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CIVIL DEFENSE RESEARCH ANALYSIS

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ABSTRACT

In Civil Defense, research is a support activity of the building system; its function is to provide support to other activities of the building system. Research itself is a system and its analysis for programming and reporting can be aided by applying the methods of systems analysis. Analytic frameworks, methods, and graphic aids are presented and demonstrated.

PREFACE TO THE FIRST EDITION

Civil defense research effort has been devoted entirely to producing information to help those working in the action programs. No research has been done to help the people working in research. This paper, in a very small way, attempts to redress this imbalance. It presents an analytic method that can help the research analyst do a better job. The method developed from an idea for a problem solving model adapted by William L. White of Stanford Research Institute from a concept by Arthur D. Hall in his book A Methodology for Systems Engineering. Our appreciation goes to both for their ideas. Our thanks go to others who helped in many ways but who cannot be named here. The errors, of course, are all mine.

Washington, D.C. — J.F.D.
December 1966

PREFACE TO THE REVISED EDITION

Since the limited distribution of the first edition, the OCD Research Staff has applied the analytic method to the OCD research program. A number of desirable improvements in this paper appeared in the process. As a result, the paper has been severely edited and somewhat rearranged. The analytic method, however, remains unchanged.

Washington, D.C. — J.F.D.
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I. INTRODUCTION

Research in civil defense is a support activity. Its product is information. Its information product is intended to help those others in civil defense who analyze, plan, program, decide, design, procure, train, and so on. So the research job is twofold: (1) to produce information and (2) to insure that its product will be as helpful as possible to fill the needs of those who use it.

Given funds and authority, producing information from research is relatively simple. Producing information that is as usable as possible to fill the needs of the other activities of civil defense is far from simple. To say that civil defense is an extremely complex thing has become trite through repetition. Unfortunately, it is also true. And this complexity poses a difficult problem for a research program that is intended to obtain maximum effectiveness.

The principal problems for civil defense are those associated with nuclear war. And nuclear war is new; nuclear weaponry is only twenty years old. By contrast, at Trafalgar Nelson's ship, HMS VICTORY, was forty years old. In the twenty years of nuclear weaponry, technological progress has been rapid; weapon yields have increased a thousandfold. Possible employments have multiplied to increase the variety of effects that can be imposed. So the difficulty of conducting an effective research program is increased by the necessity to define the problems in an environment in which the problems sometimes change rapidly.

Two nuclear weapons have been employed in war, but this cannot be taken a nuclear war. It is reasonable to say, then, that history cannot provide nuclear war experience on which to rely in planning civil defense. Instead reliance must be on the vicarious experience gained from study of hypothetical events. Simulation of nuclear war cannot be done with the reality of the pre-World War I "sham battles" or the pre-World War II "maneuvers." Thus, added to the complexity, newness, and changeability of the civil defense problems to be studied is the necessity for research to provide a reliable basis for planning without any opportunity for proof testing in a real event.

Funds available for civil defense research are small in proportion to the problems to be solved, especially when compared to the funds available to others in proportion to their problems. This places on civil defense research the responsibility to be especially efficient in their use. Fortunately, some of the technical information needed in civil defense is also needed by others and is produced by their research. But to be efficient, civil defense research must find, obtain, and use this information produced by others.

The problem for those conducting civil defense research, then, is: given funds for research, how to spend them to obtain the most in effectiveness and efficiency. The management part--how to get the work done--is not difficult. What to spend the money for is the real problem. This can be a matter of selection from a list of competing candidate studies--provided the list contained all the candidates that should compete. So it must also be a matter of insuring that all of the needed studies are considered.

Research is unpredictable. No one can be sure of what will come out of any study. Research programming can never be reduced to the mechanistic planning : scheduling : dispatching process used for controlling factory work. No rules or process can take the place of the skill and judgment of the research analyst and manager in designing and planning a research program. But when the problem is complex and changing, and time and funds are short, the analyst needs help in developing his skill and in forming and applying his judgment.

Usually, proposals of research to be done--either as preliminary ideas or as specific studies--are available far in excess of the ability to fund them. They come from many sources: action elements of civil defense (users); research contractors--some working in the program, others not; appointed advisors; research analysts; and so on. But even with such a broad base of idea sources, there is no assurance that all the information needs have been identified. Some method is needed for deriving research information requirements other than simply the application of informed judgment.

