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ABSTRACT

This paper describes the nature of the system planning approach to the problem of educational research allocations and examines several alternative structures that might support the Bureau of Research, Office of Education, in making the allocations. The first section discusses the problem and presents a summary of the major findings of the study. Section II describes the nature of the research planning task. Section III presents various possible research planning organizations that might perform the planning task. It suggests criteria for agencies to meet in planning research and examines 18 alternative structures that could perform advisory functions for the research planning job. Appendix A examines the educational system as a system. Appendix B illustrates the broad research planning process by a very simplified example. (Author/AF)

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SYSTEMS PLANNING APPROACH TO EDUCATIONAL RESEARCH PLANNING

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I INTRODUCTION

This paper studies the problem of educational research planning, suggests several organizational structures to do such planning, proposes criteria for their selection, and compares various alternative structures.

More specifically, it examines an advisory function to the Bureau of Research which would make long-range estimates of (a) the demands on the educational system which will be imposed by the society of some decades hence, and (b) the capabilities to educate which are feasible to have in that society; and using a systems planning approach, would transmute this information into a desirable research-allocations strategy for the near future.

At the outset of this section we ask, "Why plan educational research?". Next we pose the two problems to which this paper addresses itself. We examine the question, "Why wasn't educational research planning stressed before?" Finally, we summarize the paper and its conclusions.

A. Why Plan Educational Research?

Few today would question that the Nation's educational system is a prime contributor to the development of our society. As President Kennedy put it in his Message to the 88th Congress: "From every point of view, education is of paramount concern to the national interest as well as to each individual... This Nation is committed to greater investment in economic growth, and recent research has shown that one of the most beneficial of all such investments is education... Failure to improve educational performance is thus not only poor social policy, it is poor economics."

Few, similarly, would doubt that improved educational performance, both in terms of quality and quantity, derives in large measure from strong and vigorous programs in educational research, dissemination of research results, and implementation of these results in educational programs. What may not be so clear is the specific role of the Federal

Government in educational research and educational planning, and the role of research program planning.

With regard to the former, President Kennedy went on to state, "I do not say that the Federal Government should take over responsibility for education. Instead its participation should be selective, stimulative and, where possible, transitional... The proper Federal role is to identify national educational goals and to help local, State, and private authorities build the necessary roads to reach those goals." Thus the function of the Federal educational agencies and programs is not control, but rather stimulation, of the independent local units to expand their horizons, to discover, to explore, in a sense to invent the future. Effective coordination without centralized control can come about through independent allegiance to common goals.

The planning of educational research programs would be a vitally important and complex task for this reason alone, that a relatively small research activity (in terms of the fraction of the total educational expenditure) serves to stimulate innovation and improvement in a vast and loosely connected educational system. But beyond that, the task is made more difficult (and more essential) by the long lead time between the planning of a particular research task and the time its effects are felt in society. To produce a given effect in society 20 to 40 years from now, appropriate choices in educational research must be made now.

An orderly, open, broad, critical assessment of educational needs and capabilities, and hence of educational research priorities, is required. The lead time is too long, the issues too complicated, the changes too drastic, the potential too great, to allow or afford neglect of this task. We must not attempt to, and indeed we cannot, make educational choices for the next generation; they will do that in their own time and with their own freedom. But the research undertaken today can illuminate and broaden the available alternatives, and thus prepare the way for them.

B. The Problem

The two functions of this paper are to: (1) describe the nature of the research planning task of the Bureau of Research in the Office of Education, and (2) indicate and evaluate the types of organizations that could aid the Bureau in the task. The first is considered in Section II; the second in Section III.

C. It is so Important, Why Wasn't the Educational Research Planning Job Stressed Before?

In this paper we take the position that educational research planning is indispensable to the strong continuing development of our society. The reader is entitled to ask, "If such be the case, how does it happen that this is suddenly being stressed now, and how has its importance been overlooked in the past?" The need for an examination of the research program of the Office of Education arises at this time primarily because of three factors.

1. A New More Active Role for Education in the Great Society

The first is the changing role of the Office of Education itself. The revolutionary nature of the active role assigned to education in the Great Society is only slowly becoming widely appreciated. To be sure, it was enunciated clearly by Jefferson, who stated flatly that "education is the foremost function of government. Hence the state must sponsor education for all to the extent that each is capable of profiting from it; and the state must control that education as 'the most certain, and the most legitimate engine of government'" (quoted in Cremin, 1966, p. 85). And long before that, Plato had argued clearly that to shape society one had first to shape educational policy.

But in fact, in the history of this country the role of education has been more passive than active. The French sociologist, Durkheim, (1922) has summarized that passive view in stating that education is "a collection of practices and institutions that have been organized slowly in the course of time, which are comparable with all the other social institutions and which express them, and which, therefore, can no more be changed at will than the structure of the society itself."

(p. 65). Social change has been largely unplanned and evolutionary, and the role of the schools has been the passive one of transmitting culture, socializing the young, and providing training in traditional vocational and professional skills.

But such is no longer the case. According to the analysis of Clark (1962, p. 26), "The educational institution is now a prime contributor to change as it grows in size and complexity and takes on new tasks. Its relation to other institutions as well as its own character changes as the technological society assigns it an increasingly important place. Much of its new significance stems from a vast broadening of its cultural role." Regardless of whether some may view with alarm, the fact seems to be that we recognize the feasibility of exploring the future and have committed a major effort to that task. In the design of the society of a generation hence, education clearly plays a key role.

2. Rapidly Changing Needs and Technological Capabilities in Our Society

The second factor giving rise to the need for an examination of the research program of the Office of Education is the rapid changing of needs and capabilities of society. The fact that the nature of society is changing with apparently ever-increasing rapidity presents a challenge to education in the form of outputs expected or desired. At the same time, advancing technology makes it feasible to carry out educational programs which were not practicable before. The assessment of anticipated needs and anticipated capabilities, and the planning of research to actualize the potential capabilities, is prerequisite to effectively meeting the future educational demands.

Up to the present automation has modified the lives of unskilled workers. In the next generation it will affect the lives of skilled workers and the professional man as well. The influences of automation must be accounted for in the educational investments that are being made. (See Appendix A, Part C for further discussion of changing needs and capabilities.)

3. Educational Research Effort Growing and Decentralized

Finally, the requirement for an examination is seen in the growing and decentralized effort. Expanded involvement of the Federal Government in education has brought the problem of welding together an integrated and effective research program out of a large decentralized complex of individual research efforts with appreciable district, regional, and state autonomy. An added complication is the fluctuating research support and emphasis resulting from specific legislation.

4. A Systematic Research Planning Effort is Required Now

Thus the planning of educational research is required now, to an extent and with an urgency not demanded in the past, for these three reasons:

(1) the shift from a passive to an active role for education

(2) rapid changes in needs and capabilities

(3) the size, complexity, and decentralized nature of the overall research effort

These same factors make it apparent that the study of the research planning task of the Bureau of Research, as well as the identification and evaluation of organizations that could perform the task, should be undertaken with the systems planning approach in mind. The approach will have the following advantages over a less systematized, more intuitive means of arriving at research allocations and plans:

a. In problems of such extreme complexity, where no one person can qualify as an expert in all aspects of the problem, it "provides a framework which permits the judgments of experts in numerous sub-fields to be combined, to yield results which transcend any individual judgments." (Hitch, 1955, p. 25)

b. It is a way of ensuring that all relevant aspects of the problem will be examined, particularly the needs as set at the next higher level of system complexity, and the capabilities as determined by the state of affairs at the next lower level of system complexity.

c. It is a way of checking intuitive judgment, which may be very good but which in itself affords no way of determining whether it is or not.

D. The Contents of This Paper

This paper describes the nature of the system planning approach to the problem of educational research allocations and examines several alternative structures which might support the Bureau of Research in making the allocations. The remainder of this section condenses the major findings of this study. Section II describes the nature of the research planning task. Section III presents various possible research-planning organizations that might perform the planning task. It suggests criteria for agencies to meet in planning research and examines eighteen possible agencies relative to these criteria. Appendix A examines the educational system as a system. Appendix B illustrates the broad research planning procedure by a very simplified example.

E. Summary and Conclusions

1. The role of the Office of Education is to stimulate, not control, the educational system. Thus the mission of the Bureau of Research is to lead the way to educational advances through educational research. This it does through

(a) stimulation and support of needed research efforts and dissemination of research results, and,

(b) since the outputs of the educational research system are too incomplete for direct application, support of innovative programs incorporating these research results.

2. Planning of this educational research activity is characterized by being extraordinarily demanding as regards breadth of scope and projection in time.

3. As to scope, there is hardly an area of knowledge not touched by educational research in some way. In particular, the planning function must bring together knowledge and experience from:

the educational profession
the behavioral sciences
subject disciplines in the curriculum (physics, biology, humanities, etc.)
technology (suppliers of educational materials, etc.)

4. As to time, planning today's educational research allocations requires a projection of the state of society and of technology twenty to fifty years into the future.

5. The planning function requires, by way of support, an activity which will:

(a) Observe the state of society and of technology

(b) Projectively interpret the states many years into the future

(c) Make the systems considerations to:

1) relate projected needs of society to projected capability to educate

2) translate future anticipated deficiencies into today's educational research allocations.

6. This supporting function might be within the Bureau of Research or might be in an external organization, advisory to the Bureau of Research. If external, it might be within a government laboratory, an independent research institute, a university-centered institution, an industrial laboratory, or some combination of these.

7. This supporting function requires, in turn, close connection to two particular research activities, namely:

(a) Predictive research on feasible future states of society and technology, and their dependence upon present decisions

(b) Systems studies of the educational system.

These two research activities might be contained within the research-planning advisory organization or they might be subcontracted to outside sources.

8. Based on various choices with regard to these alternate possibilities, eighteen separate research planning structures are considered, in Part III of the report. Four categories of criteria are proposed on which to base a comparison:

(a) sources of research data

(b) criteria relating to fostering of objective and circumspect judgment

(c) criteria relating to fostering of breadth and long-term capabilities

(d) real-world connection

9. Selection of a suitable structure in which to carry out this supporting activity is crucial. The requirements imposed by the function are extremely difficult to meet, even when the organizational structure is optimal. One of the most important of these requirements is the capacity for self-renewal. Several of the others seem almost contradictory, which emphasizes the difficulty of achievement. Thus a close connection is required to the educational system, but also a close connection to relevant governmental agencies; but these real-world connections are desired at the same time that objectivity and detachment are recognized to be also necessary.

10. With regard to the predictive research and educational system studies mentioned in (7) above, it appears that a valuable informal kind of communication would be fostered by a structure in which these are included rather than being subcontracted out.

11. The criteria relating to fostering objectivity, detachment, breadth of scope, self-renewal, and long-term view argue for a close connection with one or more graduate universities having strong and diverse research programs.

12. The criterion of adequate real-world connections can be met in various ways.

13. Among the more suitable organizational structures for the supporting function described in (5) above are:

(a) an independent research institute with a strong university connection and also a connection to a general research institute or some other adequate real-world connection, incorporating the predictive research and educational system studies

(b) a similar but larger organization serving other government agencies in addition to the Office of Education

(c) a small in-house research planning activity within the Bureau of Research could provide a valuable check on the outside institute.

II THE EDUCATIONAL RESEARCH PLANNING FUNCTION

The complexity of the educational system, the extensiveness of the educational research problem, the extremely long lead times required for educational research, and the wide variety of sources of educational research, many of which are stimulated but not wholly supported by the Office of Education, require that the educational research planning function be done very carefully and imaginatively. This section describes this educational research planning function. First, we consider what kinds of research are to be done and who will do them. Next, we consider the function of the Bureau of Research and its relation to the educational system. Finally, we consider the activities to be carried on by the proposed advisory function in support of the Bureau of Research.

A. Kinds of Educational Research to be Performed

The four kinds of research to be performed in support of the nation's educational program are:

a. Basic research on learning and development, other educational topics, organization of knowledge in various areas to be included in the curriculum

b. Applied research

- b_1 Component research on educational techniques and technology, including methods of evaluation
- b_2 Predictive research on alternative future states of society and future states of knowledge and technology
- b_3 Education systems research

The meaning of the classifications of educational research will probably be made clearer by considering some examples. Table I, below lists several examples of each primary research area.

Table I

SUMMARY OF RELEVANT EDUCATIONAL RESEARCH AREAS

a. Basic Research

Individual growth and development
- Socialization and personality development
- Learning and thinking, habit formation
- Memory, concept formation
- Problem solving and creative thinking
- Learning ability, intelligence
- Motivation, personality structure and dynamics

Interpersonal and group behavior
- Small-group behavior
- Social stratification, classes, mobility
- Organizations and institutions
- Ethnic differences, prejudice, discrimination, authoritarianism
- Mass communication
- Opinions, attitudes, beliefs

Mechanisms of individual, group, and cultural change

Identification of desirable and attainable outcomes for the individual and for society

Relation of curriculum content to outcomes

Theory of instruction

Research methodology

b. Applied Research

b_1 Component Research

Curricula (summarized in Fig. 1)

Tools

- Media--mass instruction, individualized instruction, computer-aided simulation, etc.
- Techniques--team teaching, personality development techniques, etc.
- Environment--schools, classrooms, laboratories; automated classrooms, computer-based study carrels, traveling schoolroom, at-home education, etc.

Enabling functions--administration, organization, financing, scheduling

Auxiliary functions--counseling, health, transportation

Testing, evaluation, motivational devices

Characteristics of students, teachers

b_2 Predictive Research

Manpower and the economy

Social and political institutions

Values, mores, ethics

Physical, biological, social scientific knowledge

Materials handling, energy handling information handling technology

Predictive methodology

b_3 Educational Systems Research

Systems studies of public education system, instructional systems, component systems (fiscal support, innovative, teaching aids, etc.)

