideas and feelings.

Such programs would not present strict factual information which rightfully is the function of the professional school. But the museum can present, in laymen's terms, an overall picture of a field or discipline so as to encourage an appreciation for the wealth of past contributions that have enriched and broadened our

lives, and, perhaps, encourage those who might be considering entering one of these fields, to go on. In this way the museum could relate to the community and give of itself in a way that no other institution could begin to emulate.

Lloyd Hezekiah (MUSE, The Brooklyn Children's Museum, New York)

MUSE: The Bedford Lincoln Neighborhood Museum

In 1899 the first children's museum in the world was founded. This was the Brooklyn Children's Museum and it was located in two mansions in Brooklyn's landscaped Brower Park. "The child must feel that the whole plan is for him," said Anna Billings Gallup, the museum's first curator-in-chief. "He must feel that it was created for him and that in all of its plans it puts him first." From its inception it was a see-and-touch museum where everything presented could be sensed, touched, worn, and lived with, so that the visitor could enjoy an actively enrichening experience. The museum's former buildings were vacated in 1967 because of their exceedingly deteriorated condition, and while a new museum is being constructed on the original site the old museum continues to live through a neighborhood facility known as MUSE: The Bedford Lincoln Neighborhood Museum.

The Brooklyn Children's Museum services all the boroughs of the City of New York, surrounding counties and states, along with their respective schools whose students are transported to the museum on a reserved basis for special programs. The general public also participates in all Museum activities.

Live animals from the museum's mini-zoo are used by the curator of natural history: "Touch the dove with one finger . . . fold your hands like this so you can hold the rabbit . . . what does the duck eat? . . . our skunk doesn't smell . . . you, little girl, wear the snake as a necklace . . . yes, young man you can wear it like a necktie . . . do you know we give the sheep a haircut too? . . . look at the bees hard at work . . . the monkey's name is Jody . . . no, you can't take him home."

The museum's "treasure chest" consists of approximately 8,000 items which are acquired through bequests, gifts, exchanges, and purchases. It ranges from a 2,000 B.C. Egyptian mummy's hand to a fourth century Roman lead doll to 20th century minerals mined in Ceylon. The collections enable the museum to present see-and-touch programs and demonstrations by its curators, to mount exhibitions, to engage in loans with other museums, to operate the school-loan and take-home collection projects, and to provide workshop tools.

Musical instruction is offered in twenty-four categories including bass, drums, guitar, piano, theory, trombone, trumpet, and saxophone. Free programs are presented regularly such as films, puppet shows, dance and theatre companies, poetry readings, open discussions, etc. Once a week free jazz jam

sessions are organized, at least twice a month free jazz concerts are presented, and these events have brought many budding talents to the public eye.

The intimate nature of the planetarium allows school and public audiences to journey to the moon and other planets, to witness an eclipse of the sun from a short distance, to look at the earth from inside, to wonder, to know, to learn. The student programs follow the school curriculum closely, while the public ones are more diverse.

Our newly opened Space and Earth Science Center is already proving to be a very popular place here at MUSE, even though the installation is not yet complete. In the center there are samples of the special food that is prepared for astronauts such as shrimp and fruit cocktail, orange and grape juice, ham and applesauce, peaches, etc., and one can learn about the method that activates these scientifically dried foods into edible forms. There are automated displays that tell about the spin-off benefits that arise from space-oriented research -- benefits that are of great value in the medical and weather-forecasting fields. The center also offers dozens of minerals and fossils that can be touched and examined such as opal, hematite, limonite, lepidodendron, quartz, galena, kaolin, pyrite, selenite, slate, etc. Next to a chunk of ore of copper a group of pennies has been placed, thus linking the raw and finished products together. A child (or adult) can perform many experiments such as testing the magnetic properties of certain minerals and noting those which repel and attract, using a fingernail to scratch a piece of gypsum, comparing iron and stone meteorites, or experiencing the effects of static electricity on human beings. There is also a model of an imaginary city on the moon constructed out of numerous household articles, and this moon city, "Gleamalot", actually does glow! Contributions to the Space and Earth Science Center were received from the Allied Chemical Corporation and Family Circle Magazine.

The school-loan collection is made up of individually-designed suitcases containing artifacts of cultural, natural, and scientific history of various cultures and geographic areas of the world. School teachers may borrow kits that are linked to the classroom topic for a nine-day period, and are encouraged to use the items so that students may relate to specific cultures through direct experiences. Museum items are loaned to children for a week from the take-home collection. They may not be able to take a live racoon or guinea pig home with them, but they may choose mounted butterflies, frogs or birds, minerals, dolls, shells, fish, etc.

Children and adults may enroll in dozens of free workshops which are taught by professionals at the museum. Art, aviation, anthropology, archaeology, astronomy, creative writing, dance,

drama, gardening, music, natural history, photography, puppet-making, sculpture, and science are some of the disciplines included. A reference library is also available.

Kenneth A. Chambers (The American Museum of Natural History, New York)

Science Teaching in the Classroom and Laboratory at The American Museum of Natural History

The American Museum of Natural History has a full-time teaching staff of 20 persons. Of these, 11 have specialized backgrounds in the biological or earth sciences, the rest being concerned with anthropology. Although some of these teachers instruct at the adult level, all personnel participate with programs offered to pre-college students.

Because of its location in the center of New York City, and the fact that its Education Department is funded by the City, The American Museum has a direct responsibility to offer programs in which as many school classes as possible can be serviced. Thus, with many classes coming to the museum on each school day, the opportunity to utilize classrooms is at a minimum. As part of the large, daily program offered to elementary schools, a brief period is spent in a room where specimens, models, or colored slides are used to supplement and amplify instruction in the exhibit halls. This constitutes the only classroom activity. Another program has been designed for those schools that cannot be accommodated on the regular hall/classroom offering. This consists of a one-hour slide and sound-illustrated talk in the museum's main auditorium, where one museum teacher can address a group made up of as many as 20 classes.

On Saturdays several courses in the natural sciences are offered to young people from eight to 14 years of age. These include one or two laboratory-type introductory courses, such as identification of rocks and minerals, oceanography, and herpetology.

The only laboratory space available to pre-college students is the Louis Calder Natural Science Laboratory. This is an adjunct of the Natural Science Center for Young People. Although originally designed for use by students who have definite projects in natural science fields which they wish to carry out on their own (under the supervision of a museum instructor) the laboratory is now used for another series of Saturday courses in the natural sciences. Unfortunately it is small, with work space for only 12 students. Binocular microscopes, glassware, a refrigerator, and a sink form the major part of the equipment. At the present time the courses being given consist of introductory genetics, entomology, botany, and ornithology. A recent grant will enable this activity to be expanded to an additional room with work space for a further 16 students, and containing an autoclave, centrifuge, and other standard equipment.

From the foregoing it will be seen that, as far as classroom and laboratory work at the pre-college level are concerned, The American Museum is greatly lacking in both space and equipment. There are several reasons for this:

(1) The philosophy of the American Museum, through its Education Department, has been that teaching should take place, wherever possible, in the museum's exhibit halls. These exhibits are what most teachers wish their students to see, and this is where the museum is particularly qualified to supplement schoolwork.

(2) Although the American Museum has nine lecture rooms -- three of which can each seat more than 300 people -- these rooms are used very frequently for meetings of scientific societies and, on a less regular basis, for large conferences. It would not be practical, therefore, to change or modify these areas so that they could be used as laboratories.

(3) Within the existing plant there is a lack of space for new classrooms and laboratories.

(4) There are no funds available for construction of additional buildings where classrooms and laboratories could be located.

The schools readily avail themselves of the existing programs and other facilities offered by the museum, although, as has been previously stated, these programs are designed primarily from the point of view of teaching in the exhibition halls, rather than in the classroom. With one exception the demand for inclusion in any program offered by the Education Department at the pre-college level may be said always to have exceeded the number of classes which can be accommodated. The exception is at the junior and senior high school level. It has been increasingly difficult to attract classes or individual students in this age group into the museum, although a number of programs and activities have been planned. It is thought that the major reason for this apparent lack of interest is that the structuring of the school day precludes the setting aside of the time block necessary for a visit to the museum. As far as the individual student is concerned, it appears that parental control is a factor in persuading students to continue studies on Saturdays, so that the vast majority of Saturday students are children from the lower grades.

In summary, it may be said that, even if funding were available, a complete revision of the existing philosophies of, and programs offered by, the Education Department at The American Museum would be necessary in order to stress teaching in classrooms and laboratories rather than in the exhibit halls. Whether

or not such changes would add to the potential of the museum in its role as an institution for supplementary science education is a moot point.

Discussion Insert

Exhibits Can Best Serve as Educational Resources When This Use Is Designed into Them

DR. CHAMBERS: The Hall of North American Forests in the American Museum of Natural History portrays the Logan Pass area of Glacier National Park. Its aim is to show the type of vegetation at timberline, small stunted trees, and associated animals such as the pica (and the runways under the snow which it uses in winter) and mountain goats. When we use it for school groups we try to bring out the harshness of the environment and the adaptation of the animals. Incidentally, the exhibit portrays the Continental Divide, so we can use it for geography, for discussion of how animals adapt in winter, and discussion of conservation and national parks and vegetation. Groups of up to 40 children can take part.

DR. NETTING: First, let us avoid giving the impression that museums were organized to conduct elementary and secondary education. The major science museums are organized primarily for research -- for the "increase of knowledge," to borrow a phrase from the Smithsonian's own charter. Second, it is because museums have scholars devoted to their own original inquiry that they are able to communicate fresh knowledge to the public. About five years ago a Scandinavian archeologist came to Pittsburgh. She gravitated to the museum, but of course we had no real collections for her to work on. So we asked her to look over all Viking material in North America, resulting in the first major exhibit ever staged on the Viking contacts in North America. Her familiarity with this cultural tradition led to deep involvement with the subject, transmitted in the form of excitement and involvement. This is really the secret of presenting museum materials.

DR. OPPENHEIMER: In any community there are people with substantial expertise. Museum exhibit development provides an avenue for using this in pedagogy.

DR. SCHEELE: The smaller a museum is, the more likely is it necessary to tailor exhibits to localized interests. The visiting audience is apt to be local, and the museum must reflect the interests of those people. The Cleveland Natural Science Museum has planned a sequential exhibit on the settlement of the North American continent that reviews the history and sequence of human habitation and the effect of this sequence upon animal and plant life. Throughout the presentation, there is a repeating review of the past, present, and future that takes place in all galleries. The climax of the visit is a multi-media presentation that deals with present-day human impact upon the remaining North American environments. This is an exhibit aimed at any group of visitors, but it specifically seeks to relate the local

resident to the nationwide picture of change.

MR. LOVE: At the Oakland Museum's Natural Science Division we portray major biological zones of California in a transect across the state. The visitor senses the continuity whereby each zone flows into the next. Our goal is not so much the names of things as it is concepts of relationship. Each section is broken into communities or areas without any single standard plan. In the Great Basin there is a piñon-juniper relationship but we're treating it in the desert section, of which we believe it is more typical. We shy away from dioramas, preferring stylized cases or realistic cases. In one place we show trophic levels, linking predators and prey, layering them in sequence. Portraying grassland, we show creatures living above the grass, in the roots, and burrowing animals. We're interested more in nature and structure of communities than in the names of animals and plants. Our docents must take a college-level course in ecology before they are allowed to take people through. We think names are a dead end. Visitors will say, "What's that?" and then move on.

MR. HEZEKIAH: So few adults have ever touched animals. In the urban setting it is desirable to place things where they envelop the visitors. We're planning a new building with these rules: no corridors, no dioramas, and material for collections which can be touched directly.

DR. SCHEELE: The leading museums have a responsibility to preserve objects, which is at variance with a permissive attitude which encourages people to touch.

MR. LOVE: You simply decide to consume a few replaceable objects.

DR. KARAS: Involvement of the museum visitor is paramount -- and difficult to produce. Examples of high visitor involvement are in two permanent exhibits we conceived for the Chicago Museum of Science and Industry, "This is Photography" (for Eastman Kodak) and "Petroleum" (for Standard of Indiana Foundation). Compartmentalized exhibits are deadly. My experience is that industry is far ahead [of museums] in bringing new ideas and techniques to the art of exhibition.

DR. OPPENHEIMER: The museum is at its best when it shows different aspects of a phenomenon or principle. We have one machine showing stress in cellophane tape, but nearby is another that produces stress patterns by compressing lucite blocks. The same natural phenomenon appears and reappears in numerous different contexts.

DR. SCREVEN: Exhibit design involves not only a determination of the exhibit's overt content (as seen by the scholar or designer) but also implicit factors relating to what a person gets out of seeing the exhibit. Its content is separate from the problem of communicating with people. Some people are more predisposed to benefit from seeing an exhibit than others, and some are more highly motivated than others. A good exhibit must evoke and repay attention.

Loren D. McKinley (Oregon Museum of Science & Industry, Portland)

The Oregon Museum of Science and Industry (OMSI) has been involved in a program of science teaching in the museum classroom and laboratory for ten years. During this period we have worked very closely with the science coordinators of the various school districts of Oregon. We solicit their advice on course content and classroom equipment -- i.e., on what actions of our museum would best upgrade science education in the state of Oregon. The response to this program is enthusiastic and sincere and the results are most satisfying.

The role of science teaching in classrooms and laboratories is threefold. Each part is integral to the total educational impact a museum may have on science education in the schools of the area served.

First is the obvious function of providing science enrichment experiences above and beyond those available in the formalized school. A museum can be most successful in this, being able to draw the very best teachers from a variety of sources. Outstanding public school teachers, professional scientists and engineers, amateurs from hobby societies, students in college or even high school -- all these sources provide a wealth of competent and inspiring instructors for mini-courses offered by museums. Laboratory facilities can be designed to allow maximum participation by individual students. The museum itself serves as a vast resource of educational exhibits and equipment. The composition of the class also has much to do with its educational success, since such classes tend to draw students who are willing and eager to "walk the extra mile."

OMSI has had notable success with such a program. The museum offers over 160 different enrichment classes each year. The program is expanding to other campuses outside the museum proper as other communities seek to set up OMSI branches in their immediate environments. Six thousand youngsters, from kindergarten through high school, are receiving the immediate benefits of such classes in the northwest United States.

A second but less obvious function is to provide educational input directly to the schools. Students motivated by museum programs stimulate teachers and other students in their local schools. Museum programs often influence the type of course offerings and educational approaches used by the schools.

An example of this influence and the action resulting is the science camp program of OMSI and its effect on outdoor education and field instruction programs in the Northwest. Literally thousands of students in local schools are benefiting from activities developed originally by OMSI. New courses are instituted in schools as a result of field testing done in museum classes.

A third role of the museum, and perhaps the most important, is that of educational research. OMSI is currently setting up a full-time laboratory school where ideas can be tested and evaluated. Schools in the vicinity can observe results, examine data, and implement the proven and practical ones. The museum's extreme flexibility provides an excellent testing site and allows it to act as an incubator of new ideas and approaches.

The museum should conduct research on problems of implementing new programs in schools. For example, expertise developed in researching new curricula could be utilized through a museum service center, training school leaders by using students from the museum laboratory school. The loan of equipment for pilot programs can help implement programs at the local school level without the resulting expense.

Another method of educational input directly to the schools consists of in-service science training classes for science teachers. Our museum operates such a program, and in the last several years we have presented such classes to a total enrollment of 4,000 elementary school science teachers.

Training school leaders and teachers, providing equipment, and making available supportive data: all of these services tend to encourage educational innovation and shorten the educational time lag that exists between the development of a new idea and its eventual adoption by local schools.

In summary, the museum should provide the link that connects the art of the possible (educational research) with that of the probable (actual use in the local schools).

Eventually museums will be judged not just on their programs that exist in house for the few -- but rather on the exportability of their programs to benefit the many.

Winslow M. Shaughnessy (The Academy of Natural Sciences of Philadelphia, Pennsylvania)

"The Nature of Things"

The Academy of Natural Sciences of Philadelphia has carried on an active and extensive educational program for many years. Most of these programs are not unique. Our sister institutions in Philadelphia and in other large cities have been conducting similar programs -- museum lessons on a variety of subjects, after-school and Saturday-morning classes, auditorium presentations, and 16mm motion picture series. All of these programs are usually well-attended and worthwhile activities. They form the "backbone" of the museum's educational repertoire.

However, even a cursory examination of the youngsters being served by these programs reveal that few -- very few -- of the youngsters enrolled in the Academy's after-school and Saturday classes have been "inner city" residents. During early 1967 steps were taken to correct this alarming situation -- alarming because over fifty percent of the city's young people live in the inner city.

Through the dedicated guidance of Mr. Gilbert E. Merrill, then Chairman of Education and Exhibits, and the sponsorship of the Rotary Foundation of Philadelphia, a special series of Saturday classes, "The Nature of Things," started in late September of 1967. The 200 young people who were assembled there that first morning were all in the sixth and seventh grades. They represented 60 schools from the EIP (Educational Improvement Program) areas. Each student was selected by his school on the basis of his interest in the natural sciences, willingness to attend classes regularly, and, to a lesser extent, financial need. Nearly all of the "freshman" class were from the black community, though Spanish-speaking and oriental youngsters were in evidence. Each participating school (public and parochial) received transportation money from the Academy for the students -- enough money for round-trip bus fares between homes and the Academy for 15 class meetings.

During the first year "The Nature of Things" was an auditorium "production," held on alternate Saturday mornings for one and one-half hours. Initially the attendance was quite good. After a short while, however, attendance began to drop off somewhat, and "substitutes" appeared carrying notes from their school teachers telling us that so-and-so had dropped out and here was his replacement. We also experienced more tardiness than we were used to, and some "spotty" attendance. This made it difficult to take the roll and to maintain continuity in the presentations.

An inducement to regular attendance were all-day field trips via chartered bus to nearby natural areas. The first trip to a state park in northern Pennsylvania was nearly three hours riding

time away from the city. One hundred eighty-nine youngsters, 20 field trip leaders, and four buses made the journey. Many of the youngsters had never been out of the city before this trip. Careful attention to details, "pre-running" the trip, and knowledgeable leaders made the day a great success.

"The Nature of Things" was, and still is, organized as a potpourri of natural science subjects. The very first class was a spectacular program on birds of prey, complete with living hawks and owls. The Academy's paleontologist presented two programs, entitled "Prehistoric Life" and "The Making of Mountains." Several classes were presented on mammals and reptiles, again using living material and large-scale "props," mounted specimens, and other visuals. Other programs included "Mollusks," "Animals and Oxygen," "Forest Ecology," and "The Biology of Insects." The grand finale was a second all-day field trip to the Brigantine Natural Wildlife Refuge on the New Jersey coast.

"The Nature of Things" (or "The Rotary Course," as we call it internally) is now in its third year of operation. Each year the course has been altered, shaped, and improved according to the needs of the young people it serves. The most important change is the division of the large auditorium-sized group into four smaller classroom sections. Two sections meet in the fall for eight or nine Saturdays, and another two sections meet in the winter months for the same period of time. We feel that the smaller groups, meeting on consecutive rather than alternate Saturday mornings, are much easier to teach, have a better learning atmosphere, and offer more rewarding experiences to students and teachers alike because of the closer personal contact.

Another important change was the introduction of more student participation. During the last two series a terrarium building project has been a great success. After seeing a short series of slides about plants in their natural habitats, each student plants, waters, and takes home his own small green world. As I write this, over 100 board-feet of lumber are being sawed into 300 pieces for the construction of 50 bluebird houses. After the students assemble these, they will erect them in a suitable location as part of their spring field trip.

Much of what I have just described was difficult to assemble and organize into a meaningful program, because of the lack of pertinent literature on urban environmental education. A trial-and-error procedure has produced an innovative and exciting educational experience for these young people. During the past year a body of limited literature on this subject has appeared and is being used to augment knowledge gained from our own direct experiences.

"The Nature of Things" has been an introduction for the Academy's staff to the natural science education of urban youngsters. Through this course the staff has become more aware of the needs of inner city students. The program has also provided a jumping-off point for several more projects specifically aimed at the urban community. Three of these projects are under way, and several more are in the advanced planning stages.

William E. Scheele (Natural Science Museum, Cleveland, Ohio)

Some Educational Aspects of a Large City Natural Science Museum

The desire to create a museum of natural history in Cleveland was thoroughly discussed by community leaders and civic groups for years before the present institution was founded. It was concluded by all concerned that the educational role such a museum could play within the region would be its primary reason for existing. Because of this decision, a department of education was established, even before a museum building was provided.

The new department was one of the earliest in a museum in the country and from that point forward the education supervisor has been required to assist in planning all museum matters other than research. This includes evaluating educational concepts and content in exhibits, and overall gallery layout. As a result, today's museum consists of displays and programs directly related to current needs of school systems whose pupils utilize the museum.

The assemblage of rooms housing displays seen in many museums are absent in Cleveland. In their place is a continuous chain of galleries whose contents tell a sequential story beginning with the formation of the universe and ending with a summary of man's role in relation to his environment.

The present museum organization includes a planetarium and observatory, display galleries, four sanctuaries totalling more than 1,000 acres, workshops, classrooms, research quarters, a living animal collection, and a labelled nature trail in 12 acres of woodland in the heart of the city. The museum founded and manages the Cleveland Aquarium for the city. Independently endowed educational activities include a Future Scientists Program, a memorial dedicated to teach principles of animal behavior and wildlife conservation, and the operation of a trailer museum that interprets the Cleveland region. This latter unit is co-sponsored by the city as a result of the success of the museum's creation of the first trailer museum in America many years ago. Research collections of considerable size are housed off the premises.