Civil defense research includes a wide range of subjects--in the sciences and humanities, in systems analysis, and in operations research. Candidate studies compete with others in the same subject area and with those in other subject areas as well. For example, in programming it may be necessary to choose between a physics study in radioactivity and a social-psychology study in public attitudes. Some method is needed for selecting among such heterogeneous research possibilities other than the mere application of informed judgment.

Analyses of the civil defense system can produce both of these--completeness and priorities--as by-products. But his could be a long-drawn-out process of analysis : research : new analysis : new research : and so on. Even in a leisurely world it would take too long; some technical research has a long lead time, and in defense, we may not be able to afford a leisurely world. So while analyses of the civil defense system can, and will, help with research programming, something more is needed.

This "something more" can be contributed by systems analysis: by applying its techniques to the analysis of research itself. Research is the system; studies are the functions; research effort is the input; information is the output; the civil defense systems (building and operating) are the environment. As in all systems analyses, the secret of success is in (1) the analysis: the separation of the whole into its essential parts and (2) the study of relationships betweeen the parts.

A successful analysis of a system depends on having a logical, workable framework on which to display the parts. A language for the analysis has to be invented; names must be chosen and defined. Forms must be devised for recording data and displaying them so as to disclose relationships. And rules must be established so that what is done will be consistent.

That is what is done in this paper. It presents a framework with names and definitions and demonstrates its use. Much of the framework is not new; it is part of the framework developed over the past ten years for analysis of the civil defense systems. The idea of classifying research in terms of the day-to-day activities it supports is new. The demonstration of the relationship of this classification to the systems analysis framework is new. And, of course, the application to research is new.

The demonstration in this paper is limited to the analysis: the reduction of a research program to its essential characteristics. The paper does not demonstrate the use of the data derived in the analysis. It does contain a limited discussion of how they might be used in evaluation of the state-of-the-art, in disseminating research results, and in research programming and management. This is consistent with the intent of the paper: to provide assistance to the analyst in forming and applying judgment, not to replace his judgment. Uses for the data and ways to use them will develop far better in attempts to use them than in a paper such as this.

It appears that the "operational question" will be an important element in evaluating research and in the other uses for the data produced in the analysis. This is a description of the information need cast in terms of the civil defense operating system. It is not a new idea; it has been used in research programming in the Office of Civil Defense for several years. The development of skill in writing these operational questions will be a major factor in the success in applying the method presented in this paper.

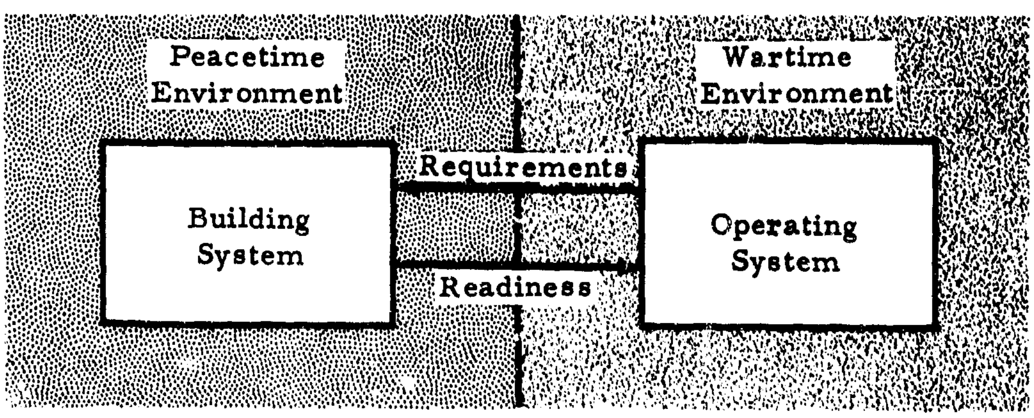
The paper has been written entirely from the point of view of research and the research analyst. This was done, of course, because it presents a method intended to be used in research programming and management. However, much that is in it may be of value to people working in the civil defense action programs. For example, it might give them clues as to effective ways to phrase questions to be asked of research. Beyond that, we do not offer any suggestions, leaving it for others to relate what the paper contains to their interests.

II. ACTIVITIES IN THE BUILDING SYSTEM

The term "civil defense" conjures up visions of enemy attack, of people being protected in shelter, of fire fighting, of fallout, of decontamination, and so on. In other words, civil defense is normally associated with enemy attack and its aftermath. In system terms, civil defense is commonly thought of as an operating system in the sense that it operates to counter the immediate effects of attack and to care for the people and their property until some semblance of a "normal" society can be reestablished.