Nonpublic and problems
- Equalizing educational opportunities for culturally deprived
- Delinquency, sec, alcohol and drugs
- Mentally, physically handicapped
- Vocationally displaced
- Teacher recruitment and training

Evaluation

International education

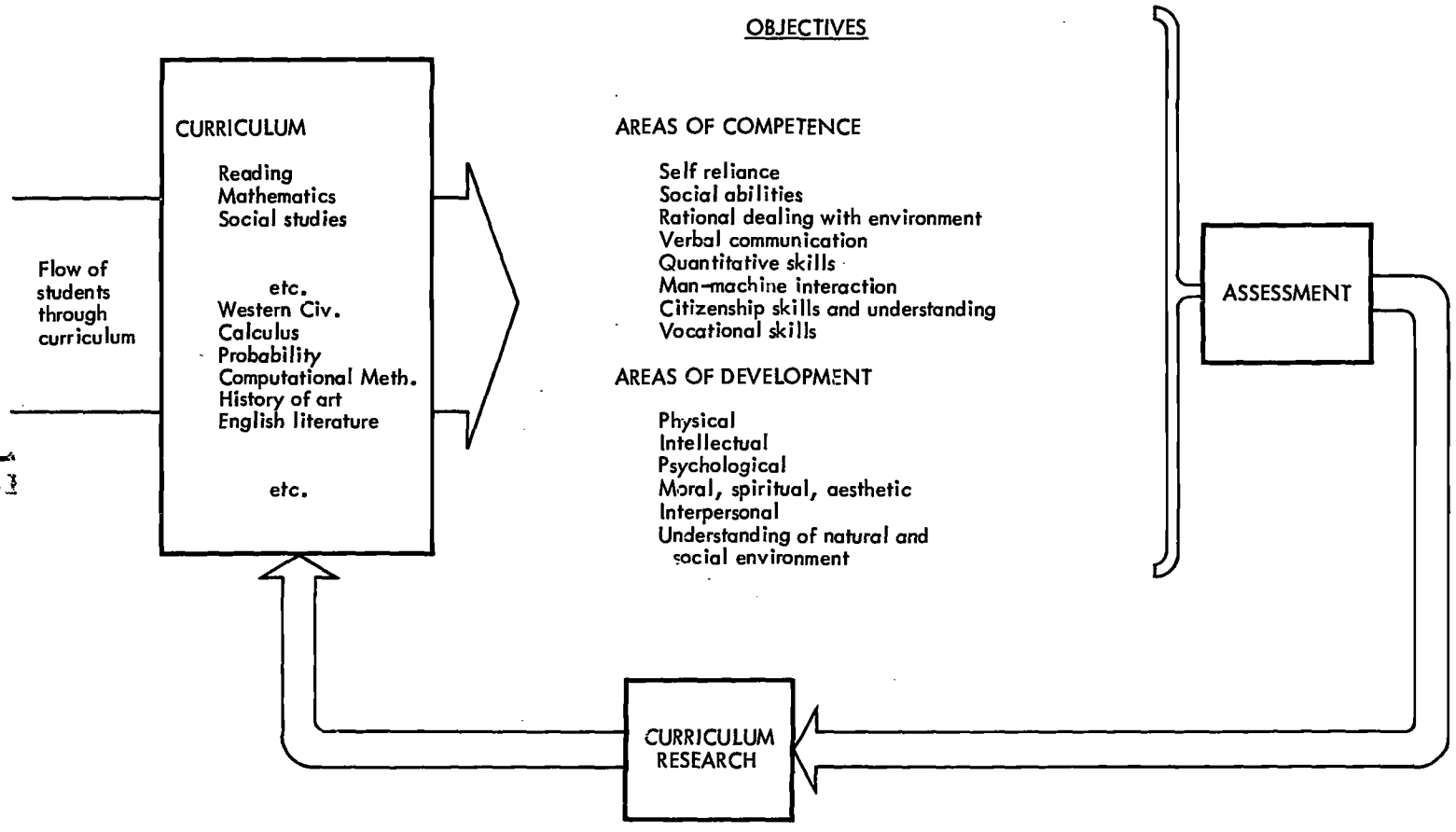

FIG. 1 REPRESENTATION OF THE NATURE OF CURRICULUM RESEARCH

FIGURE 1 -- COMMENTARY

The curriculum can be (and has been) subdivided and conceptualized variety of ways. For research-planning purposes a description in s of objectives and designed level of attainment of those objectives erhaps most useful. Thus research with regard to a particular curri- m might be characterized by specified degrees of desired realization he objectives listed below.

CURRICULAR OBJECTIVES

s of Competence

1. Self reliance--experiencing self as a free, responsible, deciding individual, capable of self-education.
2. Social abilities--experiencing self as an integral part and contributing member of society, able effectively to communicate with, relate with, and work with other members.
3. Rational dealing with environment--art and craft of inquiry, measurement, ordering experience, problem solving, hypothesis testing.
4. Verbal communication--oral and verbal linguistic and semantic ability, specification and organization of knowledge.
5. Quantitative skills--mathematical and computational methods.
6. Man-machine interaction--driver education to computer programming.
7. Citizenship skills and understanding--understanding of the history, goals, social and political institutions of the nation; of our cultural and scientific heritage.
8. Vocational skills--ability to make a specialized contribution to society in a particular vocational or professional area.

s of Development

1. Physical--development of a sound body.
2. Intellectual--rationality, objectivity; motivation to, and confidence that one can, learn further.
3. Psychological--self understanding, identity, self worth, personal values, self actualization.
4. Moral, spiritual, aesthetic
5. Interpersonal--development of wholesome and meaningful relationship with others.
6. Understanding of natural and social environment--of the great generalizations of the physical, biological, and social sciences, of history and of the humanities, but also of the meaning of specific intimate relationship with nature, a work of art, another human being.

Table II

POSSIBLE SOURCES OF RESEARCH

Major types of research / Types of research organizations	a Basic Research on the Educational Process	b_1 Component Research on Educational Techniques and Technology	b_2 Predictive Research on Future States of Society, Knowledge, and Technology	b_3 Systems Analysis of the Educational System and Component Systems	Dissemination and Implementation
Office of Education	a	a	a	a	A
USOE Research Centers (see listing on next page)	A	A	a	a	n
Regional laboratories	a	A	n	A	A
Consortia (COPED, etc.)	n	A	n	a	A
Universities (schools of education)	A	A	a	A	A
Universities (social science depts)	A	a	A	a	n
Nonprofit education research institutes (ESI, WBSI, NEA)	a	A	a	A	a
General research institutes (SRI, Battelle, Arthur D. Little)	a	A	A	A	a
Commercial educational research laboratories (ETS, RAC, SCD, SRA, GLC)	a	A	a	A	a
Industrial research laboratories (Westinghouse, North American Aviation)	a	A	a	A	n
Advanced research "think-tanks"	A	a	A	A	n
State Education research organizations	n	a	a	A	A
Professional education associations	a	a	a	a	A

A--clearly appropriate source, a--possibly appropriate source, n--not appropriate

Table II (Addendum)

Research and Development Centers presently established

University of Pittsburgh	Learning and Instructional Technology
University of Oregon	Administration
University of Wisconsin	Learning and Re-education
Harvard University	Educational Differences
University of California (Berkeley)	Higher Education
University of Georgia	Educational Stimulation (Pre-school)
Center for Urban Education (New York)	Urban Problems
University of Texas	Teacher Education
Stanford University	Teaching

Another aspect of the educational research picture is the matter of research agencies. Table II lists possible sources of educational research.

B. Place of Bureau of Research in the Educational System

Educational research generally supports the overall educational system. This relationship is indicated in the diagram of Figure 2. Here the large block at the bottom represents the diffuse, diversely supported and loosely coupled educational research system; the large block at the top shows the embeddedness of the educational system in the overall national system complex.

The educational system is viewed more in detail as a system in Appendix A. Briefly, it is a component of the system complex which is society. It consists, in turn, of a number of subsystems--curriculum, instruction, facilities, etc. (There are many ways in which such a subdivision might be carried out, depending upon the purpose in mind; this is discussed further in Appendix A). The entire educational system is loosely coordinated, with a large element of local control, but with considerable directing influence at the state and national levels.

THE EDUCATIONAL SYSTEM WITHIN SOCIETY

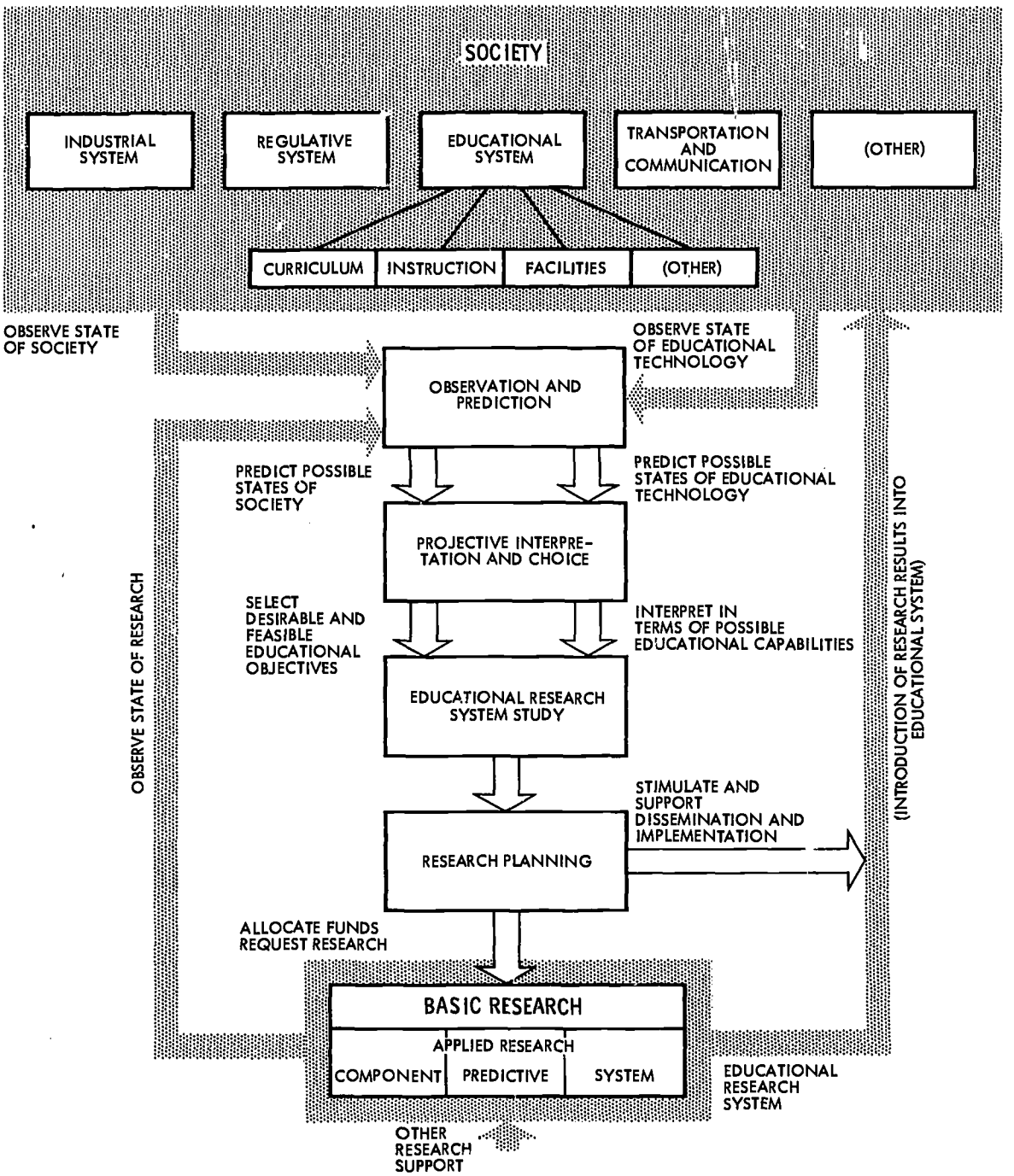

FIG. 2 THE FOUR EDUCATIONAL RESEARCH PLANNING FUNCTIONS

The educational research system is divided into four component functions described in Table I; namely basic, component, predictive, and educational systems research. Only a fraction of this research is supported by the USOE Bureau of Research. The research outputs contribute to, and are essential to, the ongoing task of the educational system. However, the outputs of the educational research system, while a most important stimulus to advances in the educational system, are too incomplete to be used directly. Thus a most important function, undertaken by the Bureau of Research is the stimulation and support of research dissemination and implementation.

Education in this country is a 40-billion-dollar-per-year operation. A 0.1- or 0.2-billion-dollar-per-year research program (small in proportion by industrial standards) could hardly be expected to bring about dramatic improvements even if the educational system were predominantly controlled from the national level. With the traditional local control of the American educational enterprise the connection between research output and educational innovation is far more tenuous. The outputs of the educational research system must be disseminated to others, accepted by them, developed further to be operational, adapted to local conditions, financed from local support, instrumented by equipment from private industry, implemented widely, evaluated, and modified to meet unforeseen problems. Finally, operational responsibility for the consequent innovation is in the hands of persons remote from the original research process.

The task of the Bureau of Research is shaped by another important consideration. The educational research being planned today will be effective in improving the lives of citizens twenty to fifty years from now. The research must be planned in terms of its effectiveness then. Educational research planned today will be done over the next five or ten years, will be implemented in the systems ten to twenty years from now, will be faced with the social problems of that era, will help to solve some of them, and will be a strong determinant of the success of the careers of the children being educated then. These careers will be at their peaks thirty to fifty years from now.

Thus the research planning task is complicated by these two factors: (a) the need for active participation in the task of research dissemination and implementation, and (b) the need for especially long-range projections. Research planning can, then, be thought of as consisting of four components, namely:

1. Request and initiate research efforts in response to needs
2. Allocate research funds
3. Disseminate research results
4. Stimulate and support implementation

In support of the research planning task, three other functions are required:

1. Observation and prediction of possible future states of society and of educational art and technology.
2. Projective interpretation of these predictions in terms of future needs and capabilities; selection of desirable and feasible educational objectives.
3. Educational research system study to determine educational capabilities needed to attain objectives, educational research required to acquire capabilities.