In assembling the components which make up the present Cleveland Natural Science Museum, there has been a studied effort to maintain a balance in programs and displays that does not separate subjects or concepts into "youth" and "adult" categories. There is no watered-down science for children.

It is a requirement that membership activities be diversified and appealing to all age groups. Income from memberships must be maintained at a high level to produce operating funds. Family

memberships (in the amount of $25.00) outnumber all other membership categories. The family aspect of usage is reflected in programs that include films and speakers, and in full enrollments for summer, weekend, and after-school programs, field trips, and individual project work.

Recent members' program speakers have included Justice Douglas, Paul Sears, Charles Wurster, LaMont Cole, and others who bring current events into focus at levels that do not talk down to young people. Speakers of this caliber at the museum frequently discuss their specialties with student audiences in seminar format. The value of these efforts is attested to by the fact that the museum's Education Department is partially supported by fees from schools using its services. Our programs are also well supported by local foundations.

In seeking school support of its programs, our Education Department meets many diverse local needs. One of these is to meet and indoctrinate all science teachers of the area. Since teacher turn-over is high everywhere, and since so many teachers are not trained in science, those new to our community are briefed concerning its natural history and are taught how to use the museum for maximum pupil and personal advantage. Teachers who desire further training in specific sciences enroll in course work which brings them up-to-date. Generally, schools pay for this service and award salary increments for completed work.

A major reason for maintaining contact with teachers is to establish firmly in their minds that the museum is a place of learning and that a class field trip is to be nothing less than an integral part of the teaching process. Effort is made to interest individual students in returning to the museum with their parents or as enrollees in one of the many programs available.

Many children must be taught respect for museum materials, for too often their behavior and concepts of value have been warped by permissive attitudes developed elsewhere. It is increasingly necessary to discourage the idea that museums are places where everything must be handled to be appreciated. This is not to imply that our course work and other programs are deadly serious at all times. Since so many federally sponsored programs and efforts by citizen groups bring large numbers of very young children to museum premises, the children must be made to realize that other class work, requiring concentration, is always in progress in the galleries.

Museum scientific and popular publications are aimed at furthering understanding of the entire science spectrum, with continual emphasis upon comprehension of significant problems that affect the area we serve. Some publications are aimed directly at classroom use and deliberately try to involve students in current environmental problems.

There is an extensive program of field trips, including motor caravans throughout the United States, to study ecology and geology. Career counseling is available, and museum non-professional jobs are available to qualified students. Animal care and curatorial chores of a low order are assigned to students. Whenever possible, outstanding students are assigned paying jobs from the moment they can demonstrate their qualifications until they have finished college undergraduate work. Scholarship money is available so that deserving students may attend any museum function and, on occasion, special funds may pay for typical school costs which are beyond a promising student's means.

The Natural Science Museum, like other museums in Cleveland, is not supported by funds from the city, county, or state. Its entire program is based upon voluntary contributions, admissions, memberships, fees for services, income from special events, and a sales desk. Throughout its history, museum galleries have been of moderate size. Fulfilling the range of activities, described here, with a total staff (including guards) of fewer than 40 individuals, has precluded any permanent displays or programs.

Present buildings were opened in 1958, and there is no exhibit in them that has not been changed several times in the last decade. Twenty-five percent of all exhibits are changed annually. This includes a 72-foot dinosaur that has been moved or remodelled three times. A maximum effort is made to relate all displays to local and regional subjects worthy of study. We serve a predominantly local audience that expects something new each time they return. The museum is open regularly seven days and one night a week, and many other evenings for special functions.

Museum trustees are always receptive to the development of new science teaching facilities not generally considered museum functions. The associations listed below reflect good service to the community; the Board of Trustees ultimately sets up these services as independent operations. In addition to features described above, the organization has at times included managing the Cleveland Zoo; planning, equipping, and staffing four trail-side museums in Cleveland's Metropolitan Park System; founding the Holden Arboretum, America's largest, which it also owned for 22 years; and serving as consultants at local, state, and national levels for museum planning and guidance in program development.

As a result of the preceding service activity there is an open staff attitude toward innovation and experimentation in programs. The need to cooperate has been a basic principle of growth, and the organization is in a healthy state because it has developed numerous cooperative outside contacts which are of value to its home community.

Robert E. Love (The Oakland Museum, Oakland, California)

Attempting an Untried Approach

Due to an opportune combination of events, the Oakland museum is in a unique position concerning much of what is "relevant" today. At the time of conception, the Natural Sciences Division was to become an enlargement of the old Snow Museum, a large collection primarily of hunting trophies. Had this persisted, with the tight budget of many such municipal ventures, I'm sure we could never compete with most other museums in the West, in spite of the relatively progressive building.

Early in the game, however, the emphasis shifted from the conservative "New Snow" approach to another idea entirely -- one directed not toward kinds of animals and plants, necessarily out of context, but rather toward relationships other than taxonomic, namely to the concepts of ecology and particularly their application in California.

I mention this because of the effect on our philosophy, and on the direction in which the museum is going. Our present effort in public communication is divided into four spheres: (1) the museum gallery or ecological transect; (2) the docent training program; (3) the docent tours; and (4) the "Museum on Wheels." Unfortunately for this report, we have very few "results" to present since we've been open scarcely four months.

The Gallery

The Name Game: Probably the most important concept concerning the main gallery is the de-emphasis on the question, "What does it do?" As an example, out of about 65 exhibits, only seven give the names of some or all the specimens, and seven more make reference to names in the case description. The rest of the exhibits mention selective pressures, climatic conditions, types of interactions, etc. -- information stressed in all cases, zone and community panels; names are needed only when the relationship is specific to particular animals and plants. The copy is presented in a literary style maintained throughout, liberally laced with humor and irony.

The Transect: The main gallery is arranged as a transect of the state, with eight ecological zones, each with two to five communities with several displays. The hope is to create an awareness of differences and similarities in situations and an understanding of the stresses which affect the organisms living there and which they must overcome. The insect is as important as the poppy, as the bear, and in most cases there is a preponderance of small organisms to offset the focus created by larger sizes. At the same time, orientation is maintained

through topographic models and photomurals.

The Introductory Area: Here again, on this photographic board display, names are not used, and a series of concept-words with arrayed pictures leads from Energy and Matter to Evolution and Ecology. Two large photos with simple abstract diagrams indicate the Flow-Energy and Cycle-Matter concepts as the transect is begun.

Docent Training

Approximately 150 docents have completed the Docent Training Program in Natural Sciences. This is quite extensive, and is given in part at Oakland's Laney College as an accredited course for biology majors, taught by a college instructor. The 26-week course is supplemented by numerous field trips, in-gallery training, and summer "refresher" lectures, and is terminated with a thoroughly researched term paper by each trainee expanding one of the exhibits in the hall.

Docent Tours

Docents conduct two regularly scheduled tours per day at present, open to those present at the time. In addition, as many as 20 additional tours may be given to groups arranging for them in advance. The docents are trained particularly to generate questions and point out relationships hopefully leading to individual awareness and interest.

Traveling Exhibit

The "Museum on Wheels," a converted semi truck, is a composite of all three of the museum's divisions -- Art, History, and Natural Sciences. It tours schools and is generally seen by all classes. In addition, one "target" class is given a classroom presentation prior to seeing the exhibit. This is intended to relate them, in their present life, to what they will see in the museum by slowly stripping away their surroundings and presenting at the end what the San Francisco Bay Area was like before the European invasion.

The Success

Of all the comments made by visitors not associated with tours, the most common concerns the lack of names. These range from indignation to disappointment, with a few in support. In response, a brochure is being planned which will identify all organisms in all exhibits. This will still stress the de-emphasis of "names" as being very often a dead-end answer to a question of fairly low heuristic value: "What is it?" In the context of our exhibits, this answer is already supplied where germane and otherwise omitted in the hope that viewers will be forced to ask more

meaningful questions and get used to finding their own answers, or even finding that no one knows!

The docents are not given a program to present. They have completed the extensive course in ecology and know the contents of the cases. From there, each is encouraged to develop her own unique presentation. In coping with the namelessness, a great deal of success has been met in using cue-cards with leading questions, and in games of making up the most applicable name on the spur of the moment: All the better that both a towhee and a California Thrasher might be a "scrub-grubbing-under-leaf-eater" on the coast, while only the thrasher a "drinkless sand wisker" in the desert.

Recently, quite without our solicitation (although we will certainly expand on this), some exceptionally interested and imaginative biology teachers, including instructors from colleges and several high schools, have viewed our exhibits previous to class visits and worked up question sheets to be answered by the students during their visits, solely from the primarily visual presentations in the transect. These questions have generally been directed toward ecological-adaptive significance -- i.e., theorizing on why certain organisms are where they are, what niche they fill, etc. Such reactions, while evidenced by only a few so far, certainly make our objectives seem much more realistic.

Present plans for the classroom presentations with the mobile unit are as yet untried. Past presentations were very well received, especially in the deep city schools. The new program will encourage children to strip the city from a large map and replace it with specimens and pictures of past wildlife in both historical and natural science contexts.

In summary, it will take more time to evaluate our impact realistically but at present the important interest has been generated. The lack of experience, tradition, and rules is the greatest asset in creating new approaches. Through these, our goal, that the public, which is increasingly required to make judgments of an ecological nature, must achieve an awareness of the intricacies of ecology, the complexity and range of interaction and interdependence of life forms and the environment, may be realized. Specifically in the future a hall on the impact of man will hopefully summarize this.

Statements about the Modern Planetarium in Education

[Correspondence concerning their programs was received from four planetarium directors and education directors: Dr. Joseph M. Chamberlain, Director of The Adler Planetarium, Chicago; Dr. Franklyn M. Branley, Chairman of the Hayden Planetarium at the American Museum in New York; Dr. Eugene J. Hanses, Education Director of the McDonnell Planetarium in St. Louis; and Dr. Carl F. Wapiennik, Executive Director of the Buhl Planetarium and Institute of Popular Science in Pittsburgh, Pennsylvania. The following composite statement taken from their descriptions indicates some of the educational activities that U.S. planetariums offer the pre-college student today. Ed.]

Planetariums are leaders in providing school groups with pertinent supplementary material in astronomy -- a field which is not often adequately covered in the standard school curriculum, in spite of the advances which have been made in recent years.

All major planetariums in this country and quite a number of the smaller installations offer regular astronomy programs for school groups. Most of the programs are based on requirements in the local school curriculum and most are designed to relate to grade levels. Usually the topics and the levels have been determined following consultation between the planetarium education staff and the curriculum representatives in the local school system.

In Chicago, in addition to a carefully curriculum-related schedule of sky shows, the Adler Planetarium offers the Astro-Science Workshop, a program financed by the National Science Foundation and designed to develop some of the exceptional potential scientific talent in the Greater Chicago Area. The American Museum - Hayden Planetarium in New York offers a similar program during the summer, also supported by NSF. The workshop at the Adler Planetarium, which runs through the school year, is open to high school students in the Greater Chicago Area who have demonstrated general academic excellence and have shown special ability and interest in the area of astronomy and related sciences. Fifty such students are carefully selected and meet each Saturday morning in the planetarium's classrooms with eight professors from midwestern universities with astronomy departments. On a typical Saturday, the students hear a lecture by one of the professors, followed by a discussion period and later by a laboratory session relating to the topic for the day. The objective of the course is to develop potential scientific talent under professional guidance. In the laboratory, the

students are provided with opportunities for formulating their own conclusions. Research and observatory field trips are a regular part of the workshop. Without exception, all past Astro-Science Workshop students have pursued their field of interest at the college level and have selected colleges in all sectors of the country. To aid in their college work, two scholarships have been established and are awarded to outstanding participants of the Workshop.

A program for high school students is being developed by the education supervisor at the Adler Planetarium in an attempt to adapt the planetarium's high school programs to the standard offerings in the school while adding elements especially pertinent for the planetarium with its specialized equipment and staff normally not available in the school. Several "lecture packages" would be available for selection to the school science teacher. One such package, for example, would relate to spherical trigonometry and would consist of a portrayal of the right spherical triangle and its solution using Napier's rules. Another package would relate to spectroscopy.

In Pittsburgh, the Buhl Planetarium and Institute of Popular Science has for many years offered programs in the planetarium related to the study of Latin, history, and other non-science disciplines. Some of the highlights in the year-round schedule of pre-college educational activities using the facilities at Buhl include:

(1) The Geography Show: This program stands today as Pittsburgh's vanguard for helping educators motivate students in the study of geography. The program has recently assumed new importance with the need today to teach students that the earth is a finite planet with rapidly dwindling resources.

(2) The Latin Festival: Now in its fourth decade of serving as a community voice for classical language studies, this program continues to serve annually thousands of students of Latin.

(3) The Foreign Language Festival: This newest of Buhl's numerous educational programs provides annually 10,000 students of French, German, Russian, and Spanish with a unique opportunity to further their language studies. The program includes a sky show, narrated by a native linguist in the student's particular foreign language of study.

(4) Buhl's classroom educational activities include a unique Summer Space Academy and a series of fall and winter Saturday classes.

(5) The Pittsburgh Regional School Science Fair is a large-scale, cooperative undertaking which annually mobilizes the educational, scientific, and industrial resources of the Greater Pittsburgh region to insure a continuing stream of able youths who will provide its technicians, scientists, and engineers in the years ahead. It is the annual high point of Buhl's 12-month program of science education, closely integrated with the programs of the public and parochial schools. Established by the Buhl Planetarium and Institute of Popular Science in 1940, the fair is now co-sponsored by the Pittsburgh Press, in cooperation with nearly 100 leading industries and professional societies, science teachers, radio, and local colleges and universities. The objectives of the fair -- and of its radio program, School Science Countdown -- are to discover and encourage the science potential in all students at the junior and senior high school level, and to help the exceptionally able achieve outstanding careers in science, education, and engineering. Scholarships are made available to student winners by several leading Pittsburgh universities and colleges and by industry. The range of divisions for exhibits is wide, and the fair's influence is extended to the 35,000 students and adults who visit Buhl annually to view the many student exhibits.

In New York City, over 200,000 school children visit the Hayden Planetarium each year. Discussions are presently in process to explore ways in which the planetarium might couperate even more extensively with the New York City Board of Education. The Hayden Planetarium has conducted formal courses in astronomy for young people of all ages for over a decade. Programs in astronomy for high school students have been presented since 1959, attended by some 1,500 students, a good many of whom have gone on to earn degrees in astronomy, physics, and mathematics. Plans are being developed to extend the high-school program in a modified fashion to a hitherto untapped audience of students in the New York City area.

The Hayden Planetarium is strongly oriented toward education; as well as classes for students, it conducts in-service programs for elementary-school and high-school teachers. These are extremely well attended, and the teachers in turn influence vast numbers of students at the pre-college level. Ways of expanding the offerings in these programs too, are constantly being explored.

The McDonnell Planetarium, part of St. Louis's Department of Parks, Recreation and Forestry, offers courses in the teaching of astronomy to elementary and secondary school teachers as part of its astronomy credit curriculum, in conjunction with local universities -- an unusual venture since the planetarium itself is

not actually connected with a college or university. The planetarium has held programs for adults and children for the past five years; in the current year courses are being offered to 1,400 paying students.

In addition, the planetarium presents free school programs, public star shows, etc. A free program for seventh- and eighth-graders was established last May, consisting of a series of four meetings as an introductory course to astronomy. Approximately 6,000 students have registered to attend anywhere from one to all four of the meetings in the course.

The McDonnell Planetarium in 1969 established a summer high school astronomy course enabling 15 students from various high schools to participate in class study for credit. The planetarium is now seeking accreditation from the public school system, a state prerequisite for larger enrollment in a credit course. The planetarium hopes to upgrade this program, which it considers unique, and to incorporate the Harvard Physics Project's section on astronomy. Participation by local university astronomers and physicists gives enrolled students a good opportunity not only to be exposed to the basic concepts and the cultural significance of astronomy, but also to understand and meet national leaders in the field of astronomy.

[These four planetariums represent an outlook on education not restricted to presentation of a standard seasonal display of the heavens. Pre-college scientific study in depth and working relationships with schools with science teachers, and with the community, are recognized as valid enterprises by modern planetariums, as by museums. Ed.]

Helmuth J. Naumer (Fort Worth Museum of Science & History)

Needed: An Attitude Change in Museum Education

Formal classroom education should be left where it belongs: with the school systems, both public and private. On the other hand, museums should strive not only to improve their existing programs of supplemental education but to experiment with new techniques and more creative methods of interpretation. Fortunately, museums are -- or should be -- flexible enough to implement changes readily. In addition, many are honestly searching for a role other than that of housekeeper and custodian of artifacts.

The classroom education syndrome, however, is evident in most museums for obvious reasons. The customary approach, for one thing, is a more comfortable cloak to wear, largely because it represents tradition and conformity. It follows then -- or so the traditionalist reasons -- that the public will automatically accept such an approach more readily than an experimental endeavor. Perhaps the time has come to speculate on the possibility that the average citizen is ready, indeed eager, for innovation.

One such method is the learning workshop: Here the student, in an informal atmosphere, does independent work with proper guidance. The success of this type of supplemental education is quite evident at the Forth Worth Museum of Science and History, which presently has an annual enrollment of over 6,000 individuals in its museum school, with continual waiting lists and waiting lines. These activities incidentally generate an annual income of $80,000. Teachers in the local school consistently refer students to the museum school, ample evidence of its worth and success. The real value of museum education, however, is particularly apparent when teenagers publish original works in such periodicals as Journal of Mammalogy, Herpetologica, and The Southwestern Naturalist. Many of them as well go on to productive careers in astronomy, art, biology, physics, and museology.

This museum's success is simple to understand but difficult to achieve. Basically the success relates to a particular attitude created by interested people. The entire staff imparts to the visitor or student a feeling of belonging, a sense of interest and enthusiasm that is contagious. To quote one teenage student: "At the museum you have a place where you belong, where you can learn to recognize something worthwhile . . . maybe most of all you see kids interested in the same things you are." This attitude is particularly prevalent within the museum school. Workshop instructors seem to learn with the students, but at the same time they give proper guidance and maintain discipline. The teaching staff must be generalists rather than specialists; instead

it is the students who become the specialists. This type of atmosphere lets the student set his own goal of achievement, which is limited only by available resources and his own ability. The student using the total museum as a resource has not only a larger horizon but a better understanding of an important aspect of science: the day-to-day routine necessary to any scientific endeavor.

It is imperative that the whole museum be made available for the student to draw upon: the staff, the collections, the exhibits, the specialized equipment, the laboratories, and even the dark corners. To foster this situation, the museum must be a working unit with this main goal in mind, a goal that can be achieved only by the selflessness and dedicated work of the staff. There simply is no room for the individual self-interest and pettiness that plague many museum educational programs. Basically, all must be free to create and experiment, with the understanding that all will work toward the success of a new program. Fortunately, the above is not an idealistic dream; Fort Worth watches it work daily.

Only in a museum can the relationships between man's objects and man himself best be interpreted. Museums then have the inherent quality to play an exciting and even unique role in educating the young people of this country. But to succeed they must be willing to experiment, and, perhaps above all, they must be flexible.

Gerald A. Dotson (Pacific Science Center, Seattle)

Motivational Lesson-Demonstrations in a Museum Setting

The teaching that is often done in a science museum is generally justified on the grounds that special equipment or materials -- too large, too expensive, or too difficult to handle in the ordinary school classrooms -- are available in the centralized setting of the museum. This is an important, often essential, reason to take the classes to the museum for special instruction. But there is another reason that I believe is even more compelling. It is this: in a programmatic educational sense, the museum is in a unique position within the community. With its classroom programs it can fill a void which school systems or universities are ill-equipped to do. That void is in the all-important motivational area -- exciting the stimulus to learn.

In the normal school situation, a given teacher works with the same group of students and presents a new lesson every day. Suppose we were to go about things a bit differently. Let's work with the same group of lessons and change the students every day. Museums are already changing their students daily. There are obvious benefits to the normal in-school program but what, if any, are the benefits of a situation where the roles of students and lessons are in a sense reversed? First, we have introduced a new route for feedback to improve the program. By doing each lab-lesson 30 to 50 times a year and varying the audience, much experience is gained which can be used to improve the program. Second, this improvement is made over a short period of time when compared to the in-school situation. The net result is a highly polished, well tried set of lesson-demonstrations.

What about content for this set of lesson-demonstrations? Given a wide range (in age and ability) of groups of students, and a time limitation of one to one-and-one-half hours (after which the students and the museum teacher usually do not meet again), what can the museum program hope to accomplish? Also, granted the fact that school systems and universities teach curricular material, what's left for the museum?

You can't teach much science in an hour. Maybe the museum shouldn't try to teach science. That is exactly my point! Schools do that so much better than a museum can. Instead, let the museum motivate teachers in the teaching of science and students in the learning of science. How? The polished lab-lessons mentioned above should be motivational introductions to, or within, areas of science. They should excite the students' interest and also that of the visiting teacher. After the museum lesson is complete, the visiting teacher should be given the materials necessary to capitalize on this excitement.

What do we have so far? Motivational introductory lessons

that have been highly polished by many presentations to a wide variety of audiences. We have established the type of lesson and a mechanism for perfecting the lesson, but what about a method of presentation?