But a "civil defense" exists today, and it differs markedly from the operating system. Today, no enemy attacks; no one is in shelter; fire fighting is not civil defense; fallout is not hazardous in a wartime sense; decontamination is a matter of ordinary sanitation. The civil defense of today is developing policy, making plans, surveying for shelter, installing warning devices, training people, and so on. In other words the civil defense of today is preparing to operate by providing hardware and trained people, operating doctrines and procedures, and by organizing them (on paper, at least) into a workable pattern for action if an enemy attack should come.

In system terms, then, civil defense has two systems: (1) the building system which is functioning now to build the operating system and would cease to function at the time of an attack and (2) the operating system which would start to function or would gain its effect at the time of an attack. The two systems have a feedback relationship: the operating system imposes requirements on the building system; the building system feeds preparedness to the operating system.



TWO CIVIL DEFENSE SYSTEMS

Many of the differences between the two systems are readily apparent. For example, the operating system's environment contains weapon effects; the building system's does not. The building system function of designing and installing a warning system is quite different from the operating system function of giving a warning. Other differences are not as readily apparent although fully as real and significant. For example, most elements of government and their people perform functions in both systems and thus seem to establish a continuity that tends to invalidate the two-system idea. However, on close examination it is found that many of them perform different functions in the two systems and that there is, in fact, discontinuity. Enough of these discontinuities can be found in the change-over from the building system to the operating system to make the two-system idea both valid and desirable.

The concern here is with a part of the Building System, research: a day-to-day activity whose purpose is to support other day-to-day activities. A problem for research is to determine how best to support building system activities in technical matters. To study this problem, it is necessary first to examine the day-to-day activities of the Building System to which research must be related. Then it will be possible to determine what the relationship might best be and how it might best be established and maintained.

For this examination, the building system is examined in terms of what it is that is being done rather than what the organization charts and functional statements say. In this way attention can be focused on the nature of the activity and the research support required, and consideration of organizational arrangements can be left to others. In addition to the nature of the activity, the dynamics -- the flow of activity -- are examined as an idealized process. Not everything that goes on in the building system starts at the beginning of this process and follows it all the way through, or needs to.

In the following discussion, each of the major activities of the building system is taken up in turn and defined. For each, the category of research that supports it is then defined. To define research simply by prefacing each activity definition by the words, "This research supports," is not enough. So what has been done is describe what constitutes the support, i.e., what kind of information is contained in the research output, and identify what is examined to produce the output. These definitions apply to these research categories throughout the remainder of the paper.

2.1 RESEARCH

Since the principal subject of this paper is research, the examination starts with it as in Figure 2.1. As the analysis develops, research will be related to the other parts.

Webster[1] defines research in a way that is quite appropriate for this discussion

> 2a. Studious inquiry or examination; especially, critical and exhaustive investigation or experimentation having for its aim the discovery of new facts and their correct interpretation, the revision of accepted conclusions, theories, or laws in the light of newly discovered facts, or the practical applications of such new or revised conclusions, theories, or laws.

In 1958, the National Academy of Sciences concluded that sufficient knowledge was available to build an effective civil defense system.[2] But research can add to the body of knowledge so as to make the civil defense system more effective, more acceptable, less costly, and so on. In addition, technology changes and the strategic situation changes. Research helps to analyze and interpret these changes and their implications for the design and building of the civil defense system.

Research adds to the body of knowledge to support the conduct of action functions. For the purpose of this analysis, research is categorized by the action function to which it provides primary support. Later on, this categorization will be correlated to that used in the research program structure.

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1. Webster's Third New International Dictionary, G&C Merriam, (Springfield, Mass.: 1963).

2. Advisory Committee on Civil Defense, The Adequacy of Government Research Programs in Non-Military Defense, National Academy of Sciences-National Research Council (Washington: 1958).

NOTE:

This illustration is but the first piece of a flow diagram of the day-to-day activities of civil defense. Research is shown as a centroid within the envelope of other civil defense activities because this paper is about research, not for any other reason.