The four planning functions are the assigned mission of the Office of Research. The three support functions could be provided from an outside supporting organization, and there are some advantages to such an arrangement. On the other hand, they could also be incorporated into the Office of Research. Both types of structure will be considered in Section III.

Figure 2 is an attempt to represent the most important relationships among the research planning task and its three supporting functions, the educational research system, and the overall educational system. Research enters and affects the educational system in various ways--through producers of educational texts and equipment, through schools of education in the universities, through publications of the Office of Education sent to school administrators and teachers, through professional journals, through the Regional Laboratories, etc. The Bureau of Research assumes the task, in addition to research initiation and research funds allocation, of aiding, coordinating, and stimulating the dissemination of research results and innovation based on these results.

The three supporting functions, shown above the "Research Planning" block in the figure, are actually three aspects of a single task, which are separated in the figure to emphasize the nature of the overall function. These are the essential functions to be performed within the structures which are compared in Section III. Within the same structure might be included the "Research Planning" function (in which case, of course, the structure is the Bureau of Research itself). Again, some amount of the research represented by the blocks (at the bottom of the diagram) "Predictive Research" and "Educational Systems Research" might be included in the same structure. Various arrangements of this sort are discussed in Section III.

As is pointed out there, some of the requirements with regard to these supportive functions seem almost contradictory. Thus while a close connection to governmental processes is required, at the same time a valuable kind of detachment and noninvolvement in day-to-day problems is gained by separateness from the Office of Education. A real-world connection with the problems of the educational system and the concerns of industry is helpful, especially in terms of increasing the likelihood that innovative programs will ultimately result from the research which is stimulated. But again the kind of long-range vision and objectivity which are required are endangered by too close a coupling to real-world problems.

C. Observation, Prediction, and System Considerations

Long-term planning for the research effort for the educational system requires: first, a projective observation on society, particularly in relation to the education system; second, observations on the states of the educational system, educational technology; and third, systems planning of educational research. Long-term planning must be made on the educational system and on its supporting research function. Short-term planning must be done on more immediate and narrowly focused problems.

1. Projective Observation on Society

Long-term planning for the educational system requires a projective observation on society. Some brief discussion is necessary of the task of predicting and choosing the characteristics of the future society, into which the products of the educational system will be fitting, and which the educational program will be instrumental in bringing into being. This then needs to be interpreted in terms of demands on the educational *system*. We have emphasized "choosing" because the future state of society is in part a function of choices made in the present time. One might ask if we do not have available, from various governmental and private agencies, ample predictive statistics of population, employment, school enrollment, population concentration, residence and travel patterns, and so on. Why do we need a new sort of research on which to base planning?

There are several reasons. One is that we need to know, as fully as possible, detailed characteristics of the society with a lead time of several decades. If we look ahead this far, various aspects of society which might for short-range predictions be independent, become strongly interrelated. (A classical example is the way the technological development of the automobile affected American courtship patterns.) Thus the predictive studies must be comprehensive and integrative. No portion of the social structure can be considered independent of the rest; society must be considered as a dynamic whole. Furthermore, not only are we concerned with the usual demographic variables and with economic, sociological, and political aspects. Relevant state variables include values and aspirations, attitudes and prejudices, beliefs and disbeliefs, enthusiasms and ennuis, visions and conviction of hopelessness.

The future is made up, in general, of three components:

1. The consequence of historically-rooted trends
2. The results of present and future decisions
3. Randomness due to unanticipated events.

Thus an estimate of the future situation will be the result of three analyses:

1. Prediction based on projection of present trends
2. Choice of goals and the estimate of the extent to which they will be realized
3. Estimates of the probabilities of various possible and relevant events.

These are by no means separate analyses; the result of each affects the others. We shall comment briefly on each.

The first of these analyses is a somewhat familiar process. Estimates are available of the effects of such present trends as increasing population, increasing urbanization, increasing mobility, increasing duration of formal educational period, decreasing work week, etc. Predictions of this sort are regularly made by the Bureau of the Census, Bureau of Labor Statistics, National Center for Educational Statistics, et al. Projections of a less quantitative sort, by experts in various fields, are available in quantity. Examples would be the prediction of the consequences of automation by Simon (1965) and of the consequences of increased free time by de Grazia (1962).

The second kind of analyses focusses on the available alternatives, the probabilities of various choices, and the effects of these choices projected in time. For example, if the analysis were being made five years ago, one might have considered the probability of a massive attack on the problem of poverty and the effect that this would have on urban living patterns, education, labor, crime, and attitudes toward ethnic differences, by say, the year 1980.

The last of these three is the most nebulous. Unanticipated events will be considered in planning depending upon the likelihood of occurrence and upon the extent of the effects they will have. For example, whatever probability may be assigned the event of widespread nuclear devastation, it very likely would not be considered in planning the

educational research system because its effect would be so great as to nullify practically the entire plan. On the other hand, we might well include consideration of the possible event of contact with extra-terrestrial beings since the assigned probability would probably not be negligible, and the effect on society would be significant but moderate. The event of development of new means of control over the origin and forms of life, or over the mental processes of other individuals regardless of their will, would almost certainly be considered; the probability to be assigned would no doubt be appreciable, and the effect on society would be significant.

When the anticipated (or desired) future state of society is interpreted, for the purposes of educational research planning, in terms of needs, these may be expressed in various forms depending upon the aspect of the design problem under consideration. Some examples are:

1. Output of graduates at specified grade or degree levels
2. Output of graduates in various vocational categories
3. Basic skill components in the general education of all citizens.

2. Projective Observation on Educational System, Educational Technology, and Educational Research

The observations on the subsystems are somewhat more direct than observations on society. When one observes and predicts the state of the educational systems he observes the functions being performed and evaluates the quality of performance as well as the completeness of the functions. As discussed in some detail in Appendix A, the functions of the educational system can be characterized as follows:

a. Related to Individual

(1) Skills

Basic
Vocational
Interpersonal
Mental-personal

(2) Knowledge

(3) Personal development

b. Related to Society

(1) Vocational and professional training

(2) Informed and competent electorate

(3) Contribute to solution of internal social problems

(4) Contribute to realization of external (international) goals

(5) Advance scientific research

(6) Provide public information services

(7) Advance arts

It should be borne in mind that projections are vital to the task of system planning. Not only must the present states be observed, but future capabilities must also be assessed.

The adequacy and effectiveness of educational technology must be assessed in relation to carrying out the educational functions. Particularly relevant is the projection of new technological capabilities. This job, requiring a fairly broad range of technical capabilities, has received too little attention in the past.

Educational research is interdisciplinary and presently inadequately projected. Even in the research community effective communication across disciplinary boundaries is uncommon.

3. Educational Research Planning

We wish to discuss the research planning problem without, for the moment, making a distinction between those components which will be done within the Bureau of Research (actual research allocation decisions) and those which may be done by outside agencies (research and advisory functions). It will be helpful to distinguish between a narrow-sense (short-term, narrow scope) research allocation problem and a wider-sense (long-term, broad scope) research planning problem. We shall comment briefly on each.

a. Narrow-Sense Research Allocation

The narrow-sense research allocation problem assumes that the annual research budget is a fixed amount, known in advance. It assumes

that there are various relevant research areas and various existing types of research organizations; that there are goals for the educational system and educational functions to be performed as effectively as possible; and that there are time preferences, varying degrees of urgency associated with the solution of specific problems or the accomplishment of certain advances. The allocation problem is to distribute the available research funds among the relevant research areas in such a way as to maximize the expected contribution toward the accomplishment of the goals. Substantial effort is placed on details of implementation and particular innovation.

We may think of the narrow-sense research allocation problem as being essentially composed of three parts, namely:

1. The projected demands on the educational system, based on predictive research on future states of society
2. Projected capabilities to educate, based on predictions of future states of technology
3. Relevant research areas to be supported to degrees yet to be ascertained.

The problem is to distribute the research funds in such a way that one ends up with the capabilities (which are a function of research) as nearly as possible satisfying the demands.

But essential time lags are present in the situation. We wish to distribute the research funds now so that capabilities will be present at some later time to educate for the needs of society at some later time. Furthermore, the development and evaluation of an educational program by a particular time requires that certain component research on the educational techniques and devices to be used must be accomplished prior to that time; this, in turn, necessitates that certain basic research must have been carried out before that.

Furthermore, we attach varying values to the satisfying of different needs. Costs are associated with the accomplishment of research in the various relevant areas. But the relationship between research expenditures and results in terms of increased capabilities is a probabilistic one. There may be a high probability that research in a

certain area will yield a modest return in capabilities, and perhaps a lower probability that some research funds gambled in a problematical area might result in a very significant new development.

Also in the category of narrow-sense research planning should be such specific problems as development of Educational Television Projects or the introduction and assessment of the "new math" curriculum.

b. Wider-Sense Research Allocation

In the wider-sense problem we would impose no such initial constraint as a fixed research budget, but rather would set out to evaluate a wider range of alternatives in which the research budget is one of the variables. To do this would necessitate placing some sort of value on meeting the demands to be placed on the educational system. Some would object that one cannot reasonably attach a dollar figure to such a subjective value as knowledge for its own sake, or the sort of self understanding that may come through studying poetry and philosophy. But we do, in fact, place a dollar value on liberal education. Each of us would be willing to pay some amount, in tuition and foregone income, for a year's education in the humanities. This amount can be ascertained, at least approximately, by suitable techniques. Thus, it is possible to approximate a value to be attached to achieving one of the goals of education to a prescribed degree. The problem can then be approached in terms of a number of different alternatives, with varying costs and payoffs, among which to choose. Among this wider range of alternatives, are supplementing research budgets with funds from private foundations and carrying on educational campaigns to obtain a higher appropriated budget, which are not included in the alternatives allowed in the narrow-sense problem.

III ALTERNATIVE STRUCTURES TO DO RESEARCH PLANNING JOB

We have taken the time to look fairly carefully into the nature of the system analysis approach to research planning, because this tells us something about the types of persons who will be able to do it effectively and about the environment and support they will need. We can see, for example, that they will need to have skill at model making, and ability to recognize where quantification and mathematical analysis will pay off--but equally important, the wisdom to recognize where non-quantitative types of analysis do more justice to the nature of the problem under consideration. They need to be broad generalists, but to be able to communicate well with specialists in a diversity of fields, from economics, psychology and anthropology to philosophy, history, and computer science. Above all, they need that rare ability to be able to free themselves from conventional thinking, to view a problem from a new perspective in which it receives a new degree of illumination, to approach it with imaginative detachment.

The function of the structure is to provide an environment in which this group can work effectively. There are innumerable possibilities, depending on such partitioning as in-government or out-of-government, university-connected or not, including the predictive research function or not, and so on.

This section will be divided into three parts. In the first we will list eighteen alternate structures which can carry out all or parts of the research planning job. In the second we present several criteria to be met by acceptable structures. The last part is a summary.

A. Alternative Structures

We have selected eighteen of what appear to be among the most reasonable alternatives, listed in Table III. It should be noted that these are structures for carrying out an advisory function, since the research planning itself is the responsibility of the Bureau of Research. Thus

TABLE III

ALTERNATIVE STRUCTURES FOR CARRYING OUT

AN ADVISORY FUNCTION ON RESEARCH PLANNING

E	In-house long-range research planning group
E_1	In-house group supplemented by occasionally meeting study council
E_2	In-house group supplemented by regional and R and D laboratories
G	Government Institute serving USOE only
L	Government Educational Research Laboratory
H	Large government Institute serving a number of departments and agencies
I	Independent non-profit institute serving USOE only
I_1	Same, with a strong connection to a university
I_2	Same, with a strong connection to a unversity and to a general research institute
F	Large institute for predictive research and planning, serving a number of government departments and agencies
F_1	Same, with a strong connection to a university
F_2	Same, with a strong connection to a university and to a general research institute
R	Project within a large general research institute such as Battelle, SRI, Arthur D. Little, etc.
R_1	Institute-type organization within a non-profit research institute
U	Institute within or closely tied to a university
U_1	Institute attached to a school of education
U_2	Institute attached to university social-science departments
Z	Project within a large industrial laboratory

when an in-house planning group is given as one of the alternatives, we have in mind a relatively insulated long-range planning group within the Bureau, so that the advisory and planning functions are in a sense combined.

The first three organizations listed in Table III represent fairly direct extensions of the staff of the Office of Education. G, L, and H are government laboratories. The next eight, I, I_1, I_2, F, F_1, F_2, R, and R_1 are research institutes (mainly non-profit) with various special characteristics. U, U_1, and U_2 are university-centered organizations. The last, Z, is a large industrial laboratory. This list is not claimed to be exhaustive, but is representative of the possibilities.

Several of these alternatives, namely H, F, F_1, and F_2, refer to organizations which would be involved with projective research and systems planning of research programs (and possibly, also implementation and action programs) in other areas as well as education--manpower, economic opportunity, urban development, transportation, and so on. Thus one type of alternative not listed specifically is an institute which would initially advise on the USOE's educational research planning task (which is the one with the longest time constant), and then later expand into a broader projective research and systems study program covering other elements of society, and serving other government agencies besides the USOE.

Another alternative not specifically listed would be a consortium or inter-institutional structure.

B. Criteria for Comparison of Alternative Structures

A number of criteria are relevant to the selection of a structure for the research-planning support function. Some of the most important ones are discussed below. In Figure 3 an attempt is made to compare the eighteen structures of Table III on the basis of these criteria. The purpose of this analysis is not so much to indicate a preferred decision as to present a rational approach to arriving at that decision.