In order to capitalize on the feedback inherent in the museum class visit situation the lesson-demonstrations must be highly interactive -- the student must make a contribution. Such interaction is difficult in theaters and auditoriums and with large groups of students. Ideally it should occur in small classrooms with groups of 20 to 40 students. You say that's nice -- we agree, but impossible -- think of the staffing problem. We will return to this later, but grant for a moment that it is possible to work with such small groups of students. An interactive demonstration requires that students work with materials and discover things on their own. The teacher directs the situation by asking leading questions and by providing essential background information, but the discoveries are made by the students and not by the teacher. What about the materials that students and teachers use? Elaborate? Sophisticated? After all, if we invest money in good equipment it certainly will be used. That's true. It will be used, but it will only be used in the museum. If used well it will succeed in making the visiting teacher come back next year with another group of students for the same lesson. But isn't there something more? Perhaps a better idea? Use simple equipment, overhead projectors, paper, paper clips. Use material which suggests to the visiting teacher that he can do this himself in his own classroom with his own students and maybe other students in the same school. Make him want to come back next year, not to see the same lesson (by now he has already done that lesson with his students by himself) but to learn something new.

The museum lab lessons should be motivational introductions using simple materials. For developing such programs a permanent museum staff is essential. It should also be responsible for training teacher-interns in their presentation. For why should not the same type of teachers who are bringing the students in to the museum learn to present such lessons? Why not teachers who work for the school district? That's good -- if they work for the school district, then we don't have to pay them. But why should a school district be willing to pay the teacher's salary? What does the district have to gain? Primarily, an experienced specialist in motivational lessons. In a fairly short period of time while working in the museum the teacher-intern gains much experience in working with students in a broad range of age and ability -- an experience which is difficult to achieve within the school system. While at the museum the teacher-intern also prepares a personal set of teaching materials and after one or two semesters returns to the school district. There he works with students and perhaps groups of other teachers in in-service education classes. The teacher-intern program has another advantage: it brings the permanent museum staff into direct and continuing contact with the teachers

who are supposedly benefiting from the motivational excitement brought about by a class visit to the museum.

Another aspect of this operation is the teacher workshop which is taught by the museum staff and attended by groups of local teachers. The workshop content is based on the motivational introductory lessons developed by the museum. Its format is a session in background information and the lesson itself, followed by a session in which the attending teachers make the simple demonstration apparatus and manipulative materials for their presentation of the lesson to their own students.

In the first case, students have to come into the museum to take a particular lab-lesson. After the lab-lesson has been developed and tried many times it becomes content for a teacher workshop. Now the students no longer have to come in for that particular lesson providing their teachers have attended the workshop. But teachers are still dependent on physical contact with the museum. After a particular lab-lesson has been presented in several workshops and experience has been gained in the making of equipment by teachers, then the final step can be taken. This step is publication and removes the lab-lesson from any physical contact with the museum. The lesson is now available on a national scale.

Are we cutting our own throats? Won't the museum programs being given on the outside spoil our business? On the contrary, the process from teaching students, to teaching teachers, to publication is a protracted one. From the initial conception of the museum lab-lesson to its publication takes about two years. All we have to do is stay ahead of the game by developing new materials and this makes the museum an exciting place to work. After two years of teaching a given lesson, it is questionable what more could be learned by the museum. When the museum is not learning from doing its programs (even though the students may still be learning) then the museum has made its contribution. The students can still learn from the lesson but as taught by their own teachers. Now let's start on something new.

In summary, I propose that the museum is in a unique position to develop motivational lessons and can do so much better than a school system or university, and that once such lessons are developed they not become the exclusive domain of the museum but rather that they be made widely available.

Discussion Insert

Dialogue between School and Museum

MISS RICHARD: Museums should contribute to the basic educational programs of school as well as to their supplemental programs.

MR. DOTSON: The museum is in a much better position than the school to motivate, while the school is in the best position to teach facts. The museum's advantage here includes possibly the possession of sophisticated equipment not owned by schools. Museums can offer students an experience in the museum (repeated until polished); teacher training; publication and dissemination of materials (for use in schools) arising from or related to the motivational experience.

MISS RICHARD: Classroom teachers do not know their options regarding curriculum resources. A critical problem we should consider is how museums could function to improve the teaching of science in the classrooms of schools. Museum-based regional science curriculum resource centers would be one answer. These would be places where comprehensive collections of curriculum materials were housed in a workshop setting which would permit the hands-on study of the materials. In these centers teacher training (pre-service and in-service) could be offered.

MISS SVOBODA: How do we know that what we are doing is good? How much feedback do we get?

DR. La SALLE: Schools will pay for good museum services. That's feedback.

DR. DEES: Are we doing away with museums? Is it possible to discuss the many roles of museums in light of the millions of children who flow through? How do we touch the many school districts which are not touched by museums?

DR. M. SASLOW: How do you reach the kids who are near museums but don't come?

MISS BENNETT: Since museums have something for everyone and tremendous potential for enrichment of the individual life, we cannot evaluate right away. We cannot expect instant evaluation.

DR. M. SASLOW: That's a cop-out.

MRS. KIMCHE: What kind of coordinated program of communication can be set up to inform schools of certain museum offerings?

MRS. ROGERS: Individual differences in attitudes of both schools and museums may prevent or hinder this communication. In 1966, about two-thirds of major U.S. museums had any working relationship with schools. Only eight percent of these had teachers on policy boards. This indicates that museums have got to do something to take the initiative in establishing such communication.

MISS RICHARD: The museum's role is not necessarily only supplemental. Museums should help change what is happening in schools.

MR. McKINLEY: OMSI (Oregon Museum of Science and Industry) has a separate for-profit materials corporation. Museum owns 51 percent of the stock. The corporation works with AAAS, schools, and others.

MR. DOTSON: The role of the classroom and lab at Pacific Science Center is to offer fresh educational experiences, including special things not available in schools, and replication of the single lesson (one and one-half to two hours is our maximum). You can't teach science in that time. The role should be "motivating."

MR. McKINLEY: Please differentiate.

MR. DOTSON: Teaching seems to be fact- or skill-oriented, whereas motivating deals more with attitudes.

DR. M. SASLOW: What's "motivating" mean? How can you demonstrate it?

MR. DOTSON: Motivating is helping kids develop a desire to participate in learning.

MR. McKINLEY: We have 5,000 students, 15 classrooms and 12-week sessions [at OMSI]. You can tell if the students and teachers are motivated.

MR. DOTSON: Ours are single-shot efforts. But once the kids are motivated, their teachers will take the excitement back to the schoolroom and work with it.

DR. LaSALLE: The key to effective use of the museum by schools is to work with the teachers as disciples -- that way, the museum can stay on the cutting edge.

MR. DOTSON: The teacher is the key. What better way to make the teacher a disciple than to let her watch you work with her kids? Many teachers use overhead projectors like blackboards until they see a demonstration.

DR. La SALLE: You have to build up the teacher's confidence first.

MR. KRESSE: What we do in the Children's Museum in Boston is sometimes lost because the teacher is unprepared and thus her students are unprepared for their experience in the museum. It would help if we brought her in on it first, before she brings the class to the museum.

MISS SVOBODA: Is there any basis in fact that your classes are motivating the students? Any information from the teacher? How do you know it's polished? This could tie in with [Miss Richard's idea of information-experiment] centers. Every package would have, filed with it, pre-visit data and post-visit data and feedback.

DR. La SALLE: This is the key -- evaluation. We have to live with it. The museum has always had the stigma of being thought a passive place. Change the name, not the museum.

MR. NAUMER: Don't get involved in teaching teachers; go after the powers that be --boards of education, administrative staff -- get them involved. If you succeed with the administrators then the teachers will learn to use the museum. We [Fort Worth Museum of Science and History] charge the Board of Education, and the school system evaluates us every year.

Frank Oppenheimer (The Palace of Arts and Science, San Francisco)

Some Special Features of the Exploratorium of Science, Technology, and Human Perception in the Palace of Arts and Science

Basic Rationale

The basic rationale of the Exploratorium of Science, Technology, and Human Perception involves developing a core of participatory exhibits and demonstrations that elucidate the mechanisms of human sensory perceptions involved in sight, hearing, touch, etc. During the past ten to fifteen years a wealth of material has been developed in research laboratories concerned with perception that can now readily be adapted for public perusal. This theme will provide a versatile and unifying theme for all the exhibits. For example, in illustrating how the eye registers and the brain perceives color or distance, one will be led into the basic sciences of optics, neuro-physiology and psychology. Since the arts rely on perception, illustrative examples of the arts will be appropriate. Since technology extends the domain of perception, our basic theme will also lead to the display of material on technological invention and industrial production. The implementation of this rationale will make the Exploratorium a pioneering effort in the museum field.

Integration of Art and Science

The removal of some of the cultural barriers in contemporary society will be furthered by involving artists in the displays of the Exploratorium. Today, many artists are exploring ways to portray and to use natural and technological phenomena that are not observed in everyday life. They present these phenomena in a way that is exceptionally striking and appealing. This role for the artists is not a new one although the subjects of their work frequently are novel: artists have traditionally made people more keenly aware of their environment. The fact that artists have become aware of natural phenomena that have heretofore been solely the concern of natural scientists extends the traditional role. They can truly make a vital contribution to the development and atmosphere of the Palace of Arts and Science.

Participating Demonstrations

Many educational programs now involve forms of two-dimensional, non-stoppable presentations. These forms include blackboard lectures, television programs and motion pictures. In the Exploratorium we plan to have predominately three-dimensional, manipulative exhibits. It is extremely difficult to learn about even such a simple phenomenon as producing an image with a lens

without provisions for varying the situation in order to discover what does and what does not work. Everyone has seen an image made by a projector; few people have held a lens in their hand in an attempt to cast an image on a screen. Our emphasis on participatory exhibits does not belittle the more passive and non-participatory educational programs. In fact, an important aspect of the Exploratorium will be its ability to illustrate the phenomena that have been presented in schools and in television programs and to use the material in the Exploratorium to generate films for these programs.

Involvement of Young People

There are important ways in which the operation of the Exploratorium involves people of high-school and possibly college age. We have initiated a program in which high-school students serve as "Explainers" of the exhibits to the public. The Explainers are more than guides; they are actively involved in showing both individuals and small groups how to operate and to understand the exhibits; they help build and repair material on display. Most of these students initially need instruction concerning the material in the Exploratorium. However, by immdediately using their knowledge of teaching, their learning becomes more profound and more precise. We have in this way been able to exploit a situation that teachers have invariably recognized: one truly begins to learn a subject when one tries to teach it. Our program is arranged by the school system. The students go to school for four hours a day and work for four hours a day for academic credit. They form a racially mixed group. In working here they not only make for a smoothly operating museum, but through their friends and parents they also bring to the Palace people who might not normally come. The students learn, interact with a cross-section of the urban population, obtain much-needed financial support for themselves, and become part of an endeavor that seems worthwhile and important to them.

Many young people are engaged in scientific and technological art projects either on their own or in connection with their school work. In the past, some of these projects have been exhibited briefly at science fairs. We have already found that such projects make appropriate exhibits for the Exploratorium. Young people have brought beautiful and instructive demonstrations to the Exploratorium. They can frequently be operated by the public or by the Exploratorium Explainers. In those instances where they require the loving care of their creators, they remain as passive exhibits until the creators come on weekends to demonstrate them more fully to the public. In addition, several high-school students have come to the Exploratorium with specific projects that they would like to develop and which fit with our over-all program. We encourage them, give them advice and guidance, and in some cases offer financial support. We believe that this program can and should be expanded and that the work of these young people, although frequently lacking in polish, can contribute greatly to the richness of our displays.

Exhibit Design

Many of the exhibits that we have made during the past few months have a decidedly home-made look. They are, nevertheless, aesthetically pleasing, attention-gathering, and instructive. They are surprisingly "public-proof." Obviously not all of our exhibits will be inexpensive. We hope to acquire sophisticated optical and electronic and mechanical equipment which in some instances may cost tens of thousands of dollars. As we develop worthwhile demonstration material that is not prohibitively costly, we will be performing a service not only for ourselves but we will also benefit the programs of other museums throughout the world.

As we develop our own carpentry, machine and electronic shops within the Palace, we will be in a position to design and fabricate exhibit material for the Exploratorium. In addition we will rely heavily on industry, on universities and on private and government research laboratories for the development of exhibit material. In this reliance we will follow a pattern similar to that adopted by the Deutsches Museum in Munich rather than the pattern adopted by some museums of science and industry which assign areas to specific industries such as steel or power generation which then have the full responsibility for the design and maintenance of the exhibits in these areas. This latter procedure does not always foster the highest pedagogical standards or develop the desired sense of unity. Furthermore, it leads to the development of exhibit material which is difficult to modify and improve as new ideas develop. Rather than using this technique of assigning specific areas to certain types of industry, we will consult industries with regard to their development of selected exhibits which elucidate scientific or technological phenomena that fulfill our needs and which fall within the competence of the selected developers. This procedure can provide industries with at least as much public relations service as the area assignment technique and will create a more unified and more interesting series of displays.

The Palace of Fine Arts

Although many of the special features that we are pioneering in the development of the Exploratorium will be applicable to other museums throughout the country, there is one important feature that will remain unique to San Francisco: the Palace of Fine Arts. This building and the site on which it is located contributes vitally to the success of this project. It is located on the way to the Golden Gate Bridge immediately opposite the popular Marina Green. The imaginative Maybeck architecture suggests other worlds and other times and, in itself, does much to dissolve the harsher edges of technology. The great hall in which the Exploratorium is being built forms an arc of a circle, 1000 feet long and 40 feet high, with steel girders bridging the 120-foot span of its width. With skillful design we will be able to preserve a sense of scale and openness

while creating the private and enclosed spaces that we require for some of the facilities and exhibits.

Robert Karplus (University of California, Berkeley)

The Lawrence Hall of Science

The Lawrence Hall of Science, established by The Regents of the University of California as a research center in science education, is attempting to integrate curriculum development, teacher education, and educational research with the more traditional museum functions.

The Hall opened in May 1968, so that its program is less than two years old. Its activities are multiplying rapidly and new cross-linkages between its diverse functions are being established daily. To say that the experiment is a success would be premature. One of the main reasons for an integrated program is that museum facilities support and nourish curriculum development, while curriculum development provides renewal for the museum functions. Thus, the test of the Lawrence Hall of Science idea is whether the Hall will still be a vital institution in five, ten, or twenty years.

The principal curriculum development project at the Lawrence Hall of Science is the Science Curriculum Improvement Study (SCIS) (See Karplus and Thier, 1967), which is supported by the National Science Foundation. This study has been developing sequential units in the physical and life sciences for kindergarten through sixth grade.

Teacher education at the Hall includes courses for regular University of California students working for advanced degrees or credentials, summer and in-service institutes for elementary and secondary school science teachers, and cooperative programs with school districts and junior colleges. Educational research makes use of museum facilities; interactive displays and educational carrels are now being developed. Computer, television, and film studies support the research, teaching, and museum functions. Some of the more traditional museum activities include weekday programs for secondary school students and a weekend program for the general public.

Some of the "cross-links" among the programs are the curriculum implementation through the introduction of the SCIS and other new curricula during teacher institutes; the improvement of curricula through research on the learning process with visiting school children (Karplus and Peterson, 1970); and the establishment of a climate receptive to educational change through the public program. Furthermore, curriculum and research activities provide material for doctoral candidates in several of the University's graduate programs; and these students develop curricula and build displays in the course of their doctoral work.

The integration came about because the Lawrence Hall of Science has been, from the outset, both a museum and a research unit on the Berkeley campus of the University of California, providing service for the public and for degree or certificate candidates. For an autonomous museum to integrate an existing program with a university would be much more difficult. Our experience to date, however, would suggest that it is worth the effort.

References

Robert Karplus and Herbert D. Thier, A New Look at Elementary School Science. Chicago: Rand McNally and Company, 1967.

Robert Karplus and Rita W. Peterson, "Intellectual Development Beyond the Elementary School: II. Ratio, A Survey." Berkeley: Lawrence Hall of Science, University of California, 1970.

David L. Walkington (Youth Science Center of North Orange County; and California State College, Fullerton)

The Accomplishments of the Youth Science Center of North Orange County, California, in Conducting Science Field Trips and Cooperative Programs

In 1961 a natural science center for the city of Fullerton, California, was founded. Originally named the Fullerton Youth Museum and Natural Science Center, it is now known as the Youth Science Center of North Orange County. The main objective of the organization is to provide for the youth of this area a science activity center which, through skilled leadership, planned programs, and appropriate facilities, will stimulate a greater appreciation and interest in science and conservation. To this end classes, programs, clubs, field trips, and public lectures are offered throughout the year. The center is a non-profit corporation supported by the community through memberships and donations. Membership is open to all, and the public lectures are free. This year there are over 1,700 individual members who have participated in approximately 200 classes and field trips. In North Orange County there are several large industries and aircraft companies, two colleges, one university, and five junior colleges. The scientists and science teachers employed by these establishments have generously contributed their time and facilities to teach the majority of these classes. Physicians, civil service employees, high-school and grade-school teachers, among others, have also given of their time and abilities to carry out the program of the center. It has been an inspiring and rewarding experience to see the all-out cooperation of these individuals and the coming together of their talents to present a successful and meaningful educational program. Three times a year, spring, summer, and fall, a six-week series of classes and field trips is organized. (See Appendix B for examples.) Class schedules are mailed to members and distributed to schools. Nearly all the classes fill to capacity, and many of them have to be repeated. A number of classes include laboratory activities and/or require the use of special equipment. These are held at the colleges or the industrial plants. This is usually doubly instructive, for not only does the youngster have the laboratory experience, but he also has the opportunity to see the inner workings of a large industrial and research institution or to become familiar with the college environment. He also becomes acquainted with a number of dedicated scientists whose enthusiasm for their subject often is contagious. Incidentally, a number of our volunteer teachers, who have not had the experience of teaching youngsters before, become eager to participate in our program on a continuing basis.

One of our more popular offerings is the Junior Naturalist Program for fourth through tenth grades, designed to acquaint the student with nature interpretation and the activities of a naturalist. This is a cooperative program with the Tucker Wildlife Sanctuary, which is owned and operated by California State College, Fullerton. The director and his staff at the sanctuary conduct a series of classes and field trips over a period of one year, instructing the students on the various phases of wildlife management, conservation, and nature appreciation. At the end of the program each student receives a certificate of completion making him a Junior Naturalist and is awarded a one-year membership in the Tucker Wildlife Society. This entitles him to receive the Journal of the Society and to participate in their field trips, programs, and conservation activities. This year the Junior Naturalists have started a project along with an ad hoc committee of the Youth Science Center Board of Directors to develop a nature trail in one of the city parks. The park is mostly oak woodland and has been used for nature walks by classes in our program at each level from kindergarten through junior high school.

This spring the central theme of our program will be human ecology. We will attempt to have a number of classes, field trips, and public lectures relating to the various parameters of pollution as they relate to man. We are also going to use for the first time "programmed field trips" which have been used quite successfully for a number of years at California State College, Fullerton. These are designed to allow the student to go by himself to a place of scientific interest such as a museum, zoo, arboretum, etc., and learn by directed observations. The student is given a written study guide that includes directions on how to get there and detailed instructions on what to look for at various places. At each point he must make certain observations and answer specific questions before he may move on. We hope that this type of field trip will increase the student's awareness and ability to observe while progressing at his own pace.

The Youth Science Center continually attempts to serve the community and to reach those who normally cannot or do not take part in our program as members. Scholarships have been made available through donations and by periodically setting money aside. We have made these available primarily to culturally deprived youngsters and secondarily to students who have demonstrated an interest in science but for some reason or another cannot afford to participate in our program. In addition to our public lectures, each year a number of our volunteer teachers, particularly members of our Board of Directors, have lectured and conducted classes for science clubs and PTA groups, and for grade schools and junior high schools especially in the more impoverished areas.

The physical facilities of the Youth Science Center today consist of office space and a lecture room located in a large children's center. We are looking forward to having more space someday with an area for museum preparations and exhibits in addition to lecture and laboratory rooms. Included in the facility would be materials for teacher training, particularly for elementary science education. In the past few years we have asked undergraduates and graduate students at the colleges to conduct certain Youth Science Center classes. This has been met with considerable enthusiasm among science educators as it has afforded future elementary and high school teachers much needed science teaching experience. We would like to expand this opportunity as much as possible and include the chance to work with science kits and materials, with proper supervision and instruction in their effective use.

The directors of the Youth Science Center consider the actual and potential accomplishments of our program significant in the educational endeavors of our community and submit that it represents a model to other, similar communities as to what a membership-supported museum or science center can do to further science education.

Donald P. La Salle and George C. Atamian (Talcott Mountain Science Center for Student Involvement, Avon, Connecticut)

Student Involvement: Bridging the Education Gap

There is much being said about the inquiry or discovery method of science teaching. It is refreshing to note that this method is receiving such concentrated attention, although the implications resulting from this attention are rather disturbing. One implication is that science has suddenly changed from whatever it used to be to a discovery or inquiry kind of activity, and because of this change, we in the schools had better present science in the new form it has now assumed. The basic methods have not changed, for individual discovery and inquiry have always been fundamental to science. This approach is new to the teaching of science in our schools, not to the scientists in their laboratories! It is fortunate that we are now attempting to teach in our schools the way science has always been, not the way it seems to have just suddenly become.