Fig. 2.1 RESEARCH

2.2 PROBLEM DEFINITION

In its simplest mode, the building system process starts with an indeterminate problem, one that is understood to exist but has not been defined, as shown in Figure 2.2. If civil defense were just starting to develop, it would be with the understanding that a possible enemy possessed some weapons that he might, in some circumstances, employ in some way that might result in some kind and amount of adverse effects on the people of the United States. Of course, we have long since derived better descriptions of the basic problem and of many of its elements. However, some problems are still undefined, especially as the planning reaches finer detail. Others, once defined, are made indeterminate again by changes in weapon technology, in the power structure, and in other elements of the strategic environment. Therefore, many indeterminate civil defense problems are still to be found.

The first step in solving any problem should be to define it. That is, the amorphous strategic situation in which civil defense problems may exist should be examined and deficiencies to be corrected, needs to be filled, or whatever is found to be done, should be described as completely and as accurately as possible. This can be said to be the definition of the desirable outputs (or consequences) of the civil defense operating system.

The problem definition needs to be explicit. Of course, solutions to problems are often attempted without explicit definitions. In much the same way, people often treat symptoms instead of having a doctor treat the disease. Sometimes they die. And sometimes solutions for assumed problems fail. Civil defense, as does medecine, deals with the lives of people and their well-being, and it has no right to treat problems defined implicitly when they can be defined explicitly.

Problems--whether for the total civil defense system or for a single action within it--arise in, and are posed by, the environment. For the total system, the environment is everything outside of civil defense. For a single action within civil defense, the environment includes everything outside of civil defense plus everything within civil defense other than the action being considered. These problems stem from interactions among elements of the environment. They would exist if the civil defense system on the one hand, or the single action on the other, did not.

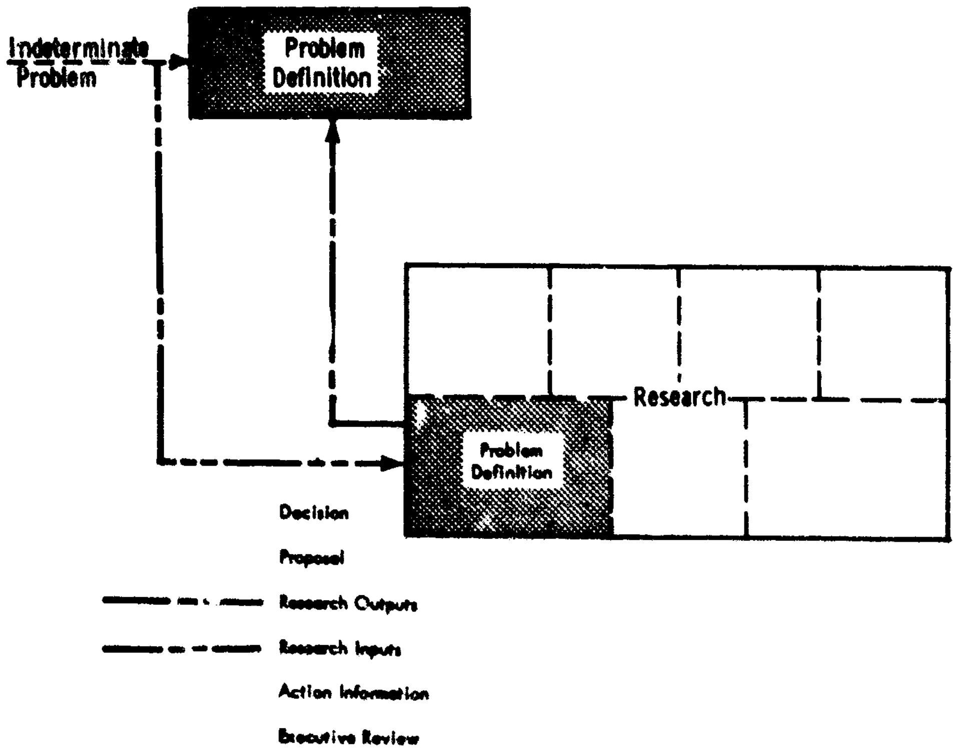


Fig. 2.2 PROBLEM DEFINITION

Problem Definition, then, is the describing of the desirable outputs, or consequences, of the system. The process of describing consists of (a) identifying pertinent elements of the environment, (b) describing their characteristics, (c) examing the interactions among them, and (d) stating the consequences of these interactions.