Four categories of criteria are considered:

1. Sources of research data
2. Criteria relating to objective and circumspect judgment
3. Criteria relating to breadth and long-term capabilities
4. Real world connection

1. Sources of Research Data

The research planning function requires inputs from four different kinds of research, as listed in Table I. Data on the current state of basic research and educational component research is readily available through technical journals and other open sources. Thus there is no serious problem involved for any organization in acquiring sufficient access to such data. A different situation exists with regard to the needed predictive research and educational systems research. The type of information required here is much more specialized, and in order to have it freely available in suitable form some of it at least will very likely have to be generated especially for the educational research planning task. This means it will have to be done in-house or sub-contracted out. Both of these appear to be workable possibilities, although there may be a very significant advantage of the in-house arrangement from the standpoint of facilitating easily-arranged, informal small-group discussion between the persons involved in this research and those involved with the interpretive and research planning activities.

In Figure 3 the probable sources of research data for the eighteen research-planning structures are indicated, using the following code:

s	subcontract out or depend upon outside sources
a	adequate input from outside sources
R	perform major research function in-house
P	perform minor research function; rely heavily upon outside sources

TYPE		STRUCTURE	APPROX. STAFF SIZE	RESEARCH INPUTS				EVALUATION CRITERIA											
					APPLIED			GENERAL				BROAD SCOPE					REAL-WORLD CONNECTION		
				BASIC	COMPONENT	PREDICTIVE	SYSTEM	a OBJECTIVITY	b NOT EXCL. GOVT.	c COMPLETENESS	d BASIC RES. CONN.	e SELF-RENEWAL	f RESPONSIBILITY	g INTERDISCIPLINE INTERACTION	h LONG-TERM	i ATTRACTIVENESS	j TO EDUC PROF	k TO EDUC INDUSTRY	l TO LOCAL DISTRICTS
IN-HOUSE	E	In-hause lang range planning graup	5	a	a	s	s	○	◐	◑	◑	◑	●	◑	●	◑	●	●	●
	E_1	E supplemented by study cauncil	5	a	a	s	s	○	◐	◑	◐	◐	●	◐	●	◑	●	●	●
	E_2	E supplemented by regional and R&D Laboratories	5	a	a	P	P	○	○	◑	◐	◐	●	◐	●	◑	●	●	●
GOVERNMENTAL ORGANIZATION	G	Gov't. institute serving USOE	30	a	a	R	R	◐	○	◑	◐	◑	●	◐	●	◐	●	◐	◐
	L	Gav't Educatianal Research Laboratary	200	P	P	R	R	◐	○	●	●	◑	●	●	●	◐	◐	◐	◑
	H	Large Gov't. inst serving several department	100	a	a	R	R	◐	○	●	◐	◐	●	◐	●	●	◐	◐	◑
INDEPENDENT INSTITUTE	I	Independent Nan-Prafit Carp serving USOE anly	50	a	a	R	R	●	○	●	◑	◐	●	◐	◐	◑	◐	◐	◐
	I_1	I assaciated with university	30	a	a	R	R	●	◐	●	●	●	●	◐	●	●	◐	◐	◐
	I_2	I_1 cannected to general research institute	20	a	a	R	R	●	●	●	●	●	●	●	●	●	◐	●	◐
	F	Large institute serving several agencies	200	a	a	R	R	●	○	●	◑	◐	●	◐	●	◐	◐	◑	◑
	F_1	F with university cannectian	100	a	a	R	R	●	◐	●	●	●	●	●	●	●	◐	◑	◑
	F_2	F_1 connected to general research institute	50	a	a	R	R	●	●	●	●	●	●	●	●	●	◐	●	◐
	R	Praject within general research institute	30	a	a	P	R	●	●	●	◑	◑	◐	◐	◐	◑	◐	●	◐
	R_1	Institute-type arganizatian within general research	50	a	a	R	R	●	●	●	◑	◑	◐	◐	●	◐	◐	●	◐
UNIVERSITY	U	Institute within ar clasely tied to university	50	a	a	P	P	●	◑	◐	●	◐	◐	◐	●	●	◐	◑	◐
	U_1	Institute attached to school educatian	20	a	a	s	s	●	◑	◑	◐	◐	●	◐	●	◐	●	◐	●
	U_2	Institute attached to university social science department	30	a	a	P	P	●	◐	◐	●	◐	◐	◐	●	●	◐	◑	◑
IN-DUSTRY	Z	Project in a large industrial laboratory	30	a	a	s	P	◐	◑	◑	○	◑	◑	◐	◑	◐	◐	●	◑

s subcantract aut ar depend upan autside sources

a adequate input fram autside sources

R perform majar research functian in-house

P perfarm minar research function; rely heavily on autside sources

● likely to meet criterian adequately

◐ likely to partially meet criterian

◑ questianable whether criterian might be met

○ unlikely to meet criterian.

FIG. 3 METHOD OF COMPARISON OF ALTERNATIVE STRUCTURES FOR RESEARCH PLANNING

2. Criteria Relating to Objective and Circumspect Judgment

A second group of criteria relate to problems of fairness, detachment, circumspection, etc. They are criteria which would be relevant to almost any evaluative task.

a. Fostering objectivity. The structure should be one which tends to provide a kind of remoteness, of detachment, from the day-to-day operations of the USOE, to avoid long-range thinking being unduly constrained by present research emphases, present legislative constraints, present organizational limitations, etc. Thus physical and administrative separation from the Office of Education appears to be advantageous. It should not be too easy for a USOE administrator to distract long-range efforts by a plea for consideration of his urgent problem. Thus location outside the immediate Washington area may be advantageous. Similarly, the desired degree of objectivity may be more easily attained in a structure which is not directly a part of the Federal government.

Another aspect of objectivity related to structure has to do with insuring freedom from possible bias due to organizational affiliation with a supplier of other educational research, educational equipment, special educational services, etc.

b. Predictive research base not exclusively government-funded. If the supporting predictive research function is to be included within the structure it would be desirable, to increase the degree of objectivity, for it not to be exclusively government-funded. The conclusions reached in such predictive research will inevitably be displeasing to some parties. Some sort of tenure assurance seems essential to protect against restrictions of research outputs by the desires and prepossessions of support sources.

c. Completeness of approach. The structure should be one which is likely to promote a complete systems approach (projecting future needs in terms of goals, assessing possible future capabilities, generating alternative means of achieving goals, analyzing uncertainties, and rationally comparing alternatives in terms of costs, gains, risks,

and desirable sub-goals). It should have strong connections with predictive research and educational systems analysis activities.

d. Connection to basic research activity. It would be advantageous for the research-planning support function to have a basic-research capability or a close connection with a strong basic research activity. This is not so much to have access to research results, which are accessible in any event, but to provide stimulation of easy and informal discussion with minds highly trained in basic scientific disciplines. It would also make it easier to attract desired staff members whose interests lie partly in basic research areas. This condition can perhaps most easily be met though affiliation with and proximity to a major research university.

3. Criteria Relating to Breadth and Long-Term Capabilities

We have pointed out earlier that educational research planning is extremely broad in scope and extremely long-term. It is related to the economic development of intra- and extra-national regions; to problems of unemployment, vocational dislocation, segregation, equality of opportunity, poverty, crime, and juvenile delinquency; to maintaining the military strength required for the defense of the nation and to reducing the likelihood that the military forces will be called into action. It has a time constant of several generations. The structure with which the research planning advisory function is carried on should reflect the wide scope and long-term nature of the planning task.

e. Provision for self-renewal. The structure should contain provision for the activity remaining vigorous and imaginative, for a continuing rejuvenation. To achieve this it is essential not only to have an environment which promotes renewal and to practice extreme selectivity in adding staff members. Some sort of feed-through provision is a necessity. There must be suitable ways in which people can leave, as well as enter, the active working group.

This is a very important and difficult problem, one which is very seldom solved to even a reasonably satisfactory extent. One

effective measure is to have a considerable portion of the staff be temporary interns, pre-doctoral and post-doctoral fellows, visiting scholars, etc. In the permanent staff and the management segment there should be easy ways provided to move toward more specifically applied research, or more academic and basic research, or to administrative activities as interests change. There should be some way provided for management to move unproductive or unsuited persons to more appropriate activity with minimum loss of face or other unpleasantness.

No structure alone can insure self-renewal abilities, of course; it can only inhibit or facilitate. What we are concerned with at this point is not the present vigor and strength of a particular group, but rather with what structure provides the potentiality of future vigor. Thus it is necessary to examine function and the potentialities of function. In both industry and government, a primary function and a primary commitment is to maintain satisfactory operation of a complex producing or governing system. In times of stress this primary commitment governs. Thus there is inevitably a subtle but pervasive influence in a direction unfavorable to very long-term research. While this factor does not rule out structures within industrial organizations or government agencies, it is one consideration which enters into the choice of structure.

The function of a university is to gather, structure, and transmit knowledge. This is inherently a renewing function. (This is not to say, of course, that universities do not have self-renewal problems; they do, notoriously. But it does mean that in the university, more than in most other social institutions, there exists a primary commitment to preservation of a climate conducive to research with a long-term view, to continual innovation and renovation of conceptual structures, and to protection of dissenters.) Thus a structure within, or with strong connection to, a university is subject to this influence toward the self-renewal capability. In addition, a strong university tie provides one way of obtaining the feed-through of temporary staff, and also provides the stimulation of giving graduate seminars, intercourse

with colleagues working in adjacent areas, organizing new research results for teaching, and exposure to an active intellectual environment.

f. Promotes commitment and responsibility. The structure should be one which promotes a responsible involvement in and sense of commitment to the overall educational problem. This sort of involvement is most likely to be present when the structure is associated with or a part of a larger social organization with a closely allied function. This consideration would tend to favor a structure within the Office of Education or within a university over one within an industrial organization.

g. Promotes interdisciplinary interaction. Educational research problems involve issues from many different disciplines and professional fields--psychology, political science, sociology, economics, anthropology, business, engineering, besides education itself and the various subject areas to be taught such as the humanities, physical sciences, and mathematics. Communication among persons having these diverse interests is difficult at best and needs to be fostered by a facilitating organizational structure. Even more difficult to achieve, and more important, is close collaboration on a broad problem of joint interest. Working together is facilitated by physical and organizational nearness. The availability of experts in these various areas, physically proximate and organizationally accessible, is a strength furnished through a strong connection with a university, general research institute, or large general industrial research laboratory.

h. Stability, long-term orientation. The structure should be one in which there tends to be stability (through endowment or diversity of support) and which promotes a long-range view. Again the university, endowed research institute, and governmental agency satisfies the criterion better than most industrial laboratories.

i. Attractiveness to high caliber staff. The structure chosen should be conducive to developing a stimulating, imagination-fostering, prestigious environment such as would attract the highest caliber of staff members. For reasons noted previously, the opportunity for a

faculty connection with a major university is a significant attraction.

Geographical location, community environment, cultural attractions, proximity to recreation areas, accessibility to a major airport, availability of research library facilities, etc., are factors not to be ignored.

4. Real-World Connection

Besides having a built-in detachment from real-world immediate problems, the structure also needs a strong real-world connection. It is essential that the research planning function maintain a relevance to the real-world educational task, and that it be realistically aware of the problems of dissemination of research results and the implementation of innovations. The needed real-world ties are as follows:

j. Connection to the educational profession.
k. Connection to the education industry.
l. Connection to the local school districts.

These latter two are relatively unlikely to be satisfactorily developed by an exclusively university-based group. They would be facilitated by connection with a general research institute, where there exists much more of a tradition of working closely with clients.

C. Summary of Qualifications of Various Organizational Structures

We have discussed four categories of criteria: (1) sources of research data; (2) criteria relating to objective and circumspect judgment; (3) criteria relating to breadth and long-term capabilities; and (4) real-world connection. In this section we will consider how these criteria may be used in a comparison of the alternative structures listed in Table III.

In so doing, we want to emphasize two things. One of these is that we discussing a comparison of potential strengths as related to structure, not a comparison of present strengths of specific groups. We are talking about planning for decades ahead, not comparing present organizations. The other point is a disclaimer that we are attempting to arrive at a unique, best solution. In Figure 3 is presented a comparison of the

eighteen structures considered, on the basis of the four categories of criteria presented above. THIS IS PRESENTED AS AN INDICATION OF A COMPARISON PROCEDURE, NOT AS AN ANSWER. Arguments such as those in the discussion above are relevant to the likelihood that the criteria will be met within the various structures. But any of the criteria could be conceivably met within any of the structures. In the final selection, between various possible specific organizations, such a comparison would have to be made for those organizations, taking into account in each case the specific circumstances which might tend to foster or to mitigate against the achievement of the desired circumspection, long-range vision, and self-renewal ability.

1. Some Tentative Conclusions

The comparisons presented in Figure 3 suggest some tentative conclusions. One of the more attractive structures is an independent research institute with a strong university connection and preferably also a connection to a large general research institute, serving either the Office of Education alone (I_2) or somewhat larger and serving several government agencies (F_2). Incorporation of the predictive and systems research bases into the same structure would tend to be a strength. Relationship to a general research institute serving industry as well as government provides a desirable connection to real-world problems in addition to the one through the Office of Education. A very much smaller in-house research planning activity within the Bureau of Research, operating independently, could provide a check on the recommendations of the outside institute. There would be some advantage in the institute doing some non-government consulting as well.

Another type of structure which meets the criteria reasonably well is a government institute (G or H) performing essentially the same functions. This might provide some economies as compared with the independent institute. However in a matter affecting the overall welfare as profoundly as educational research planning, there is a great reluctance to centralize too much of the control in Washington, and a perceived virtue in the independence of the separate institute. A similar comment

applies to the government Educational Research Laboratory (L), although this could conceivably be independent though government-supported as are the newly created Regional Laboratories.

One of the less suitable alternatives appears to be a project within an industrial research laboratory (Z), partly for a reason which does not appear in Figure 3. It is unlikely that an industrial organization would choose to risk being possibly disqualified from selling in the very large education-materials by a conflict-of-interest charge arising from a USOE advisory contract.