Science education cannot assume, as it has until now, that students have developed the beginnings of adult understanding and require only concentrated exposure to fundamental laws as embodied in current science curricula. Most students, as well as many adults, do not have the ability to organize the understanding that they have arrived at from the raw materials of experience. This ability is not acquired through the memorization of many related or unrelated facts about nature. Nor is it acquired through science curricula that merely list basic concepts the teacher is expected to convey at specific grade levels and that children are supposed to assimilate by some magical means.

In all student-oriented classroom activities the ingredients must be equipment for each youngster, the statement of a problem to which individual responses and solutions are desired, and a patient competent teacher. Within this structure new questions will arise, leading to further explorations and experiences from which other questions will be formed. The laboratory should not be considered merely as the place where questions are answered, but rather as the place where, most of the time questions are shaped. To partially fill this need is one reason the unique facility, described in the balance of this article, came into being.

The obsolescence of an anti-aircraft missile, a series of regional meetings of administrators and teachers, the difficulty of small towns in providing comprehensive science programs and the passage of a congressional bill supporting new educational ventures all played a role in the evolution of the Talcott Mountain Science Center for Student Involvement. The center's name is contrary to the presently popular rule by not being an acronym, but it does give the reader some insight into its location and purpose.

The supportive structure of the center, a basaltic extrusion 1,000 feet above sea level, bounded by a precipitous scarp on the west, while gently dipping to the east, is in itself a study in classical geology. The connective tissue is a dedicated staff comprised of highly trained, enthusiastic young men. Add to this the verve and interest exhibited by the thousands of students who come to study at the mountain, and the center begins to throb with excitement.

The elevation of the center lends itself admirably to the study of astronomy, comparative ecology, geology, meteorology, and radio communications and electronics. The location of this "school without walls" is not the only unique aspect. Instead of one telescope for a queue of eager students, there are twelve; not one fortunate student swinging a geologic hammer, but the entire class; and fifteen sling psychrometers are whirled and read by students who would normally get no closer to this instrument than hearing it spoken as part of a spelling test.

It is obvious that the byword of the center is involvement of the student. "Student" refers to those individuals in elementary through graduate school, and teachers and lay adults alike. Since the formal dedication of the center in October of 1967, more than 40,000 students have utilized its staff and facilities. Classes and special programs are conducted year round, weekdays and weekends, day and night. This degree of activity is sustained by the permanent staff of eight professional instructors, augmented by specialists from colleges, surrounding communities, and local industry. The list of consultants is quite extensive, but a name in each area should indicate the degree and quality of aid that the center has elicited during its brief existence. Individuals such as Dr. Vincent Schaefer in the area of meteorology, Dr. Thornton Page in astronomy, Dr. Joe Webb Peoples in geology, and many others have given of their time and knowledge to make the center hum at all academic levels.

The center deals with the sciences in a novel manner which has proved successful. The sciences offered are portrayed as crossing disciplines rather than as single disciplines -- interdependent, not independent. A result is the diminution of the status of titles, which so often influence individuals, and an enhancement of the role of the processes of science. Indeed, many of the individual research projects conducted by our students cross so many disciplinary lines that it becomes a challenge to describe their research with a single term. While this may be a new idea in education, it certainly is not so at the professional level, as exemplified by such hybrids as bioengineering, exobiology, astrogeology, and geochemistry.

One requirement for the effective implementation of this philosophy is science hardware. Without equipment, the center could offer only a limited view of earth and sky. With proper equipment, the earth and sky can be probed and minds prodded. Much of our equipment was provided by a Title III grant under the Elementary and Secondary Education Act, PL 59-10, and the balance was donated by private institutions and industry.

In the area of astronomy, telescopes range in aperture from a Questar, through a number of four-, six-, and eight-inch Newtonians, culminating in a 12-inch Cassegrainian by Tinsley. The latter is equipped with a filar micrometer, astro-cameras, and a photoelectric photometer. The telescope is mounted on a concrete pier, three feet in height, which permits clear access to the east and west horizon for the study of low sun phenomena.

Similarly, geology students can study collected specimens with a simple hand lens, or do their own cutting and polishing with a diamond saw and lapidary for the purpose of submitting the specimen to petrographic analysis. Meteorological investigations range from the study of local conditions recorded by instruments such as pyrheliograph and Gardner condensation nuclei counter. Nationwide weather conditions are gathered by Service C teletype. In addition, an Automatic Picture Transmission system capably receives radio signals from active orbiting satellites and converts them into fascimiles of continental cloud cover as viewed from near space. Radio communications and electronics equipment include two- and six-meter transceivers, an SCR-584 radar, a 20-foot parabolic dish used for E-M-E (Earth-Moon-Earth) communications and solar radio studies. There is also a complete 1-inch television system for classroom and telescopic work. A 120-coelostat is used to beam sunlight into a 1.5-meter Wadsworth spectrograph for solar analysis by students. The spectrograph is housed in a building with a fully equipped darkroom, to allow students to process their films.

Since space does not allow elaboration of the extensive programs offered by the center, a few examples of past and present programs may aid and suffice. In the past year, the center has:

hosted two NASA/NSTA Youth Science Congresses;

conducted continuing programs for students at all levels;

sponsored and conducted a six-week summer research program for 25 high-ability students in science from Connecticut and New York;

conducted teacher workshops, courses, orientations in all of the disciplines taught;

conducted several classes in these areas for the general community;

offered computer courses for teachers and students alike. The emphasis here was on using the computer, a LINC-8, for solving scientific problems;

sponsored an air conservation workshop for teachers.

The center is part dream and part reality. On the drawing board is a new computer facility and more student laboratories. The poet Browning put it aptly when he wrote, "A man's reach should exceed his grasp . . . ."

C. G. Screven (University of Wisconsin-Milwaukee)

The Programming and Evaluation of an Exhibit Learning System

As a learning environment, the museum has some unique advantages over conventional education, which is regarded by many as an inefficient, rigid, and restrictive system remarkably suited to discouraging curiosity, problem solving, and independent thinking. The usual museum environment, on the other hand, has no classrooms, no coercive forces, and no grades. The visitor is in an open exploratory situation moving at his own pace and on his own terms, and free to choose his own topics, develop his own solutions, and discover the consequences of his own decisions and inquiries.

Unfortunately, little is known about the museum visitor, or what happens to him, or how to go about helping him to relate to museum resources in a constructive manner. Many of the features which give museums their appeal pose serious problems for efficient communication. The museum audience is heterogeneous in age, background, interests, etc. Except for school groups, the audience is voluntary and not necessarily ready to devote time and effort to educational ends. The visitor must be "reached" while freely moving along hallways. In the museum display, it is difficult to control the order in which the visitor will view information. And the usual visitor-exhibit relationship is passive and one-way, in which the visitor's responses are often random and the exhibit remains unresponsive to them.

To make matters worse, almost all museum displays are put together by curators, artists, and other specialists with primary attention to accuracy, eye appeal, and academic integrity, but with little if any attention to whether or not the visitor actually does learn anything the exhibit is designed to teach. Displays should be viewed in terms of the visitor behaviors they elicit or intend to elicit.

Developments in the psychology of learning and motivation in recent years suggest that there is much that could be done to correct these deficiencies through self-testing and guidance systems designed to help the visitor utilize the potentials of the museum as a free access learning environment. The University of Wisconsin-Milwaukee project at the Milwaukee Public Museum, supported by a grant from the U.S. Office of Education, has been exploring such strategies over the past two years. These empirical studies of museum visitors have included automated testing systems, programmed materials, the effects on learning of individualized audio-visual guidance systems, and strategies for motivating visitors to devote time and effort to educational ends. In these

investigations, the museum exhibits have been taken "as is" -- good, bad, or indifferent -- and left unaltered in physical design. We have concentrated on programming the visitor's attention behaviors at the exhibit rather than programming the exhibit itself.

One Experiment and Its Results

The basic components of one system are diagrammed in Figure 1, below. The visitor first approaches (voluntarily) a free-standing game-like test machine and, in the process of playing it, answers a set of 12 criterion questions reflecting the instructional goal of the particular exhibit system. He then proceeds to the exhibit where he is exposed to the "learning system" consisting of three components: the physical exhibit itself, an individualized audio cassette unit which directs his attention to relevant details in the exhibit, and a portable punchboard question-feedback device on which he responds to leading questions re the exhibit objectives, receives immediate feedback, and finds he can continue only after answering questions correctly.

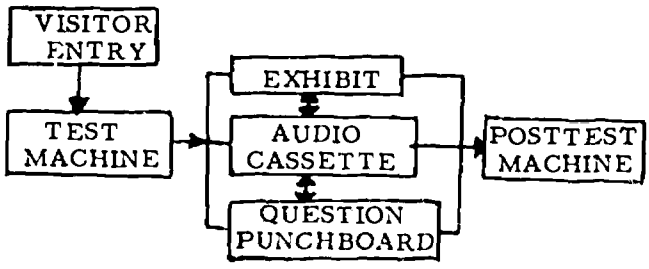

Figure 1

Figure 2 shows the game-like pretest-posttest machine used to test visitors prior to and following exposure to the different exhibit learning systems being evaluated. In order to minimize the testing experience as a possible learning situation, the visitor receives no feedback as the correctness of his choice. Questions advance immediately after any choice. A remote IBM cardpunch machine record visitor performance without his knowledge.

Figure 3 shows the cassette and punchboard devices being used by a visitor at the "Primitive Man" test exhibit. The cassette, worn over the shoulder and used with earphones, starts and stops automatically. When a question is asked, the tape stops. Punching the correct answer on the programmed question sheet with the stylus starts the tape again. Also, some lights briefly light up.

The audio usually consists of brief statements about exhibit relationships, where to look for important details, and commands to answer questions. Both the audio material and the punchboard questions were developed in terms of actual visitor performance over a series of preliminary tryouts, until error rates fell below about five percent. The stylus holes on the question sheets provide a permanent record of all visitor responses for later analysis.

Because of space limitations, we shall compare the results obtained for four exhibit learning conditions for one test exhibit -- that of "Primitive Man." However, almost identical results have been obtained from other exhibits. The four experimental conditions to be reported here consisted of:

(1) M-Condition, which used both the audio-cassette and the punchboard devices;

(2) A-Condition, which used only the audio-cassette with an identical script, but with the former punchboard questions added to the tape;

(3) E-Condition, which did not use either the audio or the punchboard; the visitor, after his pretest, was left to study the exhibit on his own without guidance or feedback; and

(4) NP-Condition, which was identical with the E-Condition except that the visitor took no pretest before going to the exhibit.

Figure 4 (next page) summarizes the results on posttest scores for two of the four experimental conditions (M and E), along with the combined performance on the pretest. The expected chance distribution is shown by the dotted curve. These curves are frequency distributions with test scores plotted against the percentage of visitors obtaining these scores.

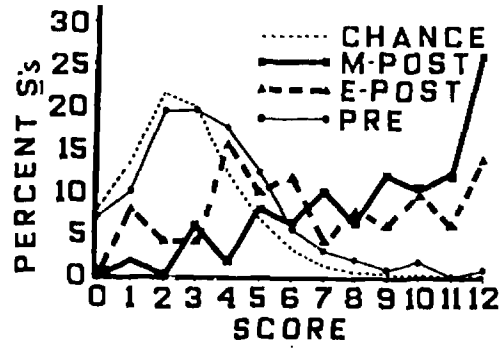

Figure 4
Frequency distributions for pretest and M and E posttest exhibit conditions

Note the similarity in Figure 4 between the expected chance distribution and the pretest distribution. The museum visitors in this sample (201 persons between 10 and 35 years of age with a median age of 14) scored about five percent above chance, thus reflecting only a small pre-exhibit knowledge of the subject matter. Along with our other studies, this pretest distribution has proved highly stable across different times of the year, different days of the week, and, to some extent, different socio-economic and age groups.

On the posttest, as may be seen in Figure 4, the M-Condition (audio with punchboard) yielded high scores for the majority of participants with almost 40 achieving a score of 92-100 percent! Dramatic improvement between pretest and posttest scores occurred in almost all visitors above 11 years of age (median score: 75%), regardless of educational or socio-economic backgrounds.

For the A-Condition (audio alone), the results (not shown in the figure) were almost identical to the M-Condition scores. Mean posttest score was 72% (median: 75%). Of course, this does not necessarily mean that audio will be as good as a programmed teaching device. This audio still involved the use of validated

programmed questions, but without the requirement of overt response.

For the E-Condition (without benefit of either audio or punchboard), posttest performance dropped sharply (to 57%) with sharp reduction in frequency of high scores (see Figure 4). However, while improvement was not as dramatic, some persons still showed significant improvement from pretest to posttest. Even without knowledge of results, the experience of the pretest provided some information re what to look for in the exhibit. This information apparently helped some visitors to "process" effectively the relevant exhibit information.

This facilitative effect of pretesting on later learning was substantiated by the results of the NP-Condition, in which no pretest was given. The frequency distribution for the NP group (not shown in the figure) closely approximated the pretest curve of Figure 4.

To obtain information concerning retention over longer periods, a second study replicated the above procedure with 67 visitors, but followed up the initial posttest with two additional test sessions at the homes of the visitors two days and 16 days later, using the same posttest questions in booklet form. Results from the 43 visitors who completed both the two-day and 16-day sessions showed no statistically significant decline in performance level for any of the exhibit conditions involved.

In conclusion, the use of programmed questions, either with the punchboard and correlated audio, or with the audio alone, was able to produce almost perfect posttest performance in over one-third of the museum participants and significant learning in a majority of the others. These results occurred in spite of wide differences in age, schooling, and socio-economic backgrounds. Without the use of these technological aids at the exhibit, or at least of the experience with the pretest prior to exhibit exposure, no relevant learning appeared to occur. The pretest experience itself, without feedback, was sufficient to result in some learning by many visitors and dramatic learning by a few.

The fact that some visitors are able to learn simply by taking a pretest opens up some interesting possibilities for relatively low-cost, simple learning systems for museum applications. Programmed exhibits using audio, or audio-visual responsive systems, while very effective, are also very costly and probably unfeasible for most museum budgets. However, if visitors are able to "program" their own input effectively from existing exhibits, on their own time simply after trying to answer pre-exhibit test questions, then some interesting economical approaches are possible.

Another Experimental Setup

One such approach now being tested in the Milwaukee project uses the self-testing machine shown in Figure 5. This machine is operated by coin or token and has been modified from a machine commercially available from a Milwaukee manufacturer.[1] The visitor freely approaches the machine and for ten cents receives a five-question "game" (representing a sample from a larger pool of 100 or more similar criterion questions on a given exhibit subject-matter). The player scores 100 points on a counter for each question answered correctly on the first try; correct answers also produce green lights, a bell, and the chance to advance to the next question. There are a buzzer and a red light for wrong choices. The system is designed to encourage a visitor to go to the nearby exhibit, study it, and return to the machine to try for a better score, again visit the exhibit, and so on. To do this, the player receives a free-play token at the end of his first game regardless of his total score. The token reads, "One Free Play; Study Exhibit & Try Again!" On subsequent plays, however, he must achieve at least one-half of the top score (i.e. answer correctly half of the questions) to receive free-play tokens. If he achieves a perfect score on any game he receives a special "expert medal" with "Museum Expert" printed on it. Thus the machine not only provides pretest information but also motivates the visitor to "recirculate" through the exhibit repeatedly while he is trying to achieve a perfect score and a gold "expert medal."

The visitor in this system must do his own processing of exhibit information, using knowledge gained from successive games to guide his study of the exhibit. The chance to win tokens to play the machine and ultimately to win a take-home "expert" prize are common motivators for most persons, including museum visitors. Since these rewards are contingent upon the visitor's engaging in relevant observation and learning behavior at the exhibit, we expect the motivation they generate will produce useful learning. Exactly what will be learned, and how useful it is, will of course depend upon the exhibit, the nature of the questions asked, and the relevance of the questions to what is actually available at the exhibit.

Most important, however, is that such unsupervised systems could become a part of the normal exploratory behavior of the museum visitor, a part of a total learning environment to which the visitor may relate and interrelate on his own terms!

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[1] Model 106 manufactured by Nutting Industries, Ltd., 3404 N. Holton, Milwaukee, Wisconsin.

While there are still many things to be learned concerning the potentials of the museum as a free access learning environment, and certainly many improvements to be made in the systems we are testing in the Milwaukee project, we are encouraged that museums can indeed serve effective educational purposes -- that the voluntary museum visitor can obtain substantive new knowledge from his museum experience, and can be motivated, at least under special circumstances, to devote considerable effort to such ends.

Discussion Insert

Can You Measure Open Education?

DR. C. SASLOW: It's harder to program people to get information from a bad exhibit than from a good one.

DR. LEE: You could use the kind of experiment Dr. Screven has described to study exhibit effectiveness too.

DR. WITTLIN: It would be interesting to take a group which has gone through this experimental program and a group which hasn't, and compare reactions to an open learning situation. Might this kind of pushing and pushing not kill initiative on the part of the learners?

DR. SCREVEN: You can aim the program specifically to elicit or teach initiative. The program described was aimed at making the visitor observant while going through the exhibit.

DR. C. SASLOW: An experiment doesn't have to be long or complex -- you can do a short or incomplete experiment, but you do have to know what you want to do. For example, with "motivational lessons" like Pacific Science Center's, it's important to specify (to yourself as experimenter or designer) what it is you want a motivated visitor or student to be able to do. The key to good evaluation is to specify the objectives at the outset. If you've set up what you want to find or test, well from the beginning, you get feedback and can modify as you go along. What kind of learning situation is appropriate to museums? Pacific Science Center's short and repeated museum courses seem to compete with schools. Also most of the courses described at this conference seem to be "creaming" -- Brooklyn Children's Museum (MUSE) excepted -- getting middle and upper-middle-class kids whose parents can afford the classes and the transportation.

DR. La SALLE: Museums often have staff and equipment with expertise which a school doesn't have. There is also the question of quality versus quantity -- at Talcott Mountain Science Center we'd rather teach a smaller number well than run through a large number who learn not much.

MR. McKINLEY: We repeat classes because the schools have asked us to. "Education Outreach" brings Negro kids to OMSI for a guided tour, three times a year.

DR. C. SASLOW: Kids surveyed [see contribution of Mr. Steven Saslow, in text] about what they see in museums said "dead things and stuff."

DR. NETTING: How many museums have the old-fashioned science contest (not science fair), giving prizes for answering questions on a test on a given Saturday?

DR. La SALLE: A real measure of a program is how many kids come back again and again. Motivation wears off when nothing follows the turn-on. Learning has to be much more than just a shot in the arm -- the tour lecture palls after you've heard the same thing a couple of times.

DR. C. SASLOW: But can museums get grants to develop pre-visit and follow-up teaching programs?

DR. HAUSMAN: Dr. Saslow's describing the lower level of interest in programs. Some have described the upper limit -- what is the average?

DR. C. SASLOW: Some of OMSI's programs might be aimed at lower-middle-class kids, but they aren't reaching those kids. Provision for getting kids to the museum when they can't afford their own transportation is inadequate in a number of museums. Museums could provide busses or come up with some other workable solution to this problem.

DR. La SALLE: It's difficult for museums when they try to serve two different kinds of audience at once.

MISS RICHARD: There's a tendency to think that more can be learned from a trip to a museum *if adequate classroom preparation* is given in advance than from a trip without preparation. But follow-up activities may be even more important, especially if the museum experience can be open-ended. How nice it would be if, after looking at an artificial sky in a planetarium, children would return home wanting to look at the real sky! What can we do to get kids hooked, so that when they leave museums they keep on learning?

DR. NETTING: Free nature movies draw kids to the Carnegie Museum, in which they have to walk through exhibit halls to get to the movie.

DR. C. SASLOW: Adams High School kids in Portland (surveyed) didn't want to go to a museum, but wanted to start their own museum, do their own collecting, etc.

MR. McKINLEY: It's hard to get funding for buildings with overhead costs as compared to educational programs.

MR. COLSON: My experiments involving teaching principles of light and color through the fourth, fifth, and sixth grades in three Fairfax County schools in Virginia [see Mr. Colson's contribution in text]. Based on this experience, if you were trying

to work through the schools, I would recommend:

(1) Ignore the teacher.

(2) Ignore curriculum coordination.

(3) Operate by putting your apparatus shell in the school and rotate the apparatus through it; follow it up with an exhibit in the museum. Give the teacher a cop-out to save his ego -- even though you know about this, pretend to the kids you don't. But don't involve the teacher.

(4) Intersperse museum visits with the rotation program through the schools.

DR. HAUSMAN: If you're ignoring the school curriculum, why have this unit on light if it's not something the school wants the students to learn? The problem is one of definition: "Curriculum" has to be broadened in people's minds to include the museum's working from within the schools -- cooperation is possible.

MR. TAYLOR: Mr. Colson found in textbooks words and concepts which the teachers had no way of demonstrating either in the classroom or on the playground. This apparatus demonstrates the principles of physics kids have never seen.

MR. KRESSE: We've found that if you present something well that the teacher can't supply, she will welcome it and find a way to justify its incorporation into her classroom schedule.

Teachers don't have to be circumvented -- the Children's Museum tried working around the teacher at first and then decided to design materials to make the learning enterprise satisfying for everyone in the classroom, including the teacher. This is a method for museums' becoming a change agent in the schools.

MR. COLSON: Teachers in Fairfax County schools did in fact participate although not told to.

MISS RICHARD: If museums are to contribute to the education of children in more than a one-shot way, they must affect what is being taught in schools and how it is being taught. Teachers are a major audience museums must reach. For every teacher that is affected, 30 or more children are potentially reached each year. This is a significantly larger number of children than museums can reach directly.