For a simple example, four pertinent elements are identified in the environment: nuclear weapons, soil, weather, and people. The weapons release energy when detonated and also leave an energy-releasing residue. Soil has a chemical composition and physical properties. Weather includes winds. People have physiological responses to energy. The energy released by a weapon changes the chemical and physical characteristics of the soil, and residue from the weapon mixes with the soil into an energy-releasing material called "fallout." The winds can transport this fallout and deposit it near people. The energy the fallout releases can cause harmful physiological responses in people resulting in their injury. For the civil defense system, (a) preventing injury of people is a desirable consequence, (b) the people are inputs, and (c) descriptions of the weapons, soils, winds and people, and of the interactions among them are descriptions of the environment. A coherent statement of all of these is a problem definition.

2.2.1 PROBLEM DEFINITION RESEARCH

Research supports this activity in two ways: (1) by the development, accumulation, and collation of "new facts" about the civil defense environment, e.g., the effects of weapons on people, and (2) by development of analysis techniques for identifying pertinent elements of the environment, studying their interactions, and drawing conclusions as to consequences that appear desirable for the civil defense system to produce. This second is a broad subject including the development of models and methods for "vulnerability assessments," for much of what is called "damage assessment," for fallout distribution estimates, and so on. Research does not include the collection of masses of data--such as a census--that are required for doing some problem definition.

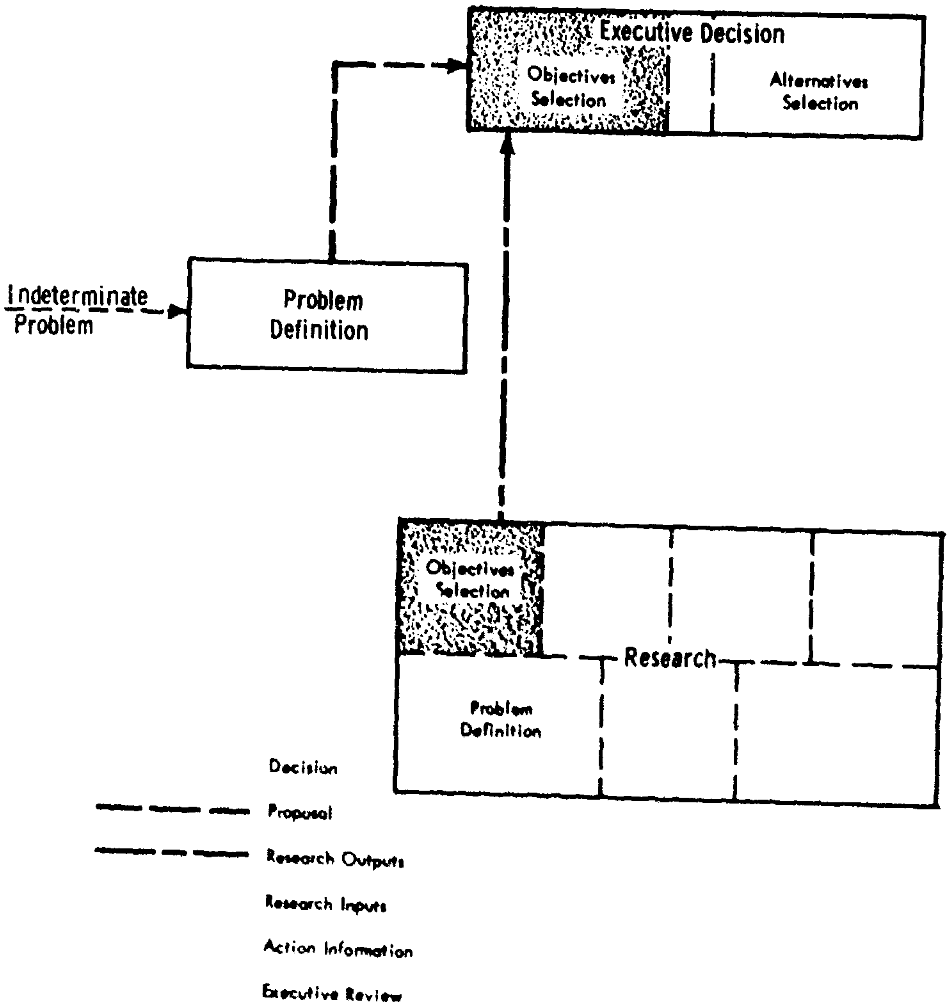


Fig. 2.3 OBJECTIVES SELECTION

2.3 OBJECTIVES SELECTION

The civil defense system may not find it feasible to provide for every output (consequence) that appears possible or desirable. In this case, it is necessary to choose for attempted solution those problems whose solutions appear feasible within whatever limits of feasibility pertain: technology, staff, cost, and so on. This is a matter of executive decision, as shown in Figure 2.3, and the selection is based on whatever criteria the executive chooses to apply. The effect of this decision is to establish objectives, or goals, to be achieved. At this state of the process, the objectives are stated in general, qualitative terms, and they are equivalent to, or would constitute, a statement of mission. In addition, the statement of objectives provides some criteria for selecting the preferred system design.