2. Concluding observation

If the educational program is central to the shape of tomorrow's society, the significance of educational planning, and before that, educational research planning, becomes clear, as does the importance of performing that research planning with the greatest attainable resources and wisdom. Systems planning is no panacea. It has much to offer in aiding us to use our resources effectively in pursuing our goals; it can also be misused to clothe bad answers with an impressive cloak of sophistication. It is well to heed the advice of the eminent statistician Professor John Tukey: "The most important maxim for data analysis is this: Far better an approximate answer to the right question, which is often vague, than an exact answer to the wrong question, which can always be made precise." *

This consideration emphasizes again that the ultimate comparison will involve not only specific structures but also specific persons. Thus any comparison of empty structures must perforce be incomplete. Far better the right group of persons in a reasonably suitable structure, than a less far-sighted and able group in a perfect structure.

* Tukey, J.W., The future of data analysis. Ann. Math. Stat. 1962 33: 13-14.

Appendix A

THE EDUCATIONAL SYSTEM AS A SYSTEM

Appendix A

THE EDUCATIONAL SYSTEM AS A SYSTEM

The educational system of the United States is an extremely complicated and diffuse system, with a multiplicity of goals, controls, and functions. It operates within a deliberate policy and tradition of local control of relatively independent units, and yet with the counterbalancing demand that there be adequate coordination among the local units so that the whole acts effectively as a system. (For example, student transfer from one geographical area to another must be facile, college preparatory programs must have fairly uniform standards, there must be a minimum common background to provide a citizenry competent to carry out the electoral responsibility, and so on,) Problems of coordination and planning have been intensified by rapid population growth, by new national determination to provide improved educational opportunities for underprivileged groups, and by technological advances which have provided at once new challenges and new opportunities. The policies of creative federalism, including marked increase in federal spending for education with continued insistence on local autonomy, accentuate still further the need for viewing the educational system of the nation as a unified whole.

The function of this appendix is to explicate this systems view. The first part analyzes in somewhat more detail the reasons for and the implications of viewing the educational system as a system. In the second part the public education system is viewed as a particular system with goals and objectives, innovation, and change. The third part discusses present and future needs and capabilities.

An effective research planning organization would need a long-range plan for the educational system as a foundation on which to work. This appendix does not attempt to provide such a plan for the job is too large for a short-term undertaking. Some relevant issues are presented

with the hope of showing the reader what the nature of the job would be.

A. Characteristics of the Educational System as a System

We shall examine five characteristics of the educational system which tend to indicate that the conceptualizations of systems analysis are essential to adequate planning for the educational system and which indicate the kind of system with which we are dealing, namely:

1. The educational system is a diffuse and diverse system with multiple support and multiple control
2. It has the dual role of supplying a consumption good and simultaneously serving multiple functions for society or for other segments of society
3. While the educational system must serve a vast population, education by its very nature must be an individual process
4. The system is dynamic; an essential characteristic is the continual absorbtion of innovation and adaptation to change
5. Education, and educational planning even more so, is projective in nature; the point of aim is always many years ahead.

These characteristics are examined in somewhat more detail below.

1. Multiple Support and Multiple Control

The national expenditure for education is around $30 billion per year for the publicly supported elementary and secondary school system alone. The federal government support component is something like 10 percent. The remainder is raised and voted and controlled by the 30,000 school districts serving as independent local agencies. In addition, there is separate support for the private schools, which accommodate approximately 12 percent of the total student population; for community colleges and institutions of higher learning; for special purpose schools in languages, music, and the arts; for industrial and special government schools, etc. The American educational system is deliberately and essentially diverse in both support and control.

And yet in spite of the reality of local control, there is equally real indirect excitation at the national level, through stimulation of

policy, emphasis, and innovation. "The influences that have decisively shaped American education in our time have not been local but national in scope and character... Given a continuing localism, we have evolved what is in many respects a national system of education; and the fundamental political problem is not whether we shall have a measure of Federal control in education but how this control will be exercised and kept sufficiently responsive to the public... We need to develop appropriate methods for formulating and reviewing educational policy at the national level; but we need to be equally creative in devising ways of decentralizing the administration of these policies." (Cremin, 1965, pp. 95-100)

Even at the level of the elemental, though most important unit in the system, the student, the distributed control characteristic is evident. The individual student is far less controlled by the system than is the infantryman or the industrial worker. The process of providing a meaningful education is that of stimulating the student to a significant educational experience, not that of control. (The apostolic psychologist Carl Rogers has pithily stated, "Anything that can be taught to another is relatively inconsequential, and has little or no significance on behavior." (1961, p. 276))

2. The Dual Role of The Educational System

The educational system plays both a primary role in supplying a consumption good and a supporting role in supplying input to various other systems--the industrial-economic system, the public safety and defense system, the governmental system, and so on. A component of the educational program may contribute mainly to the first of these roles (for example, art appreciation), or to the second (vocational training as an example), or to both (as in the case of basic reading and mathematical skills). Education in its supporting or component role may appear as a capital investment, contributing to future earning power for the individual and to productivity for the society. It also has enabling value to the functioning of society, as Thomas Jefferson recognized when he stated that an educated electorate is indispensable

to a democracy. Furthermore, education is an agent of social change. "Formal education is always a cultural agent, doing the bidding of the general society and specific social forces in it. But it is also an innovating institution, affecting the general society and in directly causing other institutions to do its bidding." (Clark, 1962, p. 42) The active and central role of education in such programs as relief from poverty, unemployment, and segregation is widely recognized. Education will clearly play a key role in our approaches to international problems.

Consideration of the educational system as a system is complicated by this dual role. The kinds of studies which economists have made (Schultz, 1963; Platt, 1962)tend to concentrate on education as an investment good and not to include the consumer good and the social change aspects adequately. (As we point out elsewhere in this report, the attaching of an economic value to a liberal arts education is an operation of debatable validity (see App. B, Pt.F).) Many component educational experiences serve both roles simultaneously. For example, a program to improve reading skills simultaneously puts the student in a better position to understand the art and culture of his times (consumption good) and also equips him to assimilate vocational training (investment good with direct economic value).

The types of contributions made by the educational system in these two roles will be articulated more fully in Part B, following. Meeting these educational objectives simultaneously is somewhat like the diet problem of choosing foods so that a minimum necessary intake of protein, minerals, carbohydrates, etc. will be maintained. Minimal levels of basic verbal and mathematical skills are necessary to meet desired levels of practical ability to function in the society, vocational accomplishment, enculturation, and personal satisfaction. An essential part of the systems analysis task is the assessment of these levels of training and the setting of critical levels which the educational system is expected to meet.

The fact that education plays a supporting role as a component function in other systems makes it needful that advances in education be coordinated with consequent or related changes in these other systems. For example, vocational training programs are affected if a substantial change is made in the teaching of the mathematical base on which they build. They will be still more affected if secondary-school students are provided with a thorough background in the use of modern digital computers. An important part of educational planning involves establishing the appropriate balance between the broad base of general skills, furnishing a flexible background for a range of vocational choices, and the specific vocational training to be included in secondary-school college programs.

Another aspect of the supportive role of education is the preparation for citizenship. Course work in government and history as preparation for electoral responsibility, remedial reading programs as a weapon in the war on poverty, integrated school experience as a component of a program of community development, are familiar examples. But the meeting of social objectives and the attainment of individual development through the educational experience can be competing goals. As Bugental warns (1965, p. 408): "Education...can be misused to obscure the truer potentials for human experience...Too often education becomes a powerful influence toward making persons into objects, toward treating people as interchangeable units, toward increasing out alienation from ourselves and our estrangement from each other. When education has these sorts of effects it is failing in its most central function." Again an appropriate balance must be established through planning.

3. Education as a Task of The Individual

Education is an animate process, and the whole process must be adapted to the needs of the individual. Because of this essential characteristic the outputs of the process are difficult to predict. Individual responses to a given curriculum development may be very different depending on the nature of the individual, the stresses on him, his degree of self-assurance, and many other factors over which

the school system itself has only limited control. The entire system needs to be laid out with sufficient flexibility that it can accommodate to the varying needs of different individuals from different community situations and with differing amounts of drive and degrees of competitiveness. In most respects educational outcomes are subject to wide statistical fluctuation. Variation is the theme rather than uniformity. The system must, in the best sense of the term, develop the individual. It must be dominated by the view that education is not only an animate process; it is a human process.

4. Continuing Innovation and Change

Part C, following, will elaborate more fully on the fact that continuing rapid change in all aspects of society, and particularly in the areas of scientific knowledge and technology, places changing demands on the educational system and also imposes pressures toward innovation because of the availability of new technological advances. There is need for innovation to be coordinated from a number of standpoints. One is the matter of sharing the costs. Transmuting the technological advance of high-fidelity audio equipment into the specific educational innovation of a language laboratory would have posed a formidable financial undertaking for one school district alone. Another is the requirement of a certain amount of standardization. For example, it was necessary that a very substantial fraction of the total school population in the country shift to the recently introduced SMSG mathematics program more or less simultaneously to avoid difficult problems involving transfer and college entrance. Yet at the same time the individual district was given the option of whether or not to adopt the new program. Evaluation also is facilitated by centralized coordination of an innovation.

5. Projective Nature of Educational Planning

Education itself represents a projection into the future. The students who are in today's primary and secondary schools will be producing members of society over the next few decades, and their productivity

is influenced by their present educational experience. Thus the consequences of a particular change in the educational program may not be fully measured for 25 to 30 years. Even a longer-term projection is involved in educational research. In educational research we are involved with possible future changes to the educational program, which in turn results in changes in the adults of a future society.

But a still further projection is involved in the planning of educational research. Educational research planning anticipates the research itself by a still further lead time, so that in planning educational research we are in a sense attempting to look ahead something of the order of 30 to 40 years. The fact that such extensive projections are necessary does not mean that the planning task is impossible. It does mean, however, that a very high degree of sophistication in projective and planning methods is required for it to be done in an effective way.

B. The Public Education System as a Particular System

In order to further clarify the systems approach as applied to education, we shall briefly describe the public education system as a particular system. The discussion will be illustrative of the approach, although necessarily oversimplified and general.

1. General Introduction of The System Problem

In analyzing a complex system one may in general think of layers of a system somewhat like the layers of an onion. A system is associated with a specific layer. Any system is a subsystem of some system complex, which is represented by an outer layer relative to it. Similarly, each system itself contains a number of subsystems as its components (inner layer). Any good system study will necessarily involve three adjacent layers; namely, the system layer, the system complex layer which includes the system as a component, and a set of subsystems which are components of the system in question. The objectives or the requirements for a given system are fed in from the next outer (system complex) layer. Similarly, the capabilities that a given system has will be determined by the capabilities of its components or subsystems (that is, the next

inner or subsystem layer).

There is no beginning and no end to subsystems. It is always possible to subdivide a system further into sub-subsystems, indefinitely. Similarly, one can think of the largest system as being a component in a still larger system complex. The more layers that one considers at one time, the more variables he has to deal with. For example, in a state educational system we have the overall system with the state board of education maintaining a certain amount of control; at the next level down there are the individual school districts (or, perhaps we might wish to consider the county offices at an intermediate level). The districts receive their goals from the level above, while their capabilities are determined by the individual schools on the level below. The schools can, in turn, be subdivided into departments, and these into classes, and these into individual faculty members and students (and the students, if we want to be ridiculous, into arms, legs, and torsos--or into remembered knowledge, learned skills, and personalities--and so on). The problem of handling the system can clearly get out of hand as one includes more and more layers. Thus a certain amount of abstraction and aggregation is necessary to limit the number of variables to a manageable number.

Mindful of the immense capabilities of modern digital computers, one is tempted perhaps to think of simulating the system, and of increasing precision by including more and more subsystems levels in detail. Simulation has its applications here, indeed (Nat. Bur. Stnds., 1966). But if one does try to buy precision by including finer detail in the model, this is still at the expense of having more and more parameters to vary, and more and more computer runs to make, in attempting to gain understanding of the system. Judicious aggregation of components into larger wholes still turns out to be an essential part of the system analyst's skill.

Which variables are kept and which variables are ignored in this process depends upon the critical factors for a given decision. All practical system analysis is done in order to enable a decision to be

made, and the kind of analysis chosen depends on the question that is being asked. Which variables are relevant is usually more or less evident, and is also determined by the nature of the decision that is to be made.

Another set of ideas applicable to systems problems in general is that of long-term analysis of a system versus short-term analysis. In the education system, for example, we will talk about a very long-term view of the educational system. It has sometimes been said that our educational system in the United States hasn't changed very much in the last 50 years. If so, in many regards this is a good thing. Inasmuch as the national goals recommended by Jefferson are still pretty good goals today, it's appropriate that the educational system of Jefferson's day should have much in common with that of today. On the other hand, in other aspects such as science teaching or "manual training", rapid changes in science and technology dictate that the system of today should differ substantially from that of 25 years ago.

In the analysis to follow we shall assume a long-term set of goals and a set of educational functions to realize these goals, and then assume a long-term system more or less as the "steady-state" approach to the problem. We will then consider short-term changes in both the needs of our society for education and also in the capabilities of certain component aspects of the educational system to provide education. Finally, we shall indicate how the approach allows tracing through the changes in the educational system which are generated as a result of changes in our environment, both technical and social.