Again, I should like to propose that museums establish regional curriculum resource centers. As I suggested before, these would contain a complete range of science curriculum materials -- book and non-book -- in a workshop setting which would permit the

hands-on study of these materials. The collection of materials could be more current and comprehensive than individual schools and colleges within the region could maintain, considering the cost of the materials and the staff requirements. The center would function as a regional information cleaninghouse on new programs and curriculum developments in science education. It would be the central place where publishers and suppliers would put their materials for review. The goal of the center would be to inform educators and the public about the rich curriculum resources that are available today.

One reason why new programs and supplemental resources are not introduced in schools is that educators do not know about them. Another reason is that classroom teachers are not asked to participate in the selection of the things they teach. Too often, teachers merely administer curriculum change in their own classrooms. Not having been involved in the selection process, they introduce change without emotional commitment to that change. The result is that "new science" and "new mathematics" get taught as "old science" and "old mathematics."

Teachers need to be involved in the selection process and they need the opportunity to study in depth the programs they choose to teach before they begin to teach them. Museums could provide the setting where this could be done -- the setting where individual teachers and curriculum teams could review curriculum programs and supplemental resources and, from these, could design programs for their own situations. Museums might even provide shop facilities where individual teachers could construct materials to be used in their own classrooms. Administrators too could use the center to become more familiar with alternative programs, and thus they would be better informed and in a stronger position to let their own faculty make the actual curricular decisions.

Museums are ideal places to set up curriculum resource centers because they are not part of the school system, and they are free of commerical publisher affiliations. Furthermore, museums have qualified professional staff who can function in an advisory capacity. The museum's educational program might also be changed if museums were to assume this role: they might become more reflective of new educational developments than they usually are now.

DR. OPPENHEIMER: We tried to set up something like this in the San Francisco Palace of Arts and Science. Although we got verbal encouragement from funding agencies, the school district administration was hostile to the idea and wanted to set up its own.

MISS RICHARD: No, you can't do this through the schools -- funding should be applied for separately. Museums should provide the service which the schools can then choose to use or not to use. To be able to choose makes the decision more of a commitment. Schools should have their own resource centers, but oftentimes they do not. Furthermore, they cannot afford to have comprehensive centers. If museums could provide the comprehensive resource collection, then schools could build more selective collections for their own use.

III.

POSSIBILITIES FOR FUTURE USES OF THE MUSEUM AS AN EDUCATIONAL RESOURCE

Emily Richard (CEMREL, Inc.: Central Midwestern Regional Educational Laboratory, Inc., St. Ann, Missouri)

Museums as Regional Science Curriculum Resource Centers

This conference has been called to consider the role of museums in pre-college science education. The letter of invitation to participate in the conference and the preliminary conference agenda suggest that museums consider their primary educational function to be the development of exhibits and educational programs of schools. If museums wish to make a broader contribution to pre-college science education, they should initiate programs designed to improve the quality of the basic educational programs of schools. These are the programs which affect all children. I propose that museums do this by establishing regional science curriculum resource centers. I shall discuss this proposal in terms of elementary science education.

During the last ten years, many millions of dollars have been spent on the improvement of elementary science education by the federal government, industry, and private foundations. Comprehensive new curriculum programs have been developed and continue to be developed. Excellent supplementary materials -- book and non-book -- have been prepared. Effective programs and training materials for pre-service and in-service teacher education have been designed. Capable, though limited, schemes for the dissemination of new programs have been demonstrated. Yet the majority of the nation's elementary school children -- often sitting in rows and threatened by grades -- continue to "learn science" by memorizing facts presented by traditional textbooks and by teachers unaware of current opportunities in science education. Even in classrooms where individual differences are respected and where children are encouraged to question and to pursue interests of their own, science may still be taught as fact or not taught at all. Why have the curriculum developments of recent years been enjoyed by so few elementary school teachers and children?

The reasons are many and complex. I shall mention only three:

(1) The Consumer Does Not Know His Options. Although there are excellent curriculum programs and supplementary resources available, the consumer (the educator) does not know about them except in a very incomplete and superficial way. The Sixth Annual Report (1968) of the International Clearinghouse on Science and Mathematics Curricular Developments indexes nearly 30 elementary science curriculum improvement projects in the United States. Many options are open to educators but if they are unaware of them they cannot choose them.

(2) The Classroom Teacher Does Not Participate in The Curriculum Decision-Making Process. The classroom teacher is not asked by administrators, except in token ways, to assume a responsible role in the curricular and instructional decisions which affect what he teaches. Thus, when innovations are introduced, he often has no commitment to them and does not change. "New" science becomes "old" science -- or no science at all.

(3) The Richness of the New Science Programs Has Obstructed Their Implementation. Not only are there new alternatives (AAAS, ESS, Minnemast, SCIS, et al.) to the traditional textbook programs, but each of these alternative programs is itself complex. The programs are expensive, require teacher training, and may demand new facilities. Most administrators and teachers have been unable to study these programs in detail prior to purchase. Information concerning the programs -- their history, philosophy, content, evaluation, cost, implementation requirements -- has not been available from a single source until the recent publication of The Elementary Science Integrated Information Unit, developed by the Far West Laboratory for Educational Research and Development. Curriculum decisions have been made in many situations, without sufficient data.

The establishment of regional science resource centers is an essential first step toward the solution of this problem. The Central Midwestern Regional Educational Laboratory, Inc. (CEMREL, Inc.) is studying the feasibility of establishing such a center in St. Louis. The addition of a science resource center to a science museum would surely be welcome in many communities. Teachers and administrators usually have a positive orientation toward museums. They offer them teaching opportunities which are not available in the classroom. It would be an easy step for teachers to turn to the science museum as a curriculum resource and information center. Museums are usually free of university affiliations, the profit motive, and program or publisher commitments. They are in an excellent position to provide the kinds of information and services to educators and to the public which could help upgrade the quality of in-service and pre-service teacher education, as well as the quality of the basic educational programs of the schools in their region.

A truly valuable regional science center would contain comprehensive collections of science curriculum materials: books, worksheets, equipment, films, and other teaching materials. The center would provide an informal setting for the hands-on investigation of curriculum materials. Individuals and groups of teachers and children could use the center to search for supplementary materials, to examine and consider alternative programs for adoption, or to construct programs from the

available resources to meet the needs of their own schools. I picture something far more extensive than tables interspersed between shelves of books and packaged materials. I suggest generous amounts of open space which can be structured according to demands and which can house a wide range of types of curricular materials. Among these materials would be sandboxes, water-tables, inclined planes, pendula, balance boards, and plants and animals which can be easily maintained in the classroom. There would be facilities for review of audiovisual materials and for experimentation in the design of multi-media programs. There would also be a shop where teachers and children could build equipment for their classrooms. In addition, provision might be made for the display of architectural blueprints and mock-ups of innovative classrooms and science teaching materials.

If educators and the public are to make informed curriculum choices, they must have the opportunity to study the curriculum options. Curriculum resource centers located in museums would provide that opportunity.

Frederick H. Kresse (The Children's Museum, Boston)

Some Thoughts on the Museum as a Learning Research Laboratory

The following thoughts are based on a recent brainstorming session I held with Mike Spock, Cynthia Cole, and Betty Nicol of the Children's Museum, and George Moore from Wellesley, and also upon about five years of talk and thought in which the concept of a laboratory museum has been evolving. What we concluded the other day was that museums, by their nature, are places where unique and important kinds of learning research can be conducted. Museums are places with at least the following characteristics:

Lots of kids can be found every day in various groupings and with various significant adults.

Museum environments are dense with a wide assortment of objects, images, concepts, experiences, etc., drawn from all over man's world. They are rich with possibilities.

The child can explore the museum environment any way he wants in response to his own interests and urgings. There is usually no structured learning mode or sequence.

The kinds of experiences available center on the use of real pieces of the world.

The diversity of media makes it possible -- although it's not always permitted, either by the museum or by an accompanying adult -- for the child to make a wide range of responses, many of which may be new or rarely aroused elsewhere.

Learning in museums is self-regulated and associated with fun, and usually the museum has no curriculum axe to grind.

Museums are neutral educational turf, with close connections to the schools and looser connections to other educational institutions.

Because of these characteristics, museums are good places to conduct research of the following kinds:

Research on attention: How is attention established, maintained, interrupted? What is the relationship between attention and retention? Is attention-span a myth or a reality? How is learning momentum sustained?

What roles do real objects play in learning? Consider the impact of "realness"; the role of the external model as a feedback mechanism to the learner; the relation of concrete experience to symbolic behavior; objects as initiators of learning.

The orienting, exploring, migratory and feeding behavior of the learner in an open situation is very interesting and subject to study. What happens when the children come in, where do they go, what influences their choices, how do they select their own resources?

What characterizes various types of joint museum-school learning systems?

Research on and development of curriculum materials.

Research on and development of new kinds of performance measures and techniques for observing and measuring learning (e.g., unobtrusive measures).

Observation and study of adult/child and child/child interactions in learning.

Investigation of the patterning of experience: random vs. controlled sequences; integrated vs. separated subject matter; the relationship between intake periods and periods of rest or exercise.

Research on strategies for training teachers and other agents of educational continuity and change.

Research on the role of the learning context and on information distribution among elements in the learning situation, the exhibit, the learner himself, the staff member, the activity in which the learner is engaged.

Research on the nature of the "meaningful encounter" with a real object -- the "Ah ha!" experience. Are there stages of learning, such as attention, intake, disorganization, integration?

What is the role of response in learning? Can new response possibilities be developed to "bring out" the child?

Research to help us know the child's mind: diagnostic experiences and the development of new, more responsive staffing and mediating strategies.

Research on the effect of various spatial contexts on learning, pace, attention, etc.

As far as we know, museums have not done much along these lines. If they do, they will find themselves working with schools, architects, psychologists, curriculum developers, schools of education, etc. As they do, they will probably find themselves changing their styles and formats in terms of space utilization, duration of contact, flexibility, staffing, etc. But, given what museums are like, all of this is possible. Perhaps the most fundamental changes needed will be a commitment to listening to and serving the real needs of the audience, and a perception of the learner as being a responsible producer of his own learning.

Robert S. Lee (IBM Corporation, New York)

Toward Social Science Education in Museums

The great strength of the museum as an educational institution is that visitors are free to explore and to discover things on their own in an environment where they can have direct experiences that are enjoyable and that also serve their needs for intellectual and cultural growth. This self-directed learning resembles learning from life. It can therefore be deeply personal, rich, and highly rewarding.

The museum appears to be a singularly appropriate place for the next major advance in educational technology. It is already a free-access exploratory environment, and because of this, museum people who understand this type of learning situation are already in a good position to extend greatly and magnify its value with responsive computers. Schools, on the other hand, may find it difficult to work with a technology based on these concepts because they have a strong book-centered didactic tradition that runs counter to the idea of self-initiated learning from direct environmental experiences.

With the aid of the computer, the science museum of the future would be able to extend its coverage to the various social sciences. We may eventually see museum halls devoted to disciplines such as economics, psychology, history and political science. As an illustration of how this can be done, I would like to present an example of a simulation-type exhibit that might be developed in sociology -- a field that does not normally lend itself to museum exhibiting.

One of the serious problems in the teaching of social studies is that unlike the physical sciences, there is no laboratory in the school where the student can directly deal with the phenomena to become familiar with them and to test out various hypotheses.

At Johns Hopkins, James Coleman and his colleagues are developing an academic game designed to show how people's lives are affected by certain sociological conditions and by key decisions that they make for themselves.

The current version of the "Life Careers Game" is played without a computer -- with the computer it could become a highly powerful museum exhibit. Two or three visitors would play the game together as a team. They are given certain information about the background and interests of a boy named Mike from a low-income family. The players make decisions for Mike -- whether he stays in school or takes a job, how he allocates his time to various activities, whether he marries the girl or doesn't and so forth. The game starts when the boy is 16 years old and

continues in cycles for 20 years. The purpose is to get as many life satisfaction points as possible for Mike over the twenty-year period.

After each yearly decision cycle, the computer would calculate Mike's satisfaction points based on actual sociological data collected in various empirical studies. While the outcome would depend on scientifically established probabilities, certain chance factors would also be incorporated to make the game realistic. In addition, the players could get dramatic feedback as to what happens to Mike as a result of their decisions through filmstrips and audio, or by means of short movie segments.

The significance of this type of simulation as a learning situation is that, after a particular game, the players could try again to see if they can make better decisions to gain more life satisfaction points for Mike. One team of players, for example, discovered that they could have Mike join the Army and exploit the Army's evening educational resources. In this way, they gave him training for an occupation that would otherwise be beyond his reach. This difficult but not unrealistic life path was wholly unanticipated by the authors of the game.

Another way the simulation could be used is to have the players manage the lives of different kinds of people -- an upper-class girl with career interests, a disadvantaged youngster with musical talent, and so forth. Through such simulation game experiences, it is possible to learn something about the possibilities, the constraints, and the realities that affect the life chances of people at different positions in society. In effect, this type of computer-based exhibit will allow the museum visitor to explore the nation's social structure.

To see what potential there might be for information-retrieval-type exhibits, we have experimented in a preliminary way with an exhibit on the anthropology of Ceylon. Here, the visitor is presented with a map on which the island's seven cultural regions are delineated. To find out something about a given region, the visitor touches that section of the map and also one of a number of buttons to select a topic that may be of interest such as the economy, the people, daily life, or religion. Immediately following each selection, one, or a short series of color slides would be projected accompanied by the music of Ceylon.

Occasionally, a multiple-screen presentation could be given showing the highly colorful religious festivals of that region. If the visitor chooses, he might press another button to call in a short audio commentary on the slide presentation.

The visitor has the option to explore one topic such as the economy by comparing the seven different regions. Or, he can stay with a single region and explore it as an entity in terms of the different topics of interest.

This sort of approach, of course, requires modern technology -- hundreds of quickly accessible slides and audio segments would be required for the exhibit to be continually rich and open-ended. An interesting feature of this format is its great flexibility. If properly designed, it should be easy to change the slides and the audio segments. This means that such an exhibit not only could be modified and updated, but that it could be completely transformed without any major change in physical construction or in the computer program. The Ceylon exhibit, for example, could be converted into an information retrieval exhibit on how a number of major artists or periods of art have handled various classical subjects such as still life, portraits, landscapes, and the nude. It also should be possible to easily reproduce the slides, audio segments and the computer program so that the exhibit can be exported to other museums with parallel computer-based exhibit stations.

We have seen only the beginning of what the museum can be as a learning environment. My own view is that the museum is a seriously underdeveloped national educational resource -- that with a major research and development effort aimed at exploiting the electronic computer, we can turn our museums into highly powerful centers of popular learning that can complement our schools and that can advance significantly the nation's cultural development.

Robert W. Lamson (National Science Foundation, Washington, D.C.)

Museums, Science Education and the Wise Use of Our Science and Technology

The fundamental problem and need which we face today is to use wisely the understanding and power which our science and technology create. Our scientific understanding can be transformed into technological power to manipulate nature, man and society. And this power is and can be used to cause as well as to cure many of the social problems which we confront today, in the United States and in the world. The lessons which we teach through science education and through museums will help to determine whether we use this scientific understanding and technological power wisely.

Museums, therefore, have an important role to play in conveying to youth, as well as to adults, a perception of:

(1) the social implications of the scientific knowledge and technological power which we are acquiring;

(2) the many social problems which confront us, for example, defense, population, environment;

(3) a range of alternate solutions to these problems and the relation of the individual to each solution; and

(4) the costs and benefits associated with each solution, and for whom.

There exists a need to translate the results of technology assessment and science policy analysis into action. If we are to fill this need, we must create systems and methods for pumping the results of analysis into the policy process at various levels and to transmit the results of policy analysis to the potential user, whether the user be a policy maker in government, in private organizations or the individual citizen himself.

Many methods are available, for example:

(1) information collection, storage and dissemination systems for the documents which are generated by the analyst. The Smithsonian Institution's Science Information Exchange is an example of this. Often it seems that such systems are of most value to the research community since the policy maker and the public tend not to read research reports;

(2) conferences;

(3) internships for the student and analyst to work as or with policy makers;

(4) training programs for the policy maker to study with the analyst;

(5) testimony and advice by the analyst;

(6) analyst as policy maker;

(7) use of the media -- movies, TV, radio, press -- science policy writing;

(8) physical exhibits (mobile or not) in museums, libraries, arboretums, zoos, Expo 67, Expo 70.

A useful way to bridge the gap between analysis and action, in addition to written reports, is to create exhibits which attempt: (a) to portray the results of the analysis of the problem, and (b) to indicate the range of choices for the future, leaving the choice of alternatives up to the observer of the exhibit -- that is, the policy maker and the citizen.

An important untapped resource for creating and maintaining such exhibits are the museums of America. However, most museums to date have not yet fully exploited their potential for developing exhibits which attempt to portray for the public the nature of various critical problems of technology assessment and science policy which confront the nation and the world, as well as the options for possibly solving these problems.

To date, many museum exhibits have been characterized by the following faults:

(1) They have tended to reflect common ideologies concerning the relation between progress and technological development, or between the increase in value and the increase man's technological power to affect nature, society, and man.

(2) Museum exhibits have tended to treat the development and history of technology as an extension of biological evolution, with the displays of hardware (automobiles, steam engines, aircraft, missiles, etc.) paralleling, for example, the displays of skeletons of horses throughout history. As a result of the portrayal of a certain historical determinism and inevitability in such displays, the viewer of the exhibit tends not to obtain a sense that there were human decisions and policy choices involved in the past development of technology, that there will be in the future, and that there are elements or areas of freedom within which one can

decide not to develop technology in certain areas, or to deflect technology in particular directions. The general lesson taught by such exhibits is that the particular trend of technology portrayed is good as well as inevitable. Such a portrayal, in turn, tends to generate a self-fulfilling prophecy. We tend to teach the public that particular technological trends are inevitable. This, in turn, reduces any effort to analyze, evaluate, and change these trends, thereby making the trend more inevitable and confirming the impression that the trend is inevitable.

(3) Museum exhibits have tended not to portray the various problems associated with technology: for example, population, environment, resources, national security and arms control, bio-medical engineering, drugs, transportation, communication, urban problems.

(4) When they have dealt with such problems, they have tended to present only the problem, and not to portray a range of alternative solutions, along with the probable good and bad effects of each.

If we are to raise the level of public understanding and debate of policy problems and alternatives related to the use of technology, then the museums of America have an important role to play -- in cooperation with the policy analyst in universities and thinktanks -- a role with has to date been greatly neglected. There is, therefore, a need to develop links between policy analysts in universities and thinktanks, and the creators of exhibits.

Specific problems concerning which greater understanding of issues and alternatives is needed by policy makers, youth, and the public, include the following:

national security and arms control;

population growth and its interaction with problems of environment, resources, waste management, economic development, welfare and poverty;

bio-medical engineering and drugs;

urban problems, city planning, transportation and communication.

Care must be taken in developing such exhibits that they remain neutral and analytical and do not become propaganda: that they present alternatives and consequences from among which the policy maker and the public (youth and adults) can choose; and that they do not end in advocating one particular course of action or solution.

Discussion Insert

Museums in Changing Communities

DR. LAMSON expressed the view that museums should create and present exhibits on leading public policy problems.

DR. OPPENHEIMER questioned the feasibility of inflexible social planning in museums, arguing instead that our greatest need was for a tolerant, adaptive public willing to correct mistakes.

DR. DEES inquired about programs serving the disadvantaged.

MR. RANDALL described a program to bring nuclear science to poorer neighborhoods in Atlanta; he noted its popularity but voiced doubt that high costs would permit the project to continue.

DR. SCHEELE described the overlapping and conflicting complexes of educational service establishments (twelve planetaria!) in the Cleveland region. He contended that concentration on inner city schools was jeopardizing the pattern of support for some major museum-like organizations.

DR. DEES asked participants to consider whether or not museums had really exhausted their traditional roles. Was innovation really necessary? Were traditional programs really obsolete?

MISS RICHARD asked if museums which offer objects on shelves are really offering relevant displays. They are doing the same kind of thing they have always done. This may not be the most effective thing they could be doing. Hands-on displays would be far more effective in many situations.

DR. OPPENHEIMER: Museums could once adequately summarize the culture and science of their day. Pointing to numerous curriculum improvement projects, he doubted that the schools alone could meet their obligations in this direction.

MR. GLOBUS described the Museum of the Media, a response to the scarcity and expense of objects, which will deal with much more readily circulated visual and auditory experiences. The object is often divorced from its context. The real question is whether the museum passively displays information or tries actively to present contexts.

DR. RITTERBUSH professed to see the characteristic limitation on the traditional museum venture as being to offer objects out of context, which drains them of meaning. The problem is not simply that museums no longer successfully transmit culture. Rather, there is no secure culture to be transmitted. It can only be invented through shared participatory responses of viewers. The museum of the future will be a place where people will go to learn together and create their culture through pageantry, participation and popularization of knowledge.

DR. SCREVEN espoused a systems approach linking performance evaluation to explicit objectives. People seem to learn more if they have advance cues reinforced by technological aids.

DR. LEE: Consider the museum as a collection of specialized resources which can foster learning experiences.

DR. OPPENHEIMER: Objects alone aren't the indispensable factor in museums. People can most readily find objects in stores and are fascinated by window-shopping, but they don't learn in the way you want. In a museum a knowledgeable person can communicate the interrelationship of the objects.