Although the selection of objectives is judgmental, the forming of a judgment is made easier if the executive is given information that illuminates the subject. Since civil defense is not starting anew, the executive can be given estimates of the probable feasibility of solving various problems. He can be given estimates of the probable effect of problem solutions on the strategic situation.

Objectives selection, then, is the process of (1) applying value judgments to the defined problems, (2) choosing those for which solutions are to be sought, and (3) setting aside the others. What value judgments can be applied depends largely on the state of knowledge in the subject being considered. In other words, if little is known about the relative probabilities of the occurrence of two problems, the more-serious one would draw more attention. On the other hand, if relative probabilities are known, the more-probable one might receive first attention even if it were less serious. Similarly, if there is knowledge about solutions to the problems, the problem with the more-feasible solution may draw first attention.

2.3.1 OBJECTIVES SELECTION RESEARCH

Research supports the objectives selection function by (1) developing techniques for comparing problems and (2) developing concepts and furnishing data for value systems. For example, projections of the strategic environment permit judgments as to the relative probabilities of counterforce as opposed to countervalue wars and the problems posed by each. However, no complete definition of objectives selection research is possible because the selection is an executive decision and the support he needs and wants depends on the executive.

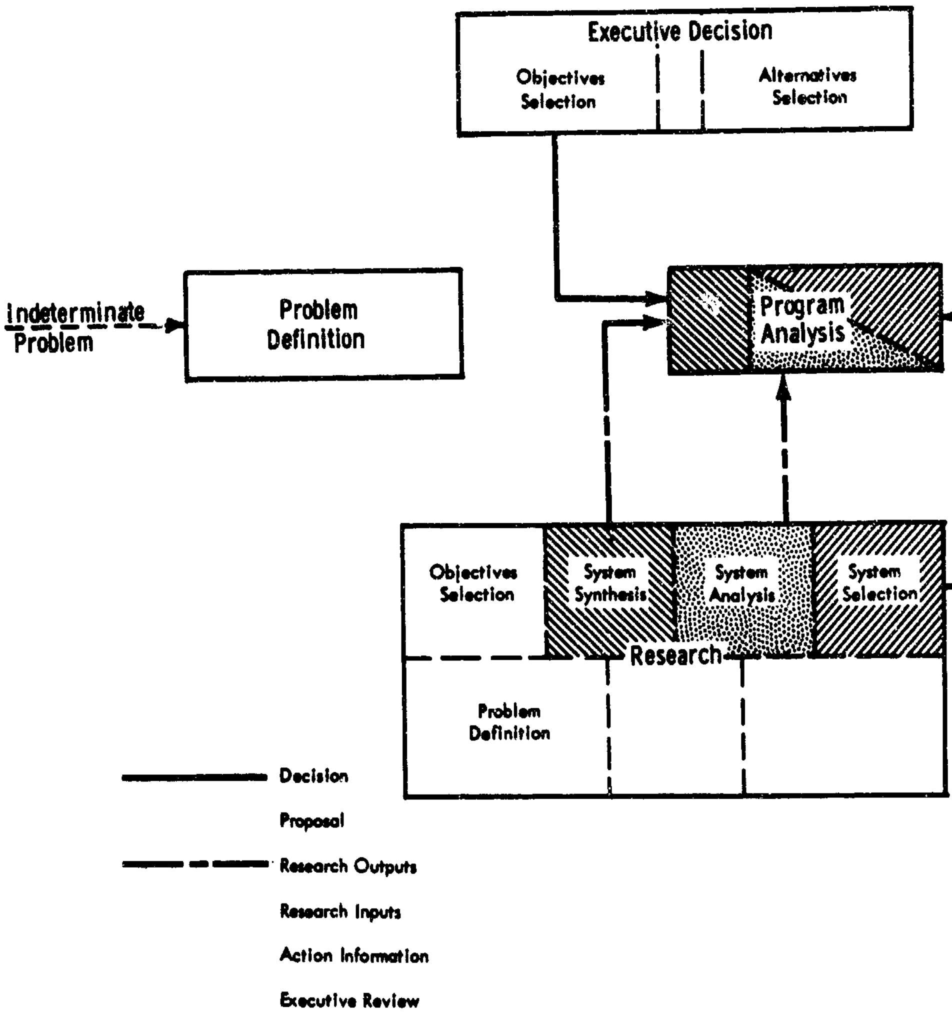


Fig. 2.4 PROGRAM ANALYSIS

2.4 PROGRAM ANALYSIS

Given general objectives, the next step in the process is to describe and evaluate alternative solutions for the selected problems as shown in Figure 2.4. In our analysis, this is a three-stage process of (1) inventing alternative systems designs, (2) estimating the cost and performance of each, and (3) evaluating them. For example, given a decision to protect people against fallout, it is possible to describe a number of significantly-different, alternative ways to obtain this protection and to estimate their cost. The effectiveness of each alternative can be estimated for a number of different attack situations. And finally, the descriptions and estimates of cost and performance can be compared for conistency, accuracy, and whatever other tests are desired and feasible. An example of this activity is the study of alternative civil defense postures in the Damage Limiting Studies.

The three parts of the program analysis process are:

a. System Synthesis: the compiling or inventing of alternative systems for achieving selected objectives. Each of the alternatives is described in sufficient detail to permit its analysis and evaluation. The amount of detail depends on the system being described. In general, the less inclusive the system, the greater the detail. In other words, an individual shelter alternative needs to be described in considerable detail while a total civil defense system alternative can be described in terms of its component countermeasure system, identifying each by its major characteristic (such as "100 Pf fallout shelter"),and giving estimates of cost and performance for it.