2. Three Levels of System Complexity

Figure A-1 shows the three levels around the educational system. The educational system itself is pictured as one of many systems in the system complex which is the nation. Others are the regulative system, military and protective system, transportation and communication system, scientific research system, industrial system, and so on. The educational system is itself split up into several subsystems. The

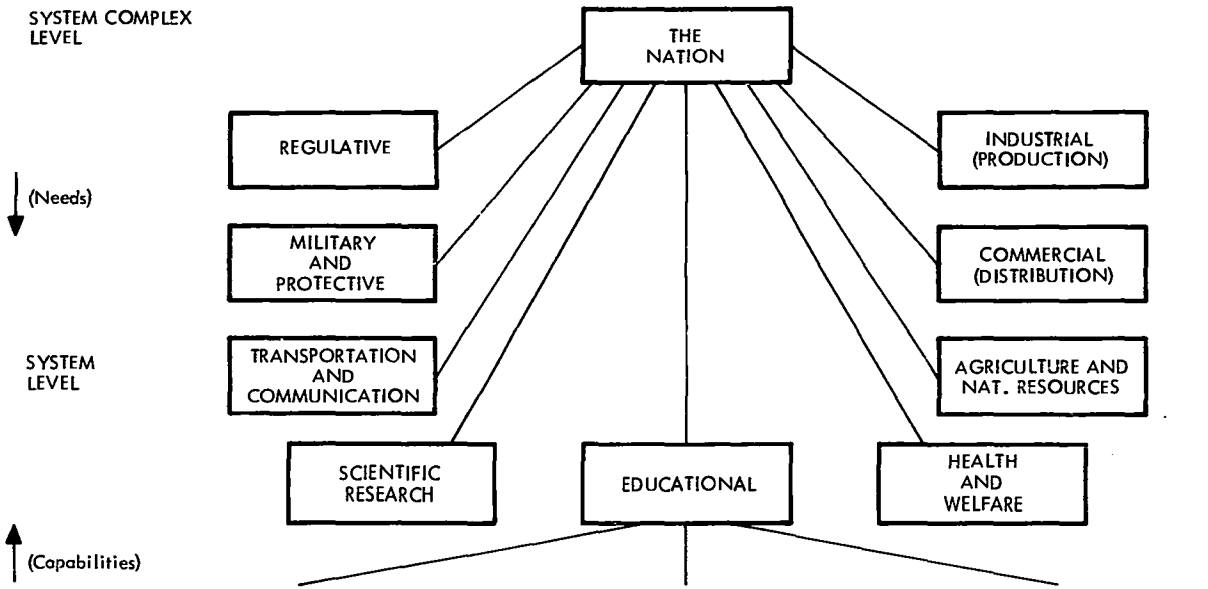

FIG. A-1 THREE SYSTEM LEVELS RELEVANT TO EDUCATION

main one of these is the public educational system, which again can be subdivided in various ways. Other subsystems include the private schools, industry-supported and profession-support training institutions, special-purpose schools (in language, music, architecture, the arts, etc.) and so on.

It should be clear that a particular subdivision of a system such as this one is somewhat arbitrary, and it would make sense or not depending upon the kind of analysis which one is undertaking.

3. Goals and Functions of The Educational System

The goals, or objectives or requirements, as was previously noted, come from the next layer above in the system diagram. Thus the goals of the educational system are determined at the national (system complex) level. From the goals derive functions and programs, as are indicated below.

a. National goals

The national goals as summarized from the 1960 Report of the President's Commission are expressed in terms of the individual as follows:

1. To guard the fundamental rights of the individual (and to contribute toward this as a supra-national goal)
2. To ensure his development physically, psychologically, intellectually, morally, aesthetically, and spiritually
3. To enlarge his opportunity culturally, economically, socially, politically, and educationally.

"The first national goal to be pursued--at all levels, federal, state, local, and private--should be the development of each individual to his fullest potential." (p. 53) "The very deepest goals for Americans relate to the spiritual health of our people--for our is a spiritually based society." (p. 22).

b. Goals of The Educational System

The goals of the educational system follow from the national goals, and may be stated as follows:

1. To make available opportunity for each individual to develop to his fullest potential. "The great basic goals of our educational system (are) to foster individual fulfillment and to nurture the free, rational, and responsible men and women without whom our kind of society cannot endure. Our schools must prepare all young people, whatever their talents, for the serious business of being free men and women." (p. 100)

2. To make this available in appropriate form at all age levels, recognizing that true education is a lifelong process of growth.

3. To make this available regardless of sex, race, economic conditions, place of residence, or religious or ideological conviction.

4. To make this available in appropriate form for individuals with diverse talents and motivations. "There must be diverse programs within the educational system to take care of the diversity of individuals; and each of these programs should be accorded respect and stature." (p. 81)

5. "The ultimate goal of the educational system is to shift to the individual the burden of pursuing his own education." (Gardner, 1963)

c. Functions of The Fducational System

The primary functions of the educational system are in considerable measure implicit in the national goals. They are:

(Functions Related to the Individual)

1. To provide for the individual opportunity for the development of seven components of education:

SKILLS

a. Basic personal skills (verbal, mathematical, physical)

b. Vocational skills

c. Interpersonal skills (communication, relationship)

d. Mental skills (organizing experience, perception, objectivity, concentration, problem solving and decision making, creativity)

KNOWLEDGE

e. General knowledge (cultural and scientific heritage)

f. Specialized knowledge (vocational and professional)

PERSONAL DEVELOPMENT

g. Self-realization (development of self reliance, identity, self worth, personal values, etc.)

(Functions Related to Society)

2. To provide trained individuals for the diverse tasks of government, industry, commerce, and the professions.
3. To provide the necessary education for an informed and competent electorate, including knowledge of the history, goals, political and social institutions of the nation.
4. To contribute to the solution of internal social problems such as juvenile delinquency, unemployment, poverty.
5. To contribute toward the realization of external (international and supra-national) goals.
6. To contribute directly and indirectly (through specialized training) to the advancement of scientific research.
7. To provide public informational services.
8. To develop public appreciation and support for the arts.

d. Programs to Serve Selected Functions

In view of these goals and functions some of the areas in which new or strengthened programs are called for appear as follows:

1. Programs for educating the economically and culturally deprived, vocationally displaced, etc.
2. New learning technology, techniques, curricula, testing methods, for teaching skills and knowledge.
3. Education toward personal development.
4. Meeting of society's needs for trained personnel.
5. Programs for social problems (juvenile delinquency, desegregation, unemployment, poverty).
6. Meeting society's research needs.
7. New abilities in public information services.
8. New programs in the arts.

One aspect of these programs is the structure set up to carry it out. Another is the exposure; that is, the delineation of that section of the population to be served by a given program. This population can be described by social status, geographic region, occupational classification and so on. For example, A-2 summarizes the exposure of

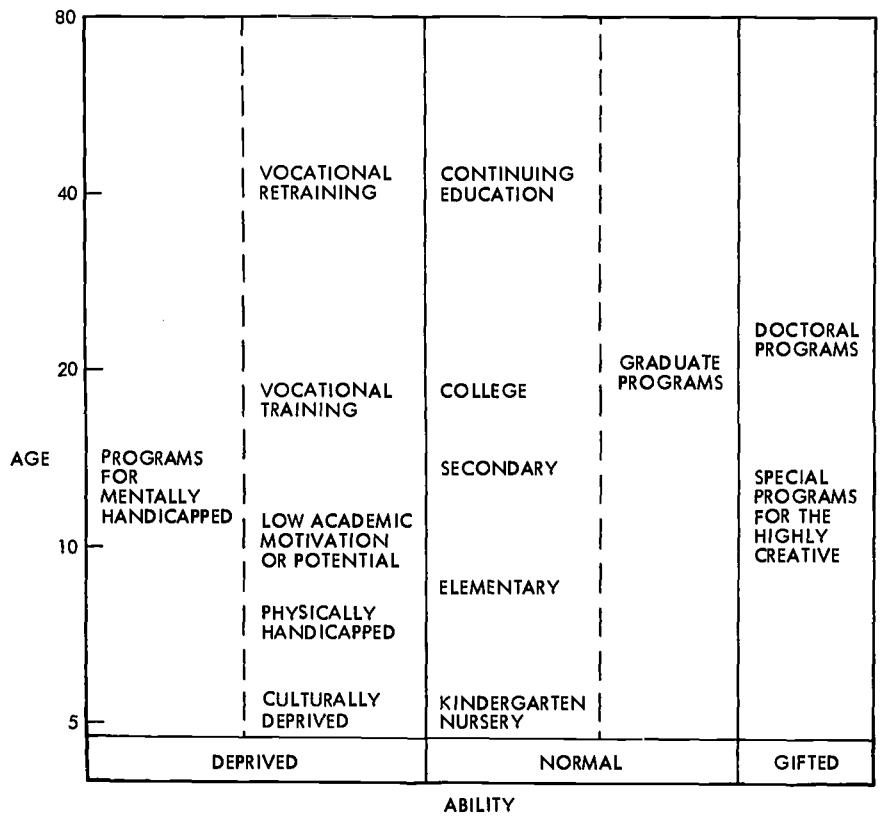

FIG. A-2 SUMMARY OF AREAS IN WHICH SPECIFIC EDUCATIONAL PROGRAMS ARE TO BE PROVIDED

various programs according to a mixture of age and ability.

e. Research in Support of Programs

The educational research system is a component system within the educational system. The function of the Bureau of Research in the Office of Education is to support and initiate and help in the implementation of educational research. Some aspects of the research system are discussed in more detail in Sec. II.

4. Aspects of System Analysis

Having shown how national goals lead to educational functions, which in turn lead to structures and programs to carry out those functions, let us now examine some aspects of the system comprising these structures and programs.

The problems with which a systems analysis might deal can be conveniently divided into long-term and short-term problems. In general the educational functions which were listed above represent relatively permanent responsibilities with which the system is charged. Some of the problems which arise with respect to these, on the other hand, may be relatively transitory. And the educational system may be called upon to assume a specific function for a period, as a consequence of some social problem or historical event.

One example relates to the balance between vocational skills and somewhat broader skills. The imparting of basic verbal and mathematical skills is a relatively timeless, or at least a long-term function. Education in vocational skills, however, tends to be a comparatively short-term function. As a specific instance, certain shop skills and drafting skills are becoming, due to the changing technology, as obsolete as blacksmithing. On the other hand, there is at the moment a particular need for the sub-professional skill of computer programming. This in turn may diminish with new programming languages and smarter compilers.

As another example, following World War II there was a very intensive program of training veterans who were returning from the war. This was a short-term function that was served by the higher education system in

the United States. Somewhat later there was a very intensive emphasis on scientific training which was this country's response to the Sputniks of the Soviet Union. More recently still, an educational program has been initiated. associated with the way on poverty, in which culturally deprived and educationally deprived segments of our society are receiving special remedial education in response to an immediate need. One of the most important educational roles today is related to the social problem of desegregation. Inasmuch as the problems of segregation involve the attitudes of every segment of our society, the educational tools are among the most essential in handling of this problem.

The programs associated with these short-term needs are particularly hard to analyze. There are time constants associated with the changes in the cultural attitudes of the country and one of the questions that alway come up is how long does a given program need to be in operation before the measurable result can be observed. In many cases this critical time is on the order of a year or so. In other cases it may be a generation or more.

Another design aspect is the intensity of the program that is needed in order to produce results. It may actually be that very substantial changes in the educational system need to be employed before effective results can be achieved in certain areas. The experiments that are being tried in many regions in regard to transportation of students from one living area to another represent a problem of this sort. There is a very high cost in terms of the social stresses on the children from both areas that are imposed by the bussing program, and other alternatives need to be compared with the bussing program in order to see whether or not it really represents the most effective way to implement integration.

The above is by no means an exhaustive listing of system problems associated with the serving of specific educational functions, but these are probably fairly representative.

5. Component Systems to be Considered

The use of system analysis would be just as applicable to subsystem considerations as it would be to analysis of the educational system as a whole. One area which needs to be modeled and in which certain design decisions need to be made is that of implementing an innovation. For example, suppose that certain research results have been achieved. Suppose a good automated instruction program using computers has been conceived which promises to provide very effective foreign language instruction to public school students. There are several aspects of this program. The first aspect of it is the research aspect itself in which the ideas are tested, in which the comparative computer evaluations are made, in which trial programs are written, and so on.

The second phase is the development aspect in which a working program embodying the concept is developed and pilot studies are planned. Then there's the phase of evaluation of the program to see whether or not it's effective and what some of the short comings are before it is broadly disseminated. Also one should ask what other learning experiences ought to be added to the automated instruction to make a better program.

The next phase is the dissemination of the results. Assuming the evaluation was positive on the basis of the pilot studies, it might be decided that automated instruction would be broadly useful for the development of foreign language skills. These results need to be disseminated broadly. Finally, there is the phase of implementation and following that the assessment of the program in its broader field applications. In each one of these applications there is the question of timing. For example, suppose that research is to be initiated in foreign language teaching. How much lead time has to be utilized in going from the research phase finally to all of the successive phases of the program to the assessment?

One of the other questions is what sort of financing ought to be provided for such a program. How much financing ought to be done by federal funds in response to specific needs and how much financing ought to be done by the local districts. This is a particularly

important problem with regard to the pilot programs in which a substantial amount of capital investment will be needed in order to carry out a plan. The costs and benefits to an individual school program associated wit making a pilot study need to be assessed. A district should not bear many of the experimental costs which really are capital costs for the development of a system which will have very wide use later.

Another question is what kind of control ought to be exercised on a typical program. Always a balancing is required between more centralized control for more effective coordination of the innovative program, and a more localized control in order to provide the diversity our society needs.

The model of fiscal support and control of a given program is another kind of component system. For example, suppose that a set of language laboratories is to be developed for teaching English in a section which is largely represented by an immigrant group in which some foreign language is much more familiar to the group than English. How to develop the most effective programs to meet this kind of need, how to support them, whatfraction should be supported by the nation as a whole, or what fraction should be supported locally are all important questions.

One example of the fiscal support and control problem comes along with a problem of desegregation. In many of the school situations in the South, the level of accomplishment of the teachers in the Negro schools is such that these teachers cannot really be considered as up to standard in terms of their training. Nonetheless, the cultural value to the Negro students of continuing to have the social contacts and to be able to rely on the ties that have already been built up with these teachers would make it an extremely bad thing for them to be excluded from the program. It might be possible to supplement the work of these teachers by automated instruction and educational television, in such a way that the capabilities of the teachers would be augmented by technical capabilities. In this way the whole system might be brought up well above minimum levels without the loss of the social benefits and

group psychological benefits which come from retaining the teachers the Negro youngsters have come to appreciate and to understand for personal reasons. Also associated with the integration program might be the matter of providing supplementary instruction for the teachers who will need to be retrained so that their capabilities will improve to compare more favorably with the national norm. But these measures are almost sure to be beyond the resources of the individual school district.