MR. KRESSE: Museums ought to be responsive to what people want to learn rather than be vehicles for a teaching program. The object confronts you with realness where you previously had only second-hand knowledge. Second, you can pursue routines which can only be undertaken in the object's presence.

MR. SHAUGHNESSY: Described the Parkway Program in Philadelphia -- a high school "without walls" that started with 200 students in 1968 and has grown to 600 students now, aimed at utilizing the museums and institutes along the Benjamin Franklin Parkway. [See also contribution by Mr. John Bremer, elsewhere in this report.] Within the Academy of Natural Sciences facilities and collections have been used for biology and physics. Recently the Parkway Program has offered its participants lectures rather than the use of collections.

DR. DEES: Returning to Dr. Lamson's point, wouldn't it help to forestall obsolescence if museums deliberately sought to predict future problems? I mention genetic engineering, for example.

MR. HEZEKIAH: Daring -- experimentation -- innovating -- backbone. We [MUSE] offer free musical instruction in 24 categories -- free classes -- also in art, aviation, etc., etc. All ethnic groups represented in location. Take-home collection project -- people can borrow objects, as in a library. Not much vandalism. Planetarium -- Program activities for 90 percent of programs -- but children can lead the programs. Teachers are often not very happy about that. In 1970's, plan training program for teachers to mediate between kids and curators.

Hope to bring in for two-hour periods, have curators throughout the building; have kids wander about and talk to curators -- live musicians too. Also will bring kids back after kids talk about what was meaningful to them -- explore that area in depth -- live animals -- kids get involved in their care too. Hold workshops in creative writing and then publish the writing.

Exhibit on rats as an offshoot of Anacostia Museum's idea -- inform, excite, disturb the public -- to educate the public -- tying historical concept of rats, plague, etc., in with present-day problems -- U.S., local, New York, Brooklyn problems.

Exhibit on architecture of the immediate neighborhood of Bedford-Stuyvesant and Crown Heights areas -- former glory and current ghetto. MUSE is doing and planning exhibits on garbage, abandoned autos, etc. -- exhibits with social relevance.

Most popular in take-home collections have been mounted birds and animals, paintings, insects.

Pratt Institute is using MUSE as a workshop lab -- Pratt students have designed the entire rat exhibit, designing brochures, etc.

Workshop teachers are all paid and working professional people, not volunteers. It's an insult to ask professional people to volunteer their time.

Museum hours --10 A.M. to 10 P.M. -- the only New York museum with these hours.

Museum staff can't relate to kids as well as school teachers can because they don't see them as often.

DR. WITTLIN: There are more adults relating to children in kindergarten than from first grade on. It's a relief for kids -- for anyone -- to relate to more than one adult all day, all week long.

DR. La SALLE: New Haven public schools and hospitals are training kids for careers in allied health fields. Museums could do more in getting kids interested in health and infestation problems -- e.g., even by care and feeding of laboratory rats and mice.

MISS WARD: How about letting kids help in planning some of the exhibits along with Pratt people? Also help with surveys.

MR. HEZEKIAH: A good idea.

MR. TAYLOR: Anacostia kids built a model of Anacostia neighborhoods.

MR. HEZEKIAH: The name "MUSE" was a kid's suggestion -- but also pertinent to weaving together of all the allied art -- because couldn't call it a museum because of the location.

[Discussion of "museum" as an archaic word.]

MR. DIXON: But we should know what we want to do -- maybe a science center and a museum are different.

MR. McKINLEY: OMSI was named by public because the full name was too long to say.

DR. KORMONDY: Museum is not just responding, it's leading, as described by Mr. Hezekiah. Maybe to be part of present-day life, a museum must lead rather than simply responding to demands.

DR. La SALLE: Maybe leadership is a way of responding to demands of present-day society.

DR. KORMONDY: Response is simply stating, "This is the problem." Leadership is presenting the problem and suggesting solutions, going beyond the immediate response.

DR. La SALLE: If you're not part of the solution, you're part of the problem.

MR. LOVE: Oakland had an exhibit on population control saying this very thing. Also exhibits on ecology movement which is centered around Oakland.

DR. WITTLIN: Leadership relates to matters of social significance, which was not always an acceptable position for a museum to take.

Suggest a string of exhibitions on housing and housing problems -- we have the technology, the idle manpower, etc., to provide adequate housing, but we also have inertia and union problems.

DR. KORMONDY: Maybe the exhibitors' ideas of social significance differ from those of the [museums'] boards which allocate the money.

MR. McKINLEY: Boards are pretty much with it these days.

DR. WITTLIN/MR. HEZEKIAH: Get young people on the boards of directors -- in their early 20's.

DR. La SALLE: If museums are going to take over the universities' role of leadership, let's do it -- get in and actively promote certain ideas, e.g., environmental problems, rather than simply react and disseminate information. It's easy to criticize but hard to offer constructive alternatives.

MR. LOVE: Museums are probably less vulnerable than universities in trying to take active leadership role in bucking traditional methods and concepts.

MISS BENNETT mentioned EPOCH's approach -- ethnic differences -- open forum with people personally challenging each other. Also served meals and had music of each ethnic group -- discussions involving thirty teachers, six meetings -- the fur flew -- very exciting confrontations, productive.

MR. HEZEKIAH: Difficult to be innovative in American school-board system, especially pre-college. Museums are the place to innovate.

DR. La SALLE: Museums also have the expertise in a lot of cases where schools don't.

DR. NETTING: New tax laws make it difficult to get money from foundations.

DR. La SALLE: Museums never got any. Up until five years ago, schools didn't either, but as a body, educational lobbyists are being very effective. Maybe museums should lobby like this.

MR. TAYLOR recommended taking account of past experience. Most of the time when we take a stand, it's not on the basis of experience so much as based on what we want to happen.

DR. WITTLIN: If you build on social relevance you will appeal to a wide range of audience. But you have to gauge your alternatives: if you don't offer any practical solutions, you risk a utopian approach; if you offer too many choices you create confusion.

DR. La SALLE: You don't need to know all the answers -- just to recognize the problem.

MR. McKINLEY: OMSI wanted to do one on pesticides -- found no place else was doing anything on this.

MISS WARD: World Health Organization is irresponsible in keeping so many people alive -- there is emphasis on death control but not birth control.

MR. DIXON: Impact on neighborhood people of neighborhood museum exhibits -- get the problems out on the street even if we don't know all the answers and the individual can think about it and do his little bit, like no chlordane and DDT in the garden or how to keep rats out of the garbage can, once the issue is brought to his attention.

DR. La SALLE: Americans are gun-at-the-head people -- we think "it can't happen here" until it does. A little shock value in exhibits doesn't hurt.

MR. TAYLOR: Museum (or school) exhibits can often get around a barrier to dissemination of information -- e.g., how to keep rats away from the grain in an Indian village which was run by an old man who couldn't afford to look ignorant and thus couldn't let information be supplied to the village.

DR. NETTING: Do we approve of continued economic growth in our society? This is what would really upset our boards, i.e., if we presented an exhibit which didn't support continued economic growth.

DR. La SALLE: There's no way to prevent it.

MR. TAYLOR: Can we have continued economic growth and not destroy the environment? Summed up: Everyone at this discussion agrees that museums should involve themselves with such sticky questions as population increase, environmental, tell it like it is, etc.

DR. La SALLE: We can't afford not to.

DR. WITTLIN: Americans (and American museums) are much more adaptable than Europeans -- Americans can adapt without losing face.

MR. McKINLEY doesn't think we'll have so much trouble with boards of trustees [over controversial issues] -- one advantage of museums is their independence [of public opinion?]

DR. WITTLIN: A little tact won't hurt. The trend is toward a greater acceptance of public welfare as a valid issue for concern and information.

MISS BENNETT: Mr. Taylor is right. Taking a position would be much less acceptable to many than is spreading information and letting people make up their minds on the basis of the information.

MR. TAYLOR: We will take a stand, because we always do -- both approaches are useful.

DR. La SALLE: There is no age barrier between Establishment and not -- you become established when you have something to lose. Kids in an affluent society have nothing to lose.

Kids love to imitate -- we should set a good example.

MR. TAYLOR: We should capitalize on kids' sense of competition. We overlook this as a means of involving viewer in exhibit.

DR. La SALLE: Haven't we inherited a tradition whereby education screened out professionals and left the rest to work in the community? But now we are trying to educate to the maximum practical extent. The thirty-student classroom is a historic relic, a design that can't be used for the new mission. If an archeologist found it a thousand years hence he would probably consider it to be a prison or a hospital! Of course my discussion of facilities must not conceal the fact that programs are really based on people.

Surrounding towns are now contributing to the [Talcott Mountain] Center's program as well as charges on a per-hour basis which we have been able to show are comparable or lower than the cost per instructional hour in surrounding school systems. We go into the schools for more time than their students spend at the center. Also to us the teachers are the needle and we are the thread being woven into their curriculum. We're not mandating curricula. We are enmeshed in a network of community resources -- citing a radio telescope made of donated components which is now being used for satellite tracking. We're now becoming the environmental sciences department of the University of Hartford on a part-time basis!

DR. WALKINGTON: In Fullerton, California, we have been delighted with the response of the community's professional people and their desire to engage in volunteer teaching. It is a shame to overlook the talent we have in our area's educational institutions and in industry.

MISS WARD: At Earlham College we are sponsoring a junior science club taught by our students, involving youngsters in our museum and in their own community. Fourth graders are most numerous, then third, fifth and sixth. Let me ask, is it more exciting for children to learn about the exotic or the commonplace? Also remember that one of the greatest virtues of learning experiences is to introduce children to books. They want to know more than they can get in a brief exposure.

DR. RITTERBUSH: Should potential government funding agencies support museums per se, to enlist them as community resources, or would it be most advantageous to support the totality of community resources?

MR. McKINLEY avowed that museums are exceptional targets of opportunity for educational investments.

DR. RITTERBUSH agreed that museums seem to be particularly well situated to marshall other community resources into patterns of educational innovation.

William C. Steere (The New York Botanical Garden)

Quite by inadvertence, museums have come in recent years to have the reputation in some quarters as being of and for "The Establishment," and not to have the "relevance" demanded by today's world. To counter this unfortunate impression, special local museums have been developed, as the Bedford-Lincoln Neighborhood Museum (MUSE) in Brooklyn and the Anacostia Neighborhood Museum in Washington, D.C. Other approaches are necessary and feasible.

The theme which most urgently needs expression in museums is that of the deteriorating human environment and the necessary steps for its improvement. The American Museum of Natural History has pioneered in the introduction of the topic of environmental pollution into museum activities through its current exhibit, "Can Man Survive?" Every museum can contribute something to this theme, whether on a major scale or a small one, and thereby achieve greater relevance to today's problems. During 1969, the U.S. Public Health Service contracted with the American Association of Museums for a study of and report on the topic, "Development of Museum Education Techniques for Human Ecology." A committee of ecologically-oriented individuals under the chairmanship of Dr. James A. Oliver, Coordinator of Scientific and Environmental Programs, American Museum of Natural History, is now at work on the study, which will lead to a report to be published in 1970. We hope that this committee can be a continuing one, because of the outstanding significance of its responsibilities.

The committee has turned its attention especially to a consideration of the various kinds and techniques of exhibits that can most effectively educate students about the various categories of environmental pollution and their alleviation and eventual cure. Museums have facilities for many types of exhibits not normally available in the classroom and can teach basic concepts to students at all levels by means of three-dimensional objects, films, photographs, models, and a whole series of other materials and techniques, to be focused on specific problems and their solution. Such exhibits should cover the total environment, including the urban ghetto, in order to develop a sense of immediacy and relevance to human problems.

Alma S. Wittlin (University of California, La Jolla)

Post-Conference Summary Remarks by the Chairman

I wholeheartedly support Emily Richards' recommendation [See paper elsewhere in this report and discussion excerpt, pp. 141 ff.] that museums act as clearing houses facilitating the use of existing, and forthcoming, manipulative science materials in elementary schools. Personally, I would enlarge the proposal to encompass study aids for junior and senior high schools. As in my statement presented elsewhere in this conference report, I would like to emphasize again the continuum of science and technology, and I would like to see technology extended to socio-technology encompassing the immediate and delayed good and bad societal effects of progressing technology.

Science materials have so far not been used adequately for two reasons, as I see them: (1) lack of a distributive mechanism, and (2) in many cases lack of personnel. When I suggested some seven years ago the need for clearing houses I was told by scientists that they were concerned with the production of science programs. (See Wittlin, 1962.)

Experience has shown that experimenters spending months of time on the preparation of a science unit can hardly convey this experience to classroom teachers with a limited background in science if contacts occur in a hectic summer workshop for teachers or, worse, in the classroom in which the teacher watches the experimenter teaching a series of lessons. In a clearing house, teachers could inspect materials under low pressure and could try them out, in the museum (acting as a clearing house) or in their own classroom, at their own pace, and with access to guidance by experts.

We need a model pilot project of a clearing house in which existing science materials would be put on view. With the help of television, such materials could be made visible throughout the country. Teachers would learn more from such surveys (kept up to date) than from the catalogues of individual projects or firms. Obviously only selected materials would be shown, and the selectors would be science educators.

Teachers should not be burdened with a feeling of guilt if they do not teach science; no human being can have competence in six to seven subjects, as elementary school teachers are expected to have. I suggest that the amazingly high rate of merely

functional literacy in the United States, with its long history of free and compulsory schooling, has something to do with the ill-use of the human resources of teachers.[1] And that we shall continue to live among masses of scientifically illiterate people if we do not face up to the need for adequate learning facilities in science. I venture to make in this respect the following specific suggestions:

(1) Do not consider it a major requirement to include pre-schoolers or pupils of primary grades in your program unless you have personnel acquainted with child development and facilities in keeping with the needs of these children. I know from direct experience that the manipulation of objects has great appeal to young children and that individuals greatly differ in maturation, but there appear to be limits to such differences.[2]

A general tour through exhibit halls of aeronautics for Head Start groups is, in my opinion, merely a picnic to 99.9 percent. We want to expose young people to offerings from which each may derive the best benefit, in keeping with his abilities, but we do not want to mistake the training of seals for education.

Projects which have been in existence for some time -- for example, the MATCH Boxes of the Boston Children's Museum, or the Berkeley Curriculum Improvement Plan -- might help others by presenting results of any longitudinal studies they have undertaken -- if they have undertaken them. We also need appropriately selected teams of evaluators. Some project directors mistake testimonials for evaluation. We have yet to identify the problems we must study in order to make museums more effective educational environments. Different schools of psychology could and should contribute to the clarification of the problems involved. Edward Robinson of Yale University, started pioneering work in the 1920's on the effectiveness of communication by exhibits, but he died before either he or his associates could go far with it; some of their findings (published by the American Association of Museums) have retained validity but seem to have been forgotten.

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[1] Cf: Koerner, 1963; Jersild, 1955; Bestor, 1955; Wittlin, 1968.

[2] Piaget's monumental work ought to be studied, together with other observations, e.g., those of the Russian psychologist Vygotsky and of Jerome Kagan of Harvard. See also Wittlin, 1963.

What one would like to facilitate in the young child is the appreciation of the numerous aspects of our physical environment. Objects have shapes, sizes, colors and textures. They are opaque or transparent, shiny or dull, they vary in hardness and in temperature. Ask adults to describe an unfamiliar object and you will find that many of us have difficulties in analyzing phenomena into their physical properties and in naming them.

(2) The museum has two great advantages over the school classroom. It can combine experiments on specific topics with exhibits providing a background to them and counteracting premature specialization. It has the freedom to seek its instructors ("facilitators of learning") among persons who possess the necessary know-how but no teaching credential. Dr. Oppenheimer now uses such resource persons in San Francisco; I had the privilege of such cooperation in New Mexico. I do not especially refer to women volunteers, who, for all their excellence, may not always be suitable to demonstrate a scientific experiment or watch youngsters doing it; I am thinking of suitable high school and college students and of retired scientists, as well as of those still at the workbench. The students ought to receive both a financial remuneration and credit for what they are doing, provided that they do it well. Think of the achievements of the Palais des Inventions in Paris.

(3) The apprentice system has for millenia proved its value. There exist a few opportunities for high school students to spend a few hours weekly or weeks of the school vacation in the laboratories of scientists, in museums or with the aid of museums in the laboratories of universities and industries. Dr. G. Netting told us that high school students receive credit for such work done during school hours -- we need to provide much more of this kind of experience. Adolescents need models of excellence, and they need opportunities for the experience of adulthood which the present culture denies them far beyond the dictates of biological development. Accordingly they set up their own, and often not very desirable, opportunities for defying adult society.

(4) In an informal conversation with Mr. Frank A. Taylor, I heard of an approach to learning in some community colleges in the Washington, D.C. area, which I found most fruitful. In this approach, as I understand it, a student who wishes to become a radio mechanic (on whatever level eventually), goes directly to the workshop. When he comes up against a problem of arithmetic, the instructor of arithmetic joins him and they work on the solution while the student is highly motivated to do so. We have to provide numerous opportunities in which a learner is stirred to learning by the pertinence of the situation.

Two thoughts occur in this connection. One concerns the inequality of people as a privilege rather than as a deprivation. The other is related to the meaning of the now popular word "relevance."

No two leaves on the same tree are equal to one another. There is ample evidence of biological differences between human beings, and a maturing democracy should acknowledge everybody's claim to the fruition of his talent. This is in no way conflicting with the principle of equality before the law. We threaten and diminish human stature if we expect a person interested in the technology of radio to assume the stance of a budding theoretical physicist. By doing so we create status symbols which then become standards of assessing people, by others and by themselves.[3] We lead people to a loss of their identity.

The terms pertinence and relevance are nearly synonymous, but not totally so. The radio mechanic who studies arithmetic in close association with his immediate job is motivated to study an abstract matter because it clearly and decisively contributes to his understanding of the concrete job that attracts him -- because it is pertinent to his personal goals and to his immediate objective. Some individuals are content with pertinence while others strive beyond it to a grasp of the wider horizons of relevance. It may be one of the tasks of education to assist people in discovering relevance in something that at first appeared to be irrelevant to them, yet it would probably be optimistic to expect that everybody will seek such insights or seek them to the same depth of meaning.[4]

(5) Since one of our fellow-conferees expressed surprise at the dearth of experimental projects in museums, I would remind us all of the bibliography of such work issued a few years ago by the Milwaukee Public Museum (see Bibliography to this report) and of the need to continue lists of this kind, preferably in a selective and interpretive manner.

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[3] Dr. Garret Hardin, Professor of Biology at the University of California in Santa Barbara, California, 93017, has written eloquently on the subject of man's biological inequality. He would no doubt be prepared to provide reprints if asked to do so.

[4] My thoughts concerning pertinence and relevance were sharpened in the course of recent informal discussions with Dr. Robert B. Livingston and Dr. Robert Tschirgi, Professors of Neurosciences at the University of California, San Diego.

(6) Climbing down from the totem pole of speculation, I express the hope that the Smithsonian Institution will take the lead in furthering the adjustment of the public institution called Museum to the demands of our era, by means of the above suggested long-term activities. Brief conferences can act as catalysts -- they can trigger action -- and they certainly should not be discontinued, but it is time to go into higher gear; otherwise interest and energies may run low. I especially hope that the Smithsonian may be able to offer a clearing house of available science materials in one of their museums and to make arrangements for a recording of students' behaviors and comments.

References

Bestor, Arthur. The Restoration of Learning. (New York: Knopf, 1955).

Jersild, A. T. When Teachers Face Themselves. New York: Columbia University Press, 1955.

Koerner, J. D. The Miseducation of American Teachers. Boston: Houghton Mifflin, 1963.

Wittlin, Alma S. "A Tentative Prognosis: Children's Chances of Using New Learning Materials." (Mimeo, 1962.) Paper, 11 pages, written for the summer workshop of Educational Services, Inc., Watertown, Massachusetts.

_____. "Scientific Literacy Begins in the Elementary School," Science Education, 1963. Paper originally presented to annual meeting of the American Association for the Advancement of Science, 1962.

_____. "The Teacher," in R. B. Bell and H. R. Stub (eds.), The Sociology of Education. Homewood, Illinois: The Dorsey Press, 1968. Originally published in Daedalus, Fall 1963 (The Professions in America, edited by K. S. Lynn).

Philip C. Ritterbush (Smithsonian Institution, Washington, D.C.)

Museums as Educational Resources: An Annotated Bibliography

The books, papers, periodicals, and reports listed here help to show that museums play an important role in elementary and secondary education in both science and art. The list is intended to serve general interests in education and museums both. It is to be hoped that designers of public programs will bear in mind the contribution which can be made to education through expanded support to museums and other community educational resources. Perhaps the museum profession will widen its interest in education, for exciting new understandings of visual learning by children are applicable to museum exhibits generally and may also lead to a new recognition of the extent to which museums and schools may benefit from cooperative activities. I am grateful to Miss Katherine Goldman, Coordinator of Studies in Museum Education, for her assistance with this bibliography. It is not intended to be complete. A number of bibliographies and references with bibliographies are cited which may lead the interested reader further. The Smithsonian Institution is endeavoring to create a museum study center as a headquarters for visiting investigators from museums and educational institutions. Contributions of books, reprints, periodicals, and project support are badly needed. The Institution is also inaugurating a Museum Communication Exchange, with names of individuals interested in museum education, learning environments, and innovation in exhibits. Inquiries about these projects may be directed to Miss Goldman, Coordinator of Studies in Museum Education, U.S. National Museum, Smithsonian Institution, Washington, D.C. 20560.