Each system synthesis should contain the following:

(1) Objectives: a statement of mission and performance requirements.

(2) Components: a descriptive listing of its major parts in appropriate detail.

(3) Organization: an organization plan.

(4) Operations: a schematic operations plan.

(5) Effectiveness: a statement of performance characteristics.

(6) Cost: an estimate of cost.

b. System Analysis: the theoretical simulation of the operation of a system in order to deduce the outputs or consequences it would be expected to produce. For example, consequences of a shelter system would include the number of survivors added, the number of injured added or decreased, the change in radiation dosage in the survivors, and so on, for given attacks. In our process, this is done for each hypothetical system compiled or invented in the System Synthesis function.

c. System Selection: a function with two elements: evaluation and decision, only the first of which is included here. The analyses of the alternative systems are evaluated for accuracy. consistency, comparability, and so on. The hypothetical systems themselves are evaluated for feasibility--technical, psychological, social, economic, and so on. The performance, cost, and feasibility of each of the hypothetical systems is compared with those of each of the others. From this evaluation conclusions can be drawn as to relative desirability of the alternatives.

2.4.1 PROGRAM ANALYSIS RESEARCH

Research support for program analysis is provided in two ways: (1) by developing analysis frameworks and techniques for estimating performance and for evaluation of the estimates and (2) by producing input data in the form of (a) suggestions as to alternative system designs and (b) unit costs and performance characteristics for parts of the system --e.g., the shelter system, the warning system, etc., are parts of the civil defense system--in the suggested new designs. Development of frameworks and techniques generally takes the form of prototype analyses that produce substantive outputs as well as advance the state of the analysis art. These substantive outputs supplement--but do not replace--the analyses made in the program analysis function.

The activities in the three parts of program analysis go on--in different levels of detail--within other major activities of the building system. Therefore, to simplify the categorization of research, the research categories will be: system synthesis, system analysis, and system selection, rather than the cumulative category--program analysis--that might have been chosen.

2.5 ALTERNATIVES SELECTION

This is the second part of the systems selection function, the executive decision: the selection of the general concept of the system to be planned, designed,and deployed, as shown in Figure 2.5. Here again, the executive may apply whatever criteria he chooses, although it is to be expected that he will be guided by the information produced in the program analysis. The decision from this step would be, for example, to proceed with the development of a full fallout shelter program.

2.5.1 ALTERNATIVES SELECTION RESEARCH

The research support for alternatives selection is of the same nature as for objectives selection. It consists chiefly of development of concepts and furnishing data for value systems for evaluating the alternatives.