C. Changes in Society and Technology and Their Influence on Education

As we have discussed earlier, the fundamental goals of education are long-term ones. On the other hand, in a rapidly changing society there are of necessity shorter-term changes in functions, structures, and programs. These come about through at least two causes:

Changes in the nature of society result in changed needs, changed demands on the educational system.

New technological, scientific, and social advances improve the capability to provide education and to achieve educational goals.

We shall examine each of these in turn.

1. Needs Generated by Social and Technological Changes

To obtain an idea of the requirements placed on education by the kind of change to which we have become accustomed in our generation, let us briefly examine the context of education in the last third of the twentieth century. Several aspects of present and indicated future change have come with such rapidity that some observers have spoken of this as a time of multiple revolutions. Among these are the following:

a. Automation

There can be little doubt that automation will have far-reaching consequences. Relieving man's mind of routine mental tasks will certainly have an effect comparable in magnitude with that of relieving him of physical tasks in the machanization of home, farm, and industry. One consequence will certainly be a continuation of the

trend to shorten the work week, which has dropped from an average 66 hours in 1850 to 38 hours in 1960 (de Grazia, 1962, p. 441). "The direction is...toward more free time. There will either be the same number of jobs--but with their hours cut down drastically and legislation to prevent overtime and moonlighting--or, more likely in view of the first possibility (that the kinds of jobs automated machines provide are those only a limited number of persons have the wit to fill), a relative few will work and the rest will live on Easy Street." (de Grazia, 1962, p. 346)

Certainly among the effects of automation already have been the virtual elimination of many routine clerical and physical jobs. In the day of automation there is obviously a much greater need for flexible education than before. The whole question of specific vocational training needs reexamination. Specialties of machinist, bookkeeper, and others are virtually becoming obsolete.

b. The Shrinking World

Almost as far-reaching as automation in its consequences is the revolution of the shrinking world. Because of the tremendous advances made in transportation and communication over the last 25 years, there is now much more trade between the nations than ever before. Travel and exchange are more commonplace; most of our children will live for an extended period of time in a foreign country. Education for world citizenship--in foreign languages, international culture, world geography and economics--becomes essential.

One aspect of the shrinking world is the enlargment of political units. In a world of tension and nuclear threat, education is an important element of foreign policy. Educational television has rich possibilities for education in democracy. Education has a major role in developing world trade and in world development of human resources.

c. The Population Explosion

The consequences of the soaring population figures scarcely need emphasis. The total enrollment in the educational system rose from

36 million in 1954 to 53 million in 1964 to an estimated 63 million in 1974 (USOE 1965). Educational demands increase much more rapidly than population because the amount of education per individual is going up. For one thing, there is an occupational shift into areas which require more education. (It is estimated that from 1960 to 1970 the number of persons in professional and technical occupations will increase by 40 percent, the number of unskilled workers will not change appreciably, and the number of farm workers will decrease by 17 percent. (Simpson, 1962, p. 19)) Some of the free time released by automation will go to furthering education. Increased longevity and earlier retirement will also tend to increase demands, particularly for liberal education.

d. Rural to Urban Shift

Changes in urban and rural living patterns represent another factor which results in altered demands on the educational system. Movement of middle-class residents to the suburbs and increased concentration of low-income residents in city centers pose difficult problems of providing equal educational opportunity.

e. Continuing or Mounting International Tensions

For the short term at least, this seems to be the unhappy fact. Reduction of the gap between the "have" and the "have-not" nations is not likely to be accomplished to any appreciable extent in the next few decades. It may even increase for a time due to the extremely rapid advancement of technology and economic development in the "have" nations. This material disparity between the few enormously rich nations and the many poor ones will lead to continued friction and tension. Increasing numbers of nations will have the capacity to arm with mass-target chemical, biological, and nuclear weapons. This too will contribute to a continuing atmosphere of fear, suspicion, and tension.

f. Increased Social Complexity

Population growth, urbanization, integration, further developments in transportation and communication, will crowd us together and force us to contend with increasingly complicated social processes. We

will be in contact with more people, called upon to play many more social roles, having to cope with many new interpersonal pressures. For example, Simon (1962, p. 45) predicts that as a result of increased automation there will be a larger fraction of the work force involved with person-to-person relationships. Increased non-working time imposes the decision as to how it will be spent; less and less is the individual's time programmed by the requirements of a relatively simple job taking up the majority of his waking hours.

g. Continual Change

The most dependable prediction of all is that the society of a generation from now will be in a state of rapid change in practically all its aspects--scientific knowledge, technology, social institutions, values and attitudes, and so on. Automation of the multifarious tasks of society will have taken place and be taking place, to a degree difficult to imagine. There will be increasing ability, and use of that ability, to control behavior, thought, and development of individuals and groups. The world will continue to shrink with the further growth of communication and transportation systems. Changes in attitudes and values such as those characterizing the current revolution of the college-age generation for new political, sexual, and "consciousness-expansion" freedoms will probably continue.

h. Education Toward Skill in Living

Thus increased emphasis appears to be needed on education toward such characteristics as flexibility, adaptability to change, ability to deal with complexity, skill in interpersonal relationship, ability to live with tension and uncertainty, etc. A strong sense of identity is required to live comfortably in a culture where there is no stable tradition with which to identify. The individual must learn to value himself not for his role in the traditional culture nor his use to society, but for himself. He has to appreciate change, to enjoy it and move with it.

i. Education Conceived as a Lifelong Process

In educating for a life where change is the rule, not the exception, and with an increasing amount of free time, education must be seen as a continuing experience. Vocational retooling will be the common thing, undertaken several times during a lifetime. Knowledge must be continually updated to remain in step. But more than this, in keeping with the assumed national goals for the individual, education must become viewed more and more in and for itself, undertaken because it is personally rewarding, because it is a deeply human experience, because ultimately meaning in life is found through the discovery and realization of our most supremely human potentialities.

2. Capabilities Provided by Research Advances

While the rapidly changing science, technology, and social structure pose new problems and make new demands, they also provide new opportunities. Among the most significant of these are the following.

a. Advances in the Social Sciences

Great advances have been made in the social sciences in the past 25 years (Berelson, 1964). Given the present appreciation of the importance of research effort in these areas, and the promise of continuing support, one can only expect acceleration in the rate at which new knowledge is acquired. Some of the areas in which the results of recent and forthcoming research efforts are likely to affect education include the psychology of learning, of motivation, of concept formation, of perception, of problem solving and creativity, of personality formation and change; studies of the processes of communication, socialization; the sociology of small groups, of organizations; studies of environmental factors and cross-cultural problems in learning.

(1) The learning process. Particularly important in developing computer-aided instruction is the modeling of the learning process. Significant work has been initiated in analysis of the learning process with a start toward quantitative modeling of the elementary processes. A very promising source of learning data can come from automated

instruction because of the possibility of repeating controlled experiments with a statistically significant number of learning situations and with widely different types of students.

b. Technological Advances

More visible in a way, although not necessarily more profound in their effect, are the increases in capabilities due to technological advances. Some obvious examples of relevant technological advances are inexpensive high-speed printing techniques, convenient and rapid local reproduction techniques, audio and video communication and program storage, data processing and information retrieval capabilities of digital computers, and so on. Some of the educational functions which can be aided by advanced technology are:

(1) Individualized Learning. Computer-based learning programs allow the student to progress at his own rate, in a noncompetitive situation when this is advantageous. Inexpensive mass-produced laboratory kits represent another possibility for individualizing the experience of discovery and organization of knowledge. Language laboratories already offer teacher-saving individualized experience in language learning.

(2) Multiple Presentation of Material. Inexpensive mass-produced educational materials, filmed instruction, educational television, are examples of new way in which identical material can be presented to large number of individuals.

(3) Accessibility of Material. New methods are available or on the verge of development for given ready access to a wide range of materials--verbal material through computer-based information retrieval systems; visual material in biology, architecture, art, etc.; audio input in learning languages, music, speech.

(4) Rapid and Frequent Feedback. Correction, guidance, and reinforcement, all important in learning, can be furnished in far greater quantity through computer-aided instruction than was previously available from a teacher.

(5) Evaluation and testing. Student testing and evaluation of programs with rapid feedback to teacher or administration.

(6) Simulation. Realistic computer-aided simulation has many applications to learning motor skill proficiencies, learning from case materials and "scenarios", simulating legal and legislative situations, international relations, and so on.

(7) Study Environment. Individual learning carrels fitted with ETV, CAI, library retrieval, etc.; automated classroom.

(8) New Techniques for Administration. Automated student performance evaluation and record keeping; computer-aided simulation for scheduling, allocation, curriculum problems, teacher and counselor training, etc.; data processing and information retrieval systems for improving counseling; regional information centers with information-retrieval systems.

With increased effectiveness in the performance of these functions many aspects of the conventional school need to be re-thought. Universal testing and uniform methods of evaluating performance are feasible to an extent they were not before. Freeing the teacher of those functions which can be effectively performed in automated programs allows the possibility of much more time per student in authentic human-human interactions. Instruction much more precisely tailored to the individual students' motivation, temperament, ability, and speed is possible. Student transportation, especially in low-density areas, could be changed by using more home study, augmented by telephone connection with the central computer-based learning-programmer. The social function of formal education might be carried on quite separately from the training function, which could be highly individualized, so that the social and cultural educational unit might be quite different from the present school.

Appendix B

EXAMPLE TO CLARIFY SYSTEMS CONSIDERATIONS IN THE RESEARCH PLANNING ACTIVITY

Appendix B

EXAMPLE TO CLARIFY SYSTEMS CONSIDERATIONS IN THE RESEARCH PLANNING ACTIVITY

In order to clarify the nature of the task of the research planning activity, it will be helpful to examine a simplified version of the educational research planning problem.

A. Description of the Problem

The basic problem description is in terms of three components: needs, capabilities, and relevant research areas.

1. Needs

Let us suppose that as a consequence of a preliminary predictive research effort it has been determined that highest priority is to be given to three demands on the educational system, namely:

- N_1--Continuing education--vocational retraining as required by a changing society and changing technology, and enrichment of adult life through further education.
- N_2--Skill in living--development of interpersonal skills of communication and relationship, education towards flexibility and adaptability, psychological development as required to live successfully in a society characterized by rapid change, tension, and increased social complexity.
- N_3--Education for world citizenship--understanding of other cultures, understanding of world economic, industrial, political and commercial systems.

It is necessary to emphasize that what we are talking about here is unfulfilled needs. In addition, of course, there are the various needs which, for the purposes of this example, we will imagine are being satisfied adequately--education is basic skills and general knowledge, initial vocational and professional training, and so on. An important part of the overall problem, not treated in this example, is the matter of tradeoffs among the various needs to be filled. For example, it may be necessary to be satisfied with a smaller increment of training in

specific vocational skills in order to buy more attainment along the lines of these three unfulfilled needs.

2. Capabilities

Further, we may consider the effects of new capabilities in two areas, namely:

- C_1--New learning technology--educational TV, computer-aided programmed instruction, computer-based simulation, etc.
- C_2--New understanding of processes of learning and development.

3. Relevant Research Tasks

To keep the example within reasonable bounds, let us assume that the problem is to allocate research funds among nine relevant research areas as listed below:

a. Basic research

R_1--Basic research on how knowledge and skills are learned

R_2--Basic research on the personal growth process, on development of interpersonal skills, adaptability self reliance, psychological maturity

b. Component research

R_3--Development of new learning technology--CAI,ETV, etc.

R_4--Applications of new learning technology to teaching knowledge and skills required for world citizenship

R_5--Applications of new learning technology to rapid acquisition of new vocational knowledge and skills

R_6--Applications of personal growth techniques to the psychological problems of vocational retraining (fear of failure, threat of student or apprentice role, threat to sense of identity when forced out of old role, etc.)

c. Predictive research

R_7--Continuing research on needs--on predicting the nature of society in the future and interpreting this in terms of demands on the educational system

d. Systems research

R_8--Programs incorporating techniques for promoting personal

growth and use of new learning technology in acquiring knowledge and skills, in educating for world citizenship and for living in a society characterized by rapid change and increased social complexity

R_9--Overall systems study of the formal educational system, aimed at optimizing investment decisions in terms of capabilities and demands.

B. Meeting a Specific Need

In our hypothetical problem the attention centers initially on educational planning. First one starts with a specific need to be met. Given the need, one usually is able to determine the requirements for programs to meet each of the needs. N_1, for example, requires a certain set of capabilities including those listed as C_1 and C_2. In any real situation there would be many more capabilities to consider, some being alternates for others. For example, in the case of vocational retraining, there might be a need for a remedial course in algebra. This course could be taught by using conventional classroom procedures, automated instruction could be utilized, or a mixture might be employed. One would need to assess the various alternative capabilities to see what was immediately available, what could be developed, and then make some allocations. The specific plan would strongly depend on timing and cost factors and various states-of-the-art in capabilities. Quantitative measures of these capabilities would be set up, and one would make allocation decisions, at least partially, on the basis of the analytical results.

There is substantial variability in the process of meeting needs, depending upon factors such as the following:

1. How broad is the need? Is it nation-wide and long-term or is it local and short-term?
2. Can the need be met from capabilities immediately available or must new capabilities be developed?
3. Does meeting this need share capabilities required with other programs, or is it separate?
4. What are the priorities associated with meeting this need compared to priorities associated with other needs?

5. What are the uncertainties associated with meeting this need and with support for it?

The view of the problem of meeting a need is dependent upon who views the problem. The planning done in the Office of Education naturally is most heavily concerned with those problems national in scope and long-term in nature. If new capabilities are required and need to be provided from Federal funds, some priorities for allocation must be made.

The view of a local administrator will generally be somewhat less circumspect and will usually be more deeply involved with specific aspects of the problem. Both the Office of Education planner and the local administrator are primarily concerned with the problem of meeting the need.