Bibliography

I. OF INTEREST TO EDUCATORS

A. A Shelf of References on Museums

AMERICAN ASSOCIATION OF MUSEUMS. Museums directory of the United States and Canada, 2nd ed. Washington: American Association of Museums and Smithsonian Institution, 1965. 1039 pp.

This is the principal reference work on museums in the U.S. and Canada. A geographic directory is followed by an alphabetical listing for the 4,956 museums and related institutions covered. The third part lists directors and department heads. The fourth part lists museums by categories. In education the following topics are included in the index: formally organized programs for adults, for children, graduate-level, undergraduate, markers, expeditions, experimental studies in science, extension courses, field work, films, hobby workshops, joint university programs, junior clubs, libraries, loans, pageants, research summer programs, television, workshops, and others (pp. 1000 - 1006). A third edition is planned for November, 1970.

AMERICAN ASSOCIATION OF MUSEUMS. Museum News.

A monthly magazine devoted to reports on museum programs, Association affairs, and articles by leading members of the museum profession. Subscriptions entered only as part of membership in AAM: individual $15; library (not museum library) $25; institutional $30 up. Additional single copies available at $1.00 each. Address: American Association of Museums, 2233 Wisconsin Avenue, N.W., Washington, D. C. 20007

AMERICAN MUSEUM OF NATURAL HISTORY. Curator.

A quarterly publication of the American Museum of Natural History. Subscriptions: $7.50 per year ($8.00 in all foreign countries, including Canada). Address: Central Park West at 79th Street, New York, New York 10024.

ERIC LARRABEE, ed. Museums and education. Washington: Smithsonian Institution Press, 1968. vii + 255 pp. $6.50.

Includes papers on museum education by Edgar P. Richardson, Henry Allen Moe, Joseph A. Patterson, Bartlett Hayes, Jr., Richard Grove, Ruth Zuelke, Alma Wittlin, Scarvia B. Anderson, Helmuth Naumer, Sue Thurman, James Heslin, Frank Oppenheimer, Michael Butler, and Stephen White, originally presented at a conference supported by the U S. Office of Education in 1966 under the sponsorship of the Smithsonian. The anthology and the summary by Eric Larrabee demonstrate the difficulty of coming to grips with specific educational needs through the medium of the museum, revealing the inherent complexity of the subject and the remoteness of direct visual learning from the formal school system. The unedited papers are available through EDRS· MS $1.00, HC $8.88, ED014814.

ELEANOR M. MOORE. Youth in museums. Philadelphia: University of Pennsylvania Press, 1941. 115 pp. illus.

An excellent survey of museum education activities based on visits to more than one hundred museums. May still be read with profit as an introduction to museum education.

GRACE FISHER RAMSEY. Educational work in museums of the United States; development, methods and trends. New York: H. W. Wilson Co., 1938. 289 pp. incl. bibliog.

A survey of the character of museum education activities including a history of evaluation experiments.

S. DILLON RIPLEY. "Museums and education," Curator, Vol. 11, no. 3 (1968).

A reaffirmation of the museums' commitment to educational programs by the Secretary of the Smithsonian Institution.

S. DILLON RIPLEY. The sacred grove; essays on museums. New York: Simon and Schuster, 1969. 159 pp. $5.00.

A deft interweaving of educational and cultural elements in museum programs by the Secretary of the Smithsonian Institution.

CHARLES RUSSELL. Museums and our children; a handbook and guide for teachers in museums and schools and for all who are interested in programs of activity for children. New York: Central Book Co., 1956. Published under the auspices of The Friends of Children's Museums. 338 pp. illus.

The author's experience as Chairman of the Department of Education of the American Museum of Natural History helps to make this an excellent practical guide, filled with examples drawn from the programs of many museums.

U.S. OFFICE OF EDUCATION. Museums and related institutions: a basic program survey, by Lola Eriksen Rogers. Report (in booklet form). Washington: U.S. Government Printing Office, 1969. 120 pp. $1.25.

Based upon a pioneering survey of 2,889 establishments considered to conform to a working definition of museum, this study, undertaken by the U.S. Office of Education with the assistance of the Smithsonian Institution and the American Association of Museums, provides important overall information on governing authority, type of exhibits, location by city and state, paid and volunteer staff, study facilities, level of operating expenditure, number of annual visits, and educational services.

ALMA WITTLIN. The museum: its history and its tasks in education. London: Routledge and Kegan Paul, Ltd., 1949. 297 pp.

Long the best known and still the standard work on museums and their educational role.

HANS L. ZETTERBERG. Museums and adult education. London: Evelyn, Adams & Mackay, for the International Council of Museums, 1968. 89 pp. illus. incl. bibliog.

A comprehensive recent discussion of museum roles in adult education.

A reference shelf should also include leaflets, program descriptions, and annual reports from nearby museums.

B. Education in Museums, Selected Writings

STEPHAN F. DE BORHEGYI. "Visual communication in the science museum," Curator, Vol. 6, no. 1 (1963), pp. 45 - 57, illus.

Discusses interpretation as the programming of visual communication, with reference to convincing and effective exhibits on anthropology. Stresses the importance of sound, touch, and spatial setting. Borhegyi's death cost museum education its foremost leader. The water pollution exhibit figured on page 55 is an example of how far ahead of the field he usually was.

G. ELLIS BURCAW. "Films for teaching museology; a guide to where they are," Museum News, Vol. 46, no. 3 (November, 1967), pp. 25 - 26.

Describes a variety of films on museum exhibitions.

DUNCAN F. CAMERON. "A viewpoint: the museum as a communications system and implications for museum education," Curator, Vol. 11, no. 1 (December, 1968), pp. 33 - 40.

In this important article the author defines those communications processes for which exhibits may be the medium of choice and concludes that education in museums should concentrate on the acquisition of visual learning skills in a manner akin to learning a language.

GERMAINE CART, MOLLY HARRISON, CHARLES RUSSELL, AND PETER FLOUD. Museums and young people. Paris: International Council of Museums, 1952. 131 pp. including an extensive bibliography.

The thoughtful introduction by Peter Floud exposes several recurring misconceptions about museum programs for children, based on his experience at the Victoria and Albert Museum.

E. C. CHUBB. Museums and art galleries as educational agents; report of a visit to the United States of America and Canada under the auspices of the Visitors' Grants Committee of the Carnegie Corporation of New York. Pretoria, South Africa: Carnegie Corporation Visitors' Grants Committee, 1929. (Yale University Sterling Memorial Library A 111.7) 48 pp. illus.

Descriptions of typical education activities of American museums in the 1920's by the Curator of the Durban Museum and Art Gallery, South Africa.

EMILY DENNIS. "Grant material: a museum program in anthropology and archaeology for high school students," Museum News, Vol. 45 (February, 1967), pp. 13 - 17, illus.

Describes direct student participation in the study of field sites near The Brooklyn Children's Museum, with support from the National Science Foundation. Of 43 respondents out of 160 participants over four years, 25 were majoring in or planning to major in anthropology.

RICHARD ELLIS. "Museum exhibits in zoos and aquariums," Curator, Vol. 10, no. 4 (1967), pp. 318 - 329, illus.

Describes mostly pictorial exhibits of written matter designed and installed to supplement live collections, to make zoos and aquaria better serve functions as "educational institutions." Article contains good photographs of exhibits.

CLARK C. EVERNHAM. "Science education: a museum responsibility," Museum News, Vol. 40, no. 2 (October, 1961), pp. 20 - 22.
A lucid discussion of the role of the educational staff in museums, coupled with a plea for new ways to train educators for museums -- something the Smithsonian is trying to develop with a museum education course.

EDWIN N. FERDON, JR., AND EMMA M. CAPPELLUZO. "A double duty docent program," Museum News, Vol. 44, no. 7 (March, 1966), pp. 20 - 24, illus.
Describes the use of college students to conduct school tours at the Arizona State Museum.

THEODORE L. LOW. The museum as a social instrument. A study undertaken for the Committee on Education of the American Association of Museums. New York: Metropolitan Museum of Art, 1942. 70 pp. incl. bibliog.
This important paper by an able advocate of popular adult education describes the institutional changes needed to establish educational capacity in museums. His arguments against prevailing conventions in school tours and exhibit technique may still be read with profit.

GILBERT E. MERRILL. "New dimensions in museum teaching," Museum News, Vol. 46, no. 2 (October, 1967), pp. 35 - 37.
A thoughtful summary of educational activities within the museum, based on the author's experience as chairman of the education department of the Academy of Natural Sciences of Philadelphia.

CONSEJO DE PLANEACION E INSTALACION, NATIONAL MUSEUM OF ANTHROPOLOGY, MEXICO. Efectividad didactica de las actuales instalaciones de Museo Nacional de Anthropologia. Mexico, D.F.: 1962.
Detailed report of a team of educators dealing with numerous factors considered in the design of the educational functions of this superb museum.

ARMINTA NEAL. Help! for the small museum; handbook of exhibit ideas and methods. Boulder, Colorado: Pruett Press, 1969. 200 pp. illus. incl. bibliog. $7.50.
The author is Curator of the Department of Graphic Design, Denver Museum of Natural History. A practical handbook on principles of display, treatment in cases and other settings, and notes on construction.

A.E. PARR. "Some basic problems of visual education by means of exhibits," Curator, Vol. 5, no. 1 (1962), pp. 36 - 44.

An earnest effort to appraise the educational effects of exhibits including an argument in favor of measuring such effects, not simply of "the absorption of knowledge" (which may be easy to quantify) but of "the achievement of understanding," an absolutely critical distinction. Dr. Parr is the author of many other excellent articles.

L.Y. RAHMANI. The educational functions of museums. Report to the Director-General of UNESCO on a fellowship in museology. Jerusalem, 1964. 30 pp.

A summary of the author's study visits devoted to the educational functions of European museums in 1963. The report includes numerous citations to European literature on museum education. (Copy on file at the Smithsonian Institution).

REDE; RESEARCH AND DESIGN INSTITUTE. Annual directory of behavior and environmental design, for 1969. 210 pp. $3.00. Address: P. O. Box 307, Providence, R. I. 02901.

This occasional directory is one of the best sources for information about visual communication in learning environments.

IRVING G. REIMANN. "The role of a university museum in the education of students and the public," Museum News, Vol. 46, no. 3 (November, 1967), pp. 36 - 39.

An excellent description of the museum of the University of Michigan and its role as a resource in the community of Ann Arbor.

C. G. SCREVEN. "The museum as a responsive learning environment," Museum News, Vol. 47, no. 10 (June, 1969), pp. 7 - 10.

Explores some psychological aspects of museums, obstacles in their communications processes, and possibilities for improvement derived from research in learning.

FRANCIS HENRY TAYLOR. Babel's tower; the dilemma of the modern museum. New York: Columbia University Press, 1945. 53 pp.

In a series of essays the then director of the Metropolitan Museum of Art argues that modern museums must help meet the challenges to democracy by increasing their effectiveness in education, including televised exhibits and explicit treatment of human values in exhibits.

UNESCO. "Museums and education," special issue of Museum, Vol. 1, nos. 3 - 4 (1948), UNESCO Publication no. 244.
Eighteen articles including some very interesting discussions of visual presentation techniques.

MIRIAM WOOD. "A museum's contribution to curriculum," Museum News, Vol. 45, no. 6 (February, 1967), pp. 36 - 37.
Describes school programs at the Field Museum of Natural History, followed by an article on the role of Chicago museums by the Associate Superintendent of Schools for Curriculum Development.

C. From the Literature of Research on Education, Potentially or Actually Applicable in Museums

1. Educational Research in Museums

DAVID ABBEY. "Kids, kulture, and curiosity," Museum News, Vol. 46, no. 7 (March, 1968), pp. 30 - 33.
Describes the museum as a communications system and refers to recent research on the psychology of perception.

MARGUERITE BLOOMBERG. An experiment in museum instruction. Washington: American Association of Museums Publications, N. S. no. 8 (1929). 40 pp.
A comparison of the educational effectiveness of a variety of learning strategies in the Cleveland Museum of Art for groups of students ranked by their schools into different ability groups.

STEPHAN F. DE BORHEGYI AND IRENE A. HANSON. "Chronological bibliography of museum visitor surveys," in Eric Larrabee, ed., Museums and Education (Washington: Smithsonian Institution Press, 1968), pp. 239 - 251 listing about 150 items.
A remarkable and very worthwhile historical checklist. An earlier version, with a few titles not repeated in 1968, is "Chronological bibliography of museum visitor surveys," Museum News, Vol. 42, no. 6 (February, 1964), pp. 39 - 41.

DUNCAN F. CAMERON. "How do we know what our visitors think?" Museum News, Vol. 45, no. 7 (March, 1967), pp. 31 - 33.
Knowledgeable advice about studies of visitors which may be conducted even by small museums and critcisms of careless data-gathering programs not readily translatable into improvements in visitor services.

INSTITUT PÉDAGOGIQUE NATIONAL, PARIS. Musées et enseignement. Memoires et documents scolaires, N.S. no. 8 (1957).

This report has been cited as one of the first European ventures in museum education research.

ARTHUR W. MELTON, NITA GOLDBERG FELDMAN, AND CHARLES W. MASON. "Experimental studies of the education of children in a museum of science," in Edward S. Robinson, ed., Studies in Museum Education. Washington: American Association of Museums Publications, N.S. no. 15 (1936).

Summarizes studies of learning conducted among children visitng the Buffalo Museum of Science, including evaluations of advance preparation, illustrated lectures, and methods of instruction. Among the more interesting findings was that children's retention of information was not significantly improved if lectures at the museum preceded visits to the halls. It may be that the study overemphasized information retention as well as arbitrary distinctions between grades and between subject matters.

MILDRED C. B. PORTER. Behavior of the average visitor in the Peabody Museum of Natural History, Yale University. Washington: American Association of Museums Publications, N.S. no. 16 (1938). 28 pp. illus.

Two years' analysis of 50 Sunday afternoon visitors showed that they followed a course leading from man through lower animals instead of the reverse as the guidebook recommended, that interest gradually declined throughout the visits except where the means of display were varied, that only four of the shortest labels were read by over half of the visitors, and that their average stay in the museum was 22 minutes. An experiment with printed hall guides is related.

EDWARD STEVENS REOBINSON. The behavior of the museum visitor. Washington: American Association of Museums Publications, N.S. no. 5 (1928). 72 pp.

A study of the behavior of 200 visitors in four art museums, including the number of rooms visited, number of pictures observed, frequency of maximum times of observation of pictures, and length of visits. A "fatigue effect," whereby less time is spent at successive visits, was observed.

HARRIS H. SHETTEL, ET AL. Strategies for determining exhibit effectiveness. Pittsburgh: American Institutes for Research, 1968. 230 pp. 33 figs. 37 tables. 13 Appendices. U. S. O. E. Final Report, Project No. V - 011, Contract No. OE-6-10-213.

Study undertaken "to initiate the systematic development of research strategies of testable hypotheses that will make it possible to better evaluate the effectiveness of scientific and technical exhibits, particularly those designed to reach educational objectives."

JAMES B. TAYLOR. Science on display; a study of the United States science exhibit, Seattle World's Fair, 1962. Seattle: University of Washington, Institute for Sociological Research, March, 1963. 185 pp. mimeographed.

The leading study of visitor learning in an exhibition, having pioneered in methodology as well as reached some important conclusions about attitude change and information retention. Sixteen appendices also available from the Institute for Sociological Research.

U. S. OFFICE OF EDUCATION. Research in Education. ERIC (Educational Resources Information Center), U. S. Dept. of Health, Education, & Welfare, Office of Education, National Center for Educational Research and Development. Subscription rate: $21.00 per year ($26.50 foreign); single copy: $1.75. Available from U. S. Government Printing Office, Superintendent of Documents, Washington, D. C. 20402.

A monthly journal of abstracts (résumés and indexes) on recently completed research and research-related reports and current research projects in the field of education. Indexes are cross-referenced by subject, author or investigator, and institution. This journal is best used in conjunction with the publication, Thesaurus of ERIC Descriptors (q. v.), which gives a clue to the ERIC system of information storage and retrieval. Reproductions of all documents cited in the "Document Résumé" section are available from ERIC, and information on ordering is included in each issue of the journal.

U. S. OFFICE OF EDUCATION. Thesaurus of ERIC descriptors, 1st ed., December, 1967. Washington: U. S. Government Printing Office, 1968. xv + 309 pp. bibliog. $2.50

A compilation of terms under which information on research reports and abstracts is stored in the ERIC system, for use in retrieving the information or ordering copies of documents. This volume is almost essential for preparing or finding information stored in the ERIC system, which cross-indexes by a method designated "The Rotated Descriptor Display." Preliminary pages explain the organization and use of the thesaurus. This edition does not contain

instructions for ordering document reproductions and thus is only a companion piece to any of the ERIC publications such as the journal, Research in Education (q. v.), that do contain information on ordering and a listing of ERIC clearing houses in the U. S. A bibliography lists dictionaries and works on programming and educational psychology.

2. Some References on the Design of Evaluation Procedures

J. CRAWFORD AND C. KIELSMEIER. The prudent pea-picker's guide to experimental design (with work book). Salem, Oregon, Box 5217: Designs for Impact, 1970.
Non-mathematical introduction to designing simple experiments.

JACK V. EDLING. Individualized instruction; a manual for administrators. Corvallis, Oregon: D. C. E. Publications, 1970.
Good layman's survey of the many alternative ways to try to individualize instruction.

J. D. FLANAGAN. "The critical incident technique," Psychological Bulletin, Vol. 51 (1954), pp. 327 - 358.
Review of a basic way of getting a rich but manageable body of data before, during and after exposure to an instructional experience.

R. M. GAGNÉ AND W. D. ROHWER, JR. "Instructional psychology," in Annual Review of Psychology, 1969 (Palo Alto: Annual Reviews, Inc., 1969), pp. 381 - 418.
Review of the state of the art.

R. S. MACKENZIE. Conference - Institute on Dental Education Research. University of Pittsburgh, School of Dental Medicine, 1969.
Individualized study guide for introducing oneself to learning, measurement, statistics and research methods.

ROBERT F. MAGER. Preparing instructional objectives. Palo Alto: Fearon Publishers, 1962.
Basic short text on writing measurable objectives.

ELIZABETH H. NICOL. The development of validated museum exhibits. Report to the Bureau of Research, U. S. Office of Education, on Project No. 5-0245. Boston: The Children's Museum, mimeo, 1969. 114 pp. illus.
A highly competent discussion of the museum as a learning environment, this report presents a case history of the development of an exhibit on animal teeth in which experiments on learning effects were applied to the design of the final installation. This is an important document in the meagre literature of exhibits evaluation.

C. F. PAULSON, JR., AND F. G. NELSON. Behavioral objectives: section I of national research training manual, 2nd ed. Monmouth, Oregon: Teaching Research Division, Oregon State System of Higher Education, 1969.
Inclusive chapter. Best read after Mager's book, q. v.

C. F. PAULSON, JR. Evaluation of instructional systems, section IV of national research training manual, 2nd ed. Monmouth, Oregon: Teaching Research Division, Oregon State System of Higher Education, 1969.
Good introduction for the determined layman.

MICHAEL G. SASLOW. "Establishing the purpose for evaluation," in C. F. Paulson, ed., A Strategy for Evaluation Design. Monmouth, Oregon: Teaching Research Division, Oregon State System of Higher Education, April 1970.
Emphasis on specifying objectives first and then designing evaluation procedures to meet those objectives. A good guide for clarifying intentions and goals, enabling one to decide precisely what it is he is trying to evaluate and suggesting a range of alternative evaluation procedures depending on the uses to which the evaluation data will be put.

II. OF INTEREST FOR MUSEUM LIBRARIES

A. Some Useful Writings on Education

TERRY BORTON. "What's left when school's forgotten?" Saturday Review, April 18, 1970, pp. 69 - 71, 79 - 80.
Process education as a method and approach.

JEROME S. BRUNER. The process of education. Cambridge: Harvard University Press, 1960; New York: Random House, Vintage paperback, 1963, 97 + xvi pp. index.
Thoughts growing out of a conference of some 34 scientists, scholars, and educators in 1959 under Dr. Bruner's directorship, discussing how science education might be improved in U. S. elementary and secondary schools. The titles of the book and of the chapters ("The importance of structure," "Readiness for learning," "Intuitive and analytic thinking," "Motives for learning," "Aids to teaching") accurately indicate the basic nature of the concerns in this report, with ideas on education not limited to the school setting. Dr. Bruner is a lucid writer as well as a profound thinker and psychologist.

JEROME S. BRUNER. On knowing: essays for the left hand. Cambridge: Harvard University Press, 1962; New York: Atheneum paperback, 1969. 165 pp.

Ten occasional essays centered around the theme of how we know and how knowledge reflects the structuring power of the human intellect, how we impart knowledge and teach the learner to construct his own world of learning. The "left hand" is fantasy, intuition. The "right hand" is systematic study, discipline, reason. Both hands are necessary to accomplish the tasks of knowing and of creation, working in concert. It has been customary in our time either to slight the role of "the left hand" or to make a separation between the left and the right, feeling vs. reason, that over-emphasizes the one or the other as the true focus of the rays of knowledge.

JAMES B. CONANT. Science and common sense. New Haven: Yale University Press, 1951.

JAMES B. CONANT. Modern science and modern man. New York: Anchor Doubleday paperback, 1959.

JAMES B. CONANT. (1) The American high school today. New York: McGraw-Hill, 1959; Signet paperback, 1964. 141 pp. incl. 8 appendices. (2) Slums and suburbs. New York: McGraw-Hill, 1961. 147 pp.