2.6 PROGRAM PLANNING

Once the general system concept has been adopted - and in this context, "system" can mean a single action, such as: the response to warning - it is necessary to design a specific action program: a plan to be followed. This is similar to program analysis, the difference lying in the level of detail. For example, assume that in program analysis a comparison was made between alternatives based on fallout shelter or on evacuation and that in alternatives selection fallout shelter was chosen. Then in program planning the alternatives for evaluation would be based on different fallout shelter system designs. This is the repetition, in finer detail, of the synthesis, analysis,and evaluation of alternatives, as shown in Figure 2.6 plus the setting of specific objectives in quantitative terms both in amount and target date. For example, a program might call for "x" million added fallout shelter spaces by a given date at a cost of not over $"y" million. The annual budget presentation is a good example of program planning at the total system level.

2.6.1 PROGRAM PLANNING RESEARCH

Since program planning differs from program analysis chiefly in level of detail, the nature of the research support for the two is the same.as shown in Figure 2.6. The research, then, is categorized in the same way: system synthesis, system analysis, and system selection.

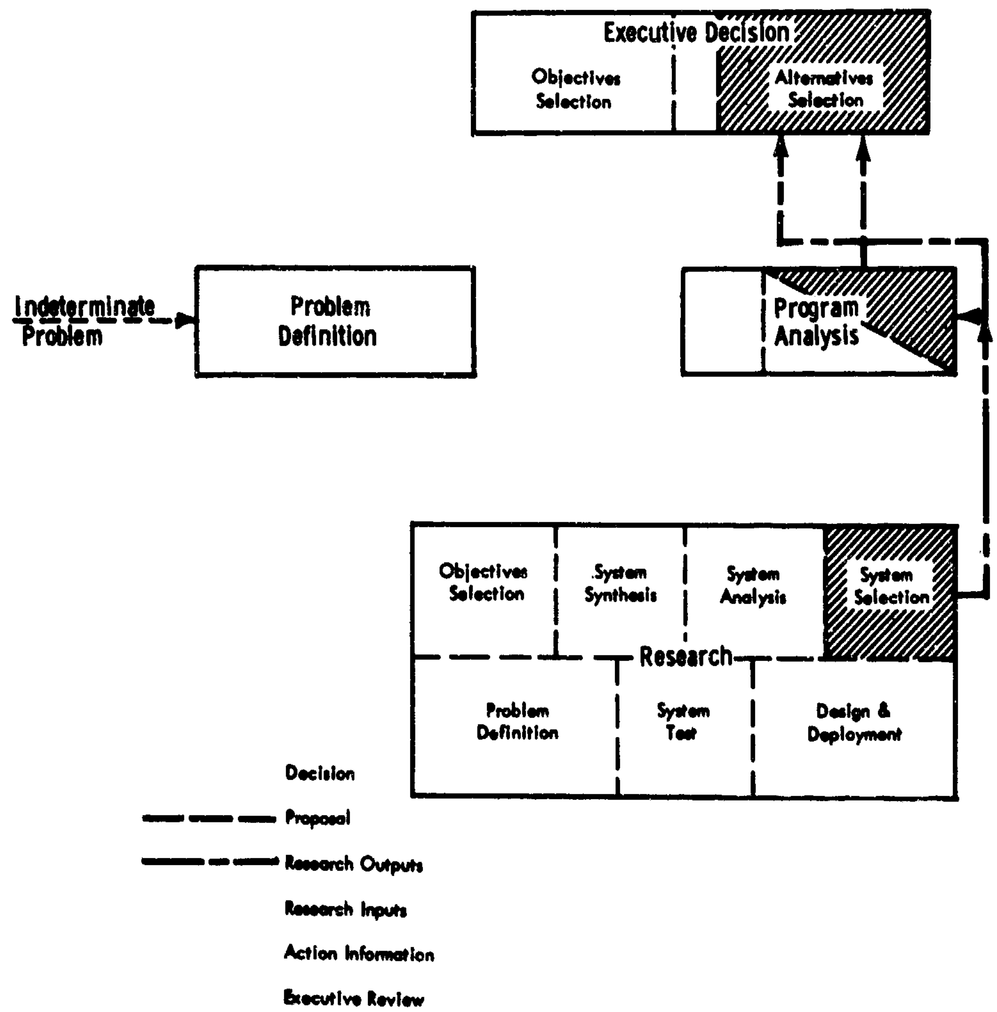


Fig. 2.5 ALTERNATIVES SELECTION