Consider the problem from the point of view of a supplier of a capability, such as a manufacturer or equipment for educational television or a trainer of program writers for ETV. This person is interested in a spectrum of uses for his particular specialty. Those needs represent his market. In his long-term planning, he must estimate what the market potential is and how to capture it. From the other side, he must continually survey the research fields bearing on his capability, and also on alternates to his capability. In a very real sense, he is a customer of the researchers.

The researchers are concerned with still different aspects of the problem. The basic researcher views the field to see what is needed to make it philosophically complete. Generally, he is more interested in theoretical principles than in applications. Close communication is needed between the applications areas and the research frontiers so that early use can be made of advances. There is undoubtedly much stimulation of basic research from insights gained when research results are utilized practically. Thus the basic research itself vitally needs feedback from applications.

The component researcher may be either a basic researcher or an applied researcher. Usually it is not helpful to distinguish research

as basic or applied, because there are many shades of this category. A fairly useful distinction can be made, however, between component research and system research. Both predictive research and what is described as system reseach are devoted to applying research to real-world application. They are focused at overall problems rather than component problems. Generally they provide a direct link between the basic research and the application area. Since all research must have sources for support, predictive and system research must continually monitor the outputs of basic research and assess the potential capabilities provided. These potential capabilities are continually compared to what is necessary to carry out the programs society needs.

This introductory summary of the components in this problem has probably implied the need for a more complete picture of the structure than a simple verbal one. Particularly, this picture is valuable if the system aspects are to be analyzed.

C. Interdependence

Again drastically simplifying the model as compared with the real-life state of affairs, we note the following interdependencies:

- Action programs to meet needs require educational planning and relevant research results
- Educational planning requires systems analysis R_9
- Systems analysis R_9 requires estimates of future needs N_1, N_2, and N_3, and of future capabilities C_1 and C_2
- Estimates of future needs require predictive research R_7
- Assessment of new learning technology C_1 requires research R_3
- Assessment of personal-growth educational possibilities C_2 requires research R_2
- Action program to meet need N_1 requires research R_5 and R_6
- Action program to meet need N_2 requires research R_8
- Action program to meet need N_3 requires research R_8
- Research R_8 requires R_4, R_5, and R_6
- Research R_6 requires research R_2
- Research R_5 requires research R_3

- Research R_4 requires research R_3
- Research R_3 requires research R_1.

These interdependencies are shown diagrammatically in Fig. B-1. This diagram is a shorthand representation of the above relationships. For example, the two interconnected blocks in the upper lefthand corner represent the outcomes of predictive research being the demands on the educational system symbolized N_1, N_2, and N_3, and these plus the two assessments of future capabilities, C_1 and C_2, being necessary inputs into the systems research and research planning operations. It should be noted that this is essentially a diagram of information flow. Quantitative relationships enter into the problem later; at this point the diagram is merely an aid to thinking.

Associated with each of the operations in the diagram is a time lag. Thus, if vocational flexibility and adaptability will be required at a particular point in time, the educational programs to provide this outcome must be operating years earlier. The educational planning must lead this. If the programs are based on component research (curriculum and learning technology), this must be accomplished still earlier. And if basic research is needed as a foundation for the component research, this, of course,must precede.

The situation is dynamic, too, as a result of the inputs to the predictive research activity being continually in flux. The anticipated society of the future is always changing, not only from the effects of forces outside the educational system, but also as a result of unanticipated research results and of decisions made about how, whom, and in what to educate. Thus feedback enters the predictive research activity from the output of the research planning and educational planning systems.

D. Discussion of Procedures

The problem, we remind ourselves, is how to allocate research funds among the nine research areas. This allocation is clearly a function of time. When research in a particular area is in the exploratory stage, it is important to support basic research; as it develops, the emphasis

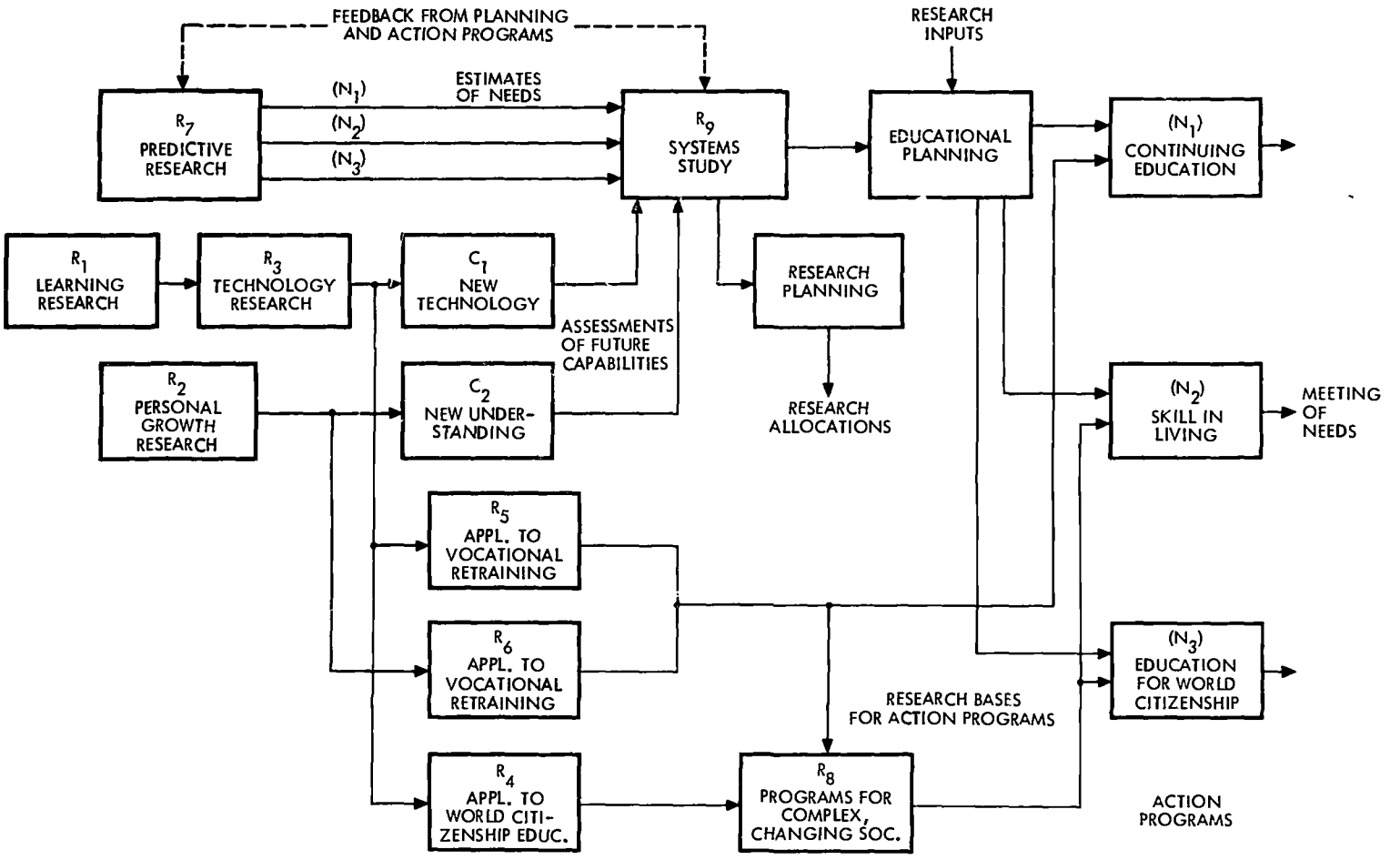

FIG. B-1 INTERRELATIONSHIP DIAGRAM FOR RESEARCH PLANNING

may shift to component and then to systems research. For the purposes of this example we will content ourselves with a few comments relevant to the allocation only of the immediate research support (next year's budget). This will lead to a few tentative conclusions and an indication of the kind of data to be gathered, and analyses to be carried out, in order to refine the conclusions.

E. Tentative Conclusions

The following tentative conclusions, then, are illustrative of the outcomes of this sort of analysis:

1. Predictive research, R_7, is essential to the systems study R_9 on which educational planning is to be based. Thus, the preliminary indication is that R_7 should be supported heavily, at least initially. (A portion of this cost may be shared with other Government agencies and industry, who also require the results of predictive research. However, the interpretation of the future state of society in terms of demands on the educational system, and the examination of the consequences of educational decisions on the future state of society, are primarily the concern of the USOE.)

2. The importance of the systems study R_9 was discussed in Section II of this report. Although the outcomes of research R_1, R_2, and R_3 are for the refinement of this process, enough data are available so that it can go ahead now. Thus, R_9 should be heavily supported and be initiated immediately.

3. Sufficient results of underlying basic and component research are already accomplished so that it makes sense to proceed with programs research R_8 on an exploratory basis with relatively modest support, and with the anticipation that within a few years this should receive heavy support.

4. Research areas R_1, R_2, and R_3 need support because the outcomes of this research are required for other component and systems research. Basic learning research R_1 gets considerable support from other sources, and there is available a large backlog of knowledge to be applied. Thus

support from USOE should be moderate and continuing. A study project to determine the major "holes" to be filled seems advisable. Personal growth research R_2 can draw on a wealth of research results from the field of psychotherapy, but this material needs reinterpretation in terms of education. This is a crucial and neglected area which needs stimulation. Modest initial support is called for, and a deliberate attempt to encourage a major research effort.

5. The development and assessment of new learning technology R_3 requires a large and expensive effort. However other agencies (Departments of Defense and Labor, particularly) and the large education-products industry have major interests here, too. This is a highly visible research area, which captures the imagination of the public. As a consequence, research in this area will be well funded even without the contribution from USOE. This indicates the advisability of some restraint in USOE support of this area.

6. Important though the area is, research on new learning aids to education for world citizenship, R_4 depends heavily on the outcomes of R_3. Thus, only very light support at the present time is indicated. A similar comment applies to some extent to the vocational retraining area R_5, except that high payoff here seems more likely and major programs support by DOD and Labor will be moving ahead.

7. Preliminary indications are that the psychological aspects of vocational retraining, research area R_6, represent a major problem area. Experience with this problem will also point up where basic research in area R_2, is particularly needed. Thus, requests for proposals should be used to initiate a significant research effort on this problem.

These, then, are the tentative conclusions. To test and refine them and make them more quantitative, it would now be desirable to gather further data and perform further analyses as needs for these have appeared. For example, the following might be indicated:

1. Further analysis of future needs on the basis of existing data; checking the completeness and priority of the three needs assumed;

preliminary assessment of the effect on these needs of various alternative decisions pertaining to the educational system.

2. Further assessment of capability C_1. A study would be valuable in which one leapfrogs over the problems of implementation and examines the more fundamental problem of what we want to do. Assuming that at some future time any function of the teacher, librarian, and educational environment that can be described precisely can be automated, what are the tasks it would be desirable to perform in this way? What essential roles should the human teacher retain? Where best to employ individual learning, small-group learning, teacher-student relationship, etc.?

3. Further assessment of capability C_2. Survey of the present state of knowledge of personal-growth techniques. (This is scattered; some in education, some in psychotherapy, some in pastoral counseling. Need assessment of nonpublic school programs where personal growth is central, such as Summerhill, Waldorf Schools, etc., also of personal-growth courses for adults such as National Training Laboratories programs, various executive development seminars and "success" courses, etc. Also need to look into the techniques of such groups as Synanon, General Semantics, Psychosynthesis, Scientology, and so on.)

4. Study to identify more completely the present and future problems which seem most in need of research.

5. Study of the nonpublic educational system. What essential elements do nonpublic schools and informal educational activities provide? How effective are these? Are private schools being driven out by Federal support of the public school system? Some tasks which may be important in educating toward the complex, changing society are in considerable measure provided in nonpublic schools--the performing arts, visual and plastic arts, musical composition, spiritual development. Will this be adequate for the future?

F. Making the Model More Quantitative

As was indicated at the beginning of this appendix, ultimately the

decisions to be made are in terms of dollars, which indicates that however hidden the fact may be, implicit dollar values are apparently attached to subjective goals. If we are examining, say, the need for vocational retraining, it is obvious enough that dollar values are involved. On the one hand, we have the direct costs of the training and the lost income to the individual and his productivity to society. On the other hand is the increased productivity and individual earning power. To make an economic model of this and base decisions on economic factors seems relatively straightforward.

But suppose we are looking at that component of education which aims toward increasing the individual's awareness of himself, toward the freedom to reexamine and consider changing his basic values and motivations, toward his discovery of what meaning life has for him--what has often gone under the term liberal education. Insofar as this increases his effectiveness as a member of society, perhaps we can attach an economic value to it. But the indications are that as the society becomes more affluent, we will be less concerned with earning power and productivity and more concerned with developing wisdom leading to higher levels of maturity. We are coming to realize that we have the knowledge and the power to direct the evolution of mankind and of society. Thus it becomes imperative that we develop the wisdom to shape new directions for mankind. But how do we develop quantitative measures for the value of this kind of educational experience?

The task has not been undertaken before, but it is by no means a hopeless endeavor. For example, one can get some estimates of values by gathering statistical data on answers to questions such as the following:

1. How much would the individual be willing to pay (tuition plus forgone income) for this educational gain?
2. How much would it be worth to society (that is, how much additional taxes would you be willing to pay) to have a wider understanding of national goals?
3. The value of a liberal education increases as one has more of it. How much would one be willing to pay in advance for a program leading to a certain degree of self discovery? How much, in retrospect, does he feel it was worth to him?

Other data needed to ascribe quantitative measures to various aspects of the problem include such items as:

4. The cost of research and the probability distribution of the increment of value that will be gained through the research.
5. The time value (urgency) of various possible advances in educational accomplishment.
6. The costs of various information-gathering programs and their probable value in terms of improved decisions.

Thus, while quantifying the models of the research planning problem is by no means a simple task, it represents a further degree of sophistication which is undoubtedly worthwhile in view of the financial stakes involved.