Together these two books represent Dr. Conant's recommendations for improvement of secondary education in the U. S. based on his study of the "comprehensive" American high school, aimed at education for everyone. This very influential work, by the noted educator, scientist, former president of Harvard, led to a spate of studies pressing for curriculum reform.

HERBERT GINSBERG AND SYLVIA OPPER. Piaget's theory of intellectual development; an introduction. Englewood Cliffs: Prentice-Hall, 1969. xi + 237 pp.

Presents a biography of Piaget and a clear statement of his major theories of the intellectual development of children in non-technical terms.

GILBERT HIGHET. The art of teaching. New York: Random House, Vintage paperback, 1950. vii + 259 pp. index.

Methods and general principles of teaching cutting across all subjects. "Not a book of educational theory, but a book of suggestions drawn from practice" (author's preface). What makes a good teacher? What makes a great teacher? Includes a section on teaching in everyday life, as done by ordinary parents to children, family members to each other, doctors, priests, psychiatrists, politicians, propagandists, artists, authors, those who teach consciously and unconsciously. A very good book.

JOHN HOLT. How children fail. New York: Pitman Publishing Co., 1964; Delta paperback (Dell Publishing Co.), 1964, 181 pp.

What is wrong with education in American schools in the mid-1960's; how schools fail to meet the needs of children; distinctions between real and apparent learning. Author is a teacher, educational researcher and consultant in elementary, junior high, and high schools, and an observer of children in and out of schools. Written for the layman from a journal the author kept while observing and teaching in a fifth-grade class.

JOHN HOLT. How children learn. New York: Pitman Publishing Co., 1967. 189 pp.

Observations and reflections on the ways of a child's mind as it develops into an effective instrument of learning -- mostly the young child's mind, before he gets to school. Anecdotal, written for the layman. Considered a companion volume to author's earlier book, How Children Fail (1964), q. v.

GAYLE JANOWITZ. Helping hands; volunteer work in education. Chicago and London: University of Chicago Press, 1965. 125 pp. incl. bibliog.

A report from the front lines of volunteer efforts to create out-of-school supplementary study centers, certain to provoke thought and rededication for museum volunteer docents.

The Journal of Aesthetic Education, Quarterly, $7.50 per year. Address: The University of Illnois Press, Urbana, Illnois.

Considers education in relation to new communications media and environmental arts. Frequently publishes basic education articles of interest to museum personnel.

GEORGE LEONARD. Education and ecstasy. New York: Delacorte Press, 1968; Delta paperback, 1968. 239 pp.

Ecstatic, slightly gushy about the wrongs of current-day education and suggestions for righting them before its too late. Advocates the kind of learning that could take place in environments such as those museums provide and currently schools don't. Author is an editor on staff of Look Magazine; portions of the book were serialized therein. Author is also connected with Esalen Institute in California, which experiments with unorthodox modes of opening people (not necessarily intellectually) to responsive interaction with themselves, each other and the world(s) they live in.

MEDIA AND METHODS INSTITUTE, INC. Media and Methods. Monthly, September-May. Subscriptions: $5.00 per year, $6.00 in Canada. Address: 134 N. 13th Street, Philadelphia, Pa. 19107

Devoted to visual learning with concentration on audio-visual aids and motion pictures. Committed to innovation with a fresh approach that occasionally draws cries of outrage from readers. Excellent source for advertisements on commercially available media.

MARIA MONTESSORI. The discovery of the child. Available from: Saint Leo League, Box 577, Newport, Rhode Island 02840. $6.50.

A 1948 revision of some of Dr. Montessori's earlier writings.

MARIA MONTESSORI. The formation of man. Available from: Saint Leo League, Box 577, Newport, Rhode Island 02840. Paperback. $1.25.

Résumé of Dr. Montessori's work, of her more important concepts, and of her approach to "world literacy."

NATIONAL SCIENCE TEACHERS ASSOCIATION. The science teacher. Monthly, September - May. Subscription: $10.00 per year. Address: 1201 Sixteenth Street, N. W., Washington D. C.

PRESIDENT'S SCIENCE ADVISORY COMMITTEE. Innovation and experiment in education; a progress report of the Panel on Educational Research and Development . . . Washington: U.S. Government Printing Office, 1964. 79 pp.

A representative and important statement on the need for educational reform at the time of its publication, this report should still have value to museum personnel seeking to become acquainted with the background and purpose of U.S. Government efforts to improve the quality of education, especially in the sciences.

MATILDA B. REES AND WILLIAM J. PAISLEY. Social and psychological predictors of information seeking and media use. A multivariate re-analysis. Standord University: Institute for Communication Research, 1967. 112 pp. incl. bibliog.

A report on the use of the total communications system of society by adults. Although museums are omitted, this pioneering study of selective use of different media of interest to museum personnel trying to determine where museums fit into the total system.

U.S. OFFICE OF EDUCATION. Pacesetters in innovation fiscal year 1968. Washington: U.S. Government Printing Office, 1969. 180 pp. Annual. $2.50.

A compilation of project descriptions supported by planning and operational grants under Title III of the Elementary and Secondary Education Act of 1965, indexed by subject and locality. An excellent medium for museum personnel seeking to adapt ideas from supplementary education centers and programs throughout the nation.

ALFRED NORTH WHITEHEAD. The aims of education. New York: Macmillan, 1929; Mentor paperback, 1949, 158 pp. with a three-page appreciation of Whitehead by Felix Frankfurter.

Basic work on philosophy of education "on its intellectual side." Seeks to restore a sense of unity to education which has broken down into compartments of isolated specialization. Premise: "The students are alive and the purpose of education is to stimulate and guide their self-development" (author's preface, 1929).

B. Extending the Museum into the School

ALVA MUSEUM REPLICAS. Museum in the classroom. Rosetta stone classroom kit. Pictograph to cuneiform kit. Africa kits i and ii. Address: 30-30 Northern Boulevard, Long Island City, New York.

Developed under the direction of Professor Hyman Kavett of Richmond College of the City University of New York.

LINDA BLOCH. "The red box: an improvised suitcase exhibit," Museum News, Vol. 48, no. 7 (March, 1969), pp. 29 - 31, illus.

Describes a travelling exhibit, circulated to schools from the Little Rock (Arkansas) Museum of Science and Natural History, intended to stimulate curiosity about natural objects.

BOSTON CHILDREN'S MUSEUM. Circulating materials, Match Kit units available for loan and sale in some fifteen subjects and loan exhibits. For information write to: The Children's Museum, Jamaicaway, Boston 02130.

JEROME S. BRUNER. "Man: a course of study," ESI Quarterly Report, Summer-Fall, 1965, Vol. III, no. 3, pp. 85 - 95. Watertown, Mass.: Educational Services, Inc. (now Education Development Corp., 11 Brattle Street, Cambridge), 1965.

CEMREL, INC. "The arts in general education." Irregular newsletter, available from CEMREL, Inc., 10646 St. Charles Rock Road, St. Ann, Missouri 63074.

Describes a three-year project now under way in the school district of University City, Missouri, of value to designers of museum-based education programs intended to rely on aesthetic response.

EDUCATIONAL RESEARCH COUNCIL OF AMERICA. Annual reports, ERC papers in science education, ERC Science News, "ERS Science Program." Address: Rockefeller Building, Cleveland, Ohio 44113.

One objective of the ERC is the development of an interdisciplinary, sequential science program from kindergarten through grade 12 which may serve to coordinate new courses and curricula.

JAMES J. GALLAGHER. An annotated bibliography of anthropological materials for high school use. New York: Macmillan, 1967. 135 pp.

Lists 370 publications identified and evaluated by the Anthropology Curriculum Study Project, but does not include a list of museum-based resources.

DAVID HAWKINS. "Messing about in science," ESI Quarterly Report, Summer-Fall, 1965, Vol. III, no. 3, pp. 39 - 44. Watertown, Mass.: Educational Services, Inc. (now Educational Development Corp. 11 Brattle St., Cambridge), 1965. Also published in Science and Children, vol. 2, no. 5 (February, 1965), National Science Teachers Association, Washington, D.C. 20036.

Dr. Hawkins, a physics teacher, sees three major phases in good teaching, applicable to all aspects of elementary education. Emphasizing flexibility and variation, he claims that "good science teaching moves from one phase to the other in a pattern which, though it will not follow mechanical rules or ever be twice the same, will evolve according to simple principles." Of particular value is the phase of "messing about," of free and unguided exploratory work; this phase has so far been the one most neglected in our approaches to education of children in the school setting.

HAZEL W. HERTZBERG. The great tree and the longhouse; the culture of the Iroquois. New York: Macmillan, 1966. 122 pp.

Produced by the Anthropology Curriculum Study Project; an excellent example of imaginative presentation of a culture, which could readily be illustrated with museum objects. A teacher's guide is also available.

CARL S. JOHNSON, DAVID L. ERICKSON, AND CHARLES A. DAMBACH. Qualities of conservation materials, transactions of the thirty-first North American Wildlife and Natural Resources Conference (Washington: Wildlife Management Institute, 1966), pp. 396 - 406.

Conclusions based on a two-year study of about 8,000 titles (of the estimated 20,000 available!) of free or inexpensive materials regarding the conservation of nature offered to schools by governmental and commercial sources in 1963. This preliminary report was sharply critical of agency and industry bias, poor appearance, unreadability owing to the use of technical language, and failure to deal with radioactive wastes, air pollution, land-use planning and population control, as well as general neglect of soil, mineral, and water resources. The analysis of these materials continues under the direction of Dr. Carl S. Johnson, Professor of Conservation, Natural Resources Institute, Ohio State University, and will be of interest to museums seeking to develop school materials on environmental topics. The summary of the project, "Survey of printed materials for conservation education," no. 5 - 1058, is available from the Educational Resources Information Center, Room 3006, U.S. Office of Education, 400 Maryland Avenue, S.W., Washington, D.C. 20202.

ALICE MARRIOTT. Kiowa years; a study in culture impact. New York: Macmillan, 1968. 173 pp. illus.

Produced by the Anthropology Curriculum Study Project; a teacher's guide is available. Museum materials for the classroom might be programmed to supplement this kind of presentation on the interaction of cultures.

ALAN R. MUNRO. "The yellow submarine," Museum News, Vol. 46, no. 6 (February, 1968), pp. 20 - 23, illus.

Describes a mobile museum devoted to introducing Tennessee children to the ancient seas from which the Appalachia was formed, listing exhibit contents and the budget for a total learning environment trailer with imaginative visual aids.

NATIONAL SCIENCE FOUNDATION. Course and curriculum improvement projects; mathematics, science, engineering. Washington: U.S. Government Printing Office, 1966 (NSF 66-22). 117 pp. 65 ¢. See also: Released textbooks, films and other teaching materials prepared by course and curriculum improvement projects supported by the National Science Foundation. Washington: U.S. Government Printing Office, 1968 (NSF 68-24). 72 pp.

ONTARIO INSTITUTE FOR STUDIES IN EDUCATION. The multi-media kit on the 1930's.

Assortment of filmstrips, tapes, records, pictures, stamps, etc., relating to life in North America in the 1930's; for children of secondary-school age.

LYDIA POWEL. The art museum comes to the school. New York: Harper & Bros., 1944. 160 pp. illus. Foreword by Thomas Monro.

A critical review of a cooperative program conducted by five museums and their school systems with support from the General Education Board of New York. It includes valuable discussion of the dynamics of cooperation, the need for exhibition space in schools, more flexible scheduling, and the capacity of museum cooperation to contribute to educational reform.

FERDINAND S. RUTH. "Natural history teaching kits," Museum News, Vol 44, no. 3 (November, 1965), pp. 33 - 40, illus.

Describes portable cases prepared by the Lawrence Hall of Science, Berkeley, California containing marine animals, animal kingdom survey, amphibians and reptiles, bird study skins, and mammal study skins (as well as specimens in drawers and botanical specimens) which introduce natural history specimens directly into the classroom, and cites books which accompany them.

C. Explorations Bearing upon the Museum Potentials for Education

RUDOLF ARNHEIM. Toward a psychology of art. Collected essays. Berkeley: University of California Press, 1966. 375 pp. illus. $10.00.

Topics covered include perception, expression, symbolism, creativity, and means of studying the work of art as an objective entity within the visible world.

PETER L. BERGER AND THOMAS LUCKMANN. The social construction of reality; a treatise in the sociology of knowledge. New York: Doubleday, 1966; Anchor Books paperback, 1967, $1.45.

This discussion of social processes that contribute to the sense of reality provides a conceptual framework for considering the "reality" which is so often attributed to museum objects.

B. R. BUGELSKI. The psychology of learning. New York: Henry Holt and Co., 1956.
This is included in the list of references in Harris H. Shettel, et al., Strategies for Determining Exhibit Effectiveness (U.S.O.E. Final Report, 1968), q.v., p. 160.

G. EVELYN HUTCHINSON. The ecological theater and the evolutionary play. New Haven: Yale University Press, 1965.
These wise essays illuminate the humanist commitment central to much of science and exemplify the kinds of analysis which bring museum objects unforgettably to life.

GEORGE KUBLER. The shape of time; remarks on the history of things. New Haven and London: Yale University Press, 1962; paperback, 1968. xii + 136 pp.
The degrees of creativity manifested by artifacts are the object of this study, which seeks to gauge the extent of innovations by situating them in sequences of interrelated forms.

MARSHALL McLUHAN. Understanding media; the extensions of man, 2nd ed. New York: Signet Books, 1964. 95 cents.
All should play this conceptual shell game, which imposes severe tests upon one's system of categories regarding perception and learning. It should promprt museum personnel to reconsider their views of the needs of children and the potentialities of visual learning.

HERBERT READ. Education through art. London: Faber and Faber, 1943. xxiii + 320 pp. incl. bibliog.
Educators can derive much benefit from this thoughtful analysis of learning.

PHILIP C. RITTERBUSH. The art of organic forms. Washington: Smithsonian Institution Press, 1968. 168 pp. illus. bibliog.
Treats the visual imagination in biology as the source of an aesthetic endowment in organic forms that has rendered them attractive to 20th-century artists, contending that as a result works of abstract art can be employed to teach about science. See also, "Science teaching and the future," The Science Teacher, Vol. 36, no. 6 (September, 1969), pp. 32 - 39, illus.

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APPENDICES

Appendix A

Possible Functions of a Science Museum

The following suggestions on roles that the science museum might assume were presented in a panel discussion sponsored by the Academy of Science of St. Louis. The meeting was held at the Museum of Science and Natural History and attended by representatives of four school districts in the St. Louis area. A member of the educational staff of the museum was chairman of the panel. Although the meeting was held four years ago, the suggestions made are relevant to the situation today. There was general agreement that the new approach in science teaching requires active student participation rather than passive listening to the teacher. It was also felt that the greatest need in science education today is for better trained, more informed, and more flexible teachers.

The suggestions made on the part that the science museum could play were as follows:

(1) Since training teachers in science and science teaching was seen as the greatest current need in science education, in-service workshops for teachers are needed. These should make use of inexpensive equipment that teachers can both readily understand and easily obtain on their own. The science museum could conduct such workshops effectively.

(2) The science museum could take an active part in bringing science to the classroom. Transportation costs now often prohibit the inner-city school classes from going to the museum. Museum personnel could go into the inner-city classroom, give lecture-demonstrations, and then let the children investigate and work on their own with materials easily obtainable for the classroom teacher. Example: To test for limestone, only vinegar is needed. Children could then test many materials in their neighborhood to see if any are limestone.

(3) Possibly the science museum could allocate funds to bring the children to the museum. This would be difficult to arrange under the present system.

(4) Teachers everywhere are pressured for time. A teacher may attend a science workshop, enjoy and appreciate it, but fail to use her new knowledge in her classroom because she does not have the time to look for low-cost equipment to buy, and then to set up the experimental situation. The science museum might provide five different experimental set-ups per year for a class of students, and notify teachers what they were. Then the teacher could bring her class to work in the museum at the times when these experiments fitted into her teaching plans.

Because the teacher is so pressured for time, she also frequently does not have an adequate opportunity to prepare her class for a trip to the science museum. Consequently, even if she does take the children to the museum, they often do not receive the benefit from the visit that they would have received with the right preparation. The suggestion was made that a science museum might develop a series of experimental investigations covering a broad range of concepts in science. Teachers would be given the background of each concept and each experiment, plus the listing of investigations offered. Each teacher could then choose ahead the investigations he or she wished to use, and bring the class to the museum at the time most appropriate for the particular investigation.

(5) In-service courses on the specific offerings of a science museum might be offered to teachers. Explanations of museum exhibits and facilities would be accompanied by suggestions on where each might appropriately fit into a particular area of classroom study. Harris Teachers College in St. Louis has offered such in-service credit courses with great success at the Museum of Science and Natural History, the Planetarium, the Zoo, and the Botanical Gardens.

(6) Science museums might develop their own individual educational TV programs. These would not be lectures, but would require student involvement and participation.

(7) Science museums might maintain "basic boxes" of equipment that is more sophisticated and expensive than many schools can afford. Teachers might borrow a "basic box," as they would from a library, or museum personnel might visit the school and supervise class use of the equipment.

Appendix C

Typically Available Statistical Information on Museums and Pre-College Science Education

The following information has been excerpted from Museums and Related Institutions: A Basic Program Survey (U.S. Department of Health, Education and Welfare, Office of Education, with the assistance of the American Association of Museums and the Smithsonian Institution, 1969). Data are from responses to a 1966 questionnaire and were analyzed to indicate the national pattern of museum distribution, facilities and resources, staff, operating expenditures, attendance, and programs. (See also the paper by Lola E. Rogers, elsewhere in this report.)

Total operations queried: 5,234
Total responses: 4,958
Non-responses: 276

Total museums and related operations in scope of "universe" nationwide: 2,889

Science museum or center:	438	= about 1/7 of total
Art & Science (same institution):	44	= 338 in combination, almost 1/9 of total
History & Science:	176	
Art & History & Science:	118	
Total with Science:	776	= about 1/4 of total

Out of total of 2,889 museums (all kinds):

Exhibit buildings:	2,067
Botanic gardens:	118
Aquaria, zoos:	128
Nature or conservation centers:	254
Planetaria:	85*

Attendance: Total annual visits reported by 2,754 museums: 559,721,619

28% reported class/study group visits (about 212,000,000)
66% reported guided tours for school groups

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* Cf. data from America's Museums: The Belmont Report (American Association of Museums, 1968), p. 16: "A recent survey reported 421 of them [planetaria] in 45 of the 50 States. Nearly all have educational programs, some of them very extensive."

Attendance (continued):

Science only:	438 museums	209,511,093 total visitors
Art only:	420	211,630,644
History only:	1,424	78,880,361
Art & History:	269	13,044,092
Art & Science:	44	9,661,200
History & Science:	176	26,026,737
Art & History & Science:	118	10,967,492

Median number of visits for all museums: 12,000 per year
Median, science only: 65,066
Median, art-science: 114,950

Of the total 438 science museums, 298 had some sort of relationship with a local elementary and secondary school district. Selected program activities offered by the 438 science museums were as follows:

Guided tours for school children:	302 museums
Presentations at schools:	153
Organized school loan service:	68
Classes, clubs, study groups for children:	129
Planetarium programs:	46

Median number of participants in study group and class activities for all museums (all ages): 1,100; median for science only: 3,329.

Selected categories of age groups served by museums are as follows:

	Total in Survey	All Ages	Children /Youth	Non-Response
Total museums:	2,889 (100%)	1,819 (63%)	253 (8.8%)	472
Science only:	438 (15.2%)	275	80	54
Art only:	420 (14.5%)	225	17	42
History only:	424 (49.3%)	941	84	288
Art-History:	269 (9.3%)	159	19	44
Art-Science:	44 (1.5%)	32	6	4
History-Science:	176 (6.1%)	115	24	24
Art-History-Science:	118 (4.1%)	72	23	16

Of the 438 science museums, 127 had programs for special population groups, including:

Handicapped (adults and children):	62 museums
Preschool children:	66
Talented/gifted children:	63
Disadvantaged (includes adults, but mostly children):	76

States with ten or more science museums (based on U.S. totals of 438 sciences museums and 2,889 all museums):

	Science Only	Science with Art or History or Both		Total with Science	Total Number Museums in State
Arizona	13	(+ 4	=	17)	45
California	54	(+ 29	=	83)	220
Colorado	10	(+ 5	=	15)	51
Connecticut	14	(+ 8	=	22)	77
Florida	19	(+ 15	=	34)	89
Illinois	17	(+ 14	=	31)	99
Maryland	10	(+ 3	=	13)	52
Massachusetts	19	(+ 19	=	38)	178
Michigan	21	(+ 12	=	33)	85
Missouri	11	(+ 7	=	18)	62
New York	30	(+ 24	=	54)	254
North Carolina	10	(+ 4	=	14)	66
Ohio	23	(+ 17	=	40)	129
Pennsylvania	23	(+ 14	=	37)	141
Texas	15	(+ 12	=	27)	103
Washington	15	(+ 2	=	17)	52

Five states had over 20 science museums each (science only). Delaware had no science museums or museums with science exhibits (out of ten museums total in the state). California had the greatest number of science museums of all the states. New Jersey had only five science museums, but 15 museums with science in combination with art or history (out of 67 total museums in the state); similarly, Wisconsin had only six science museums, but 11 museums with science in combination (out of 72 total museums in the state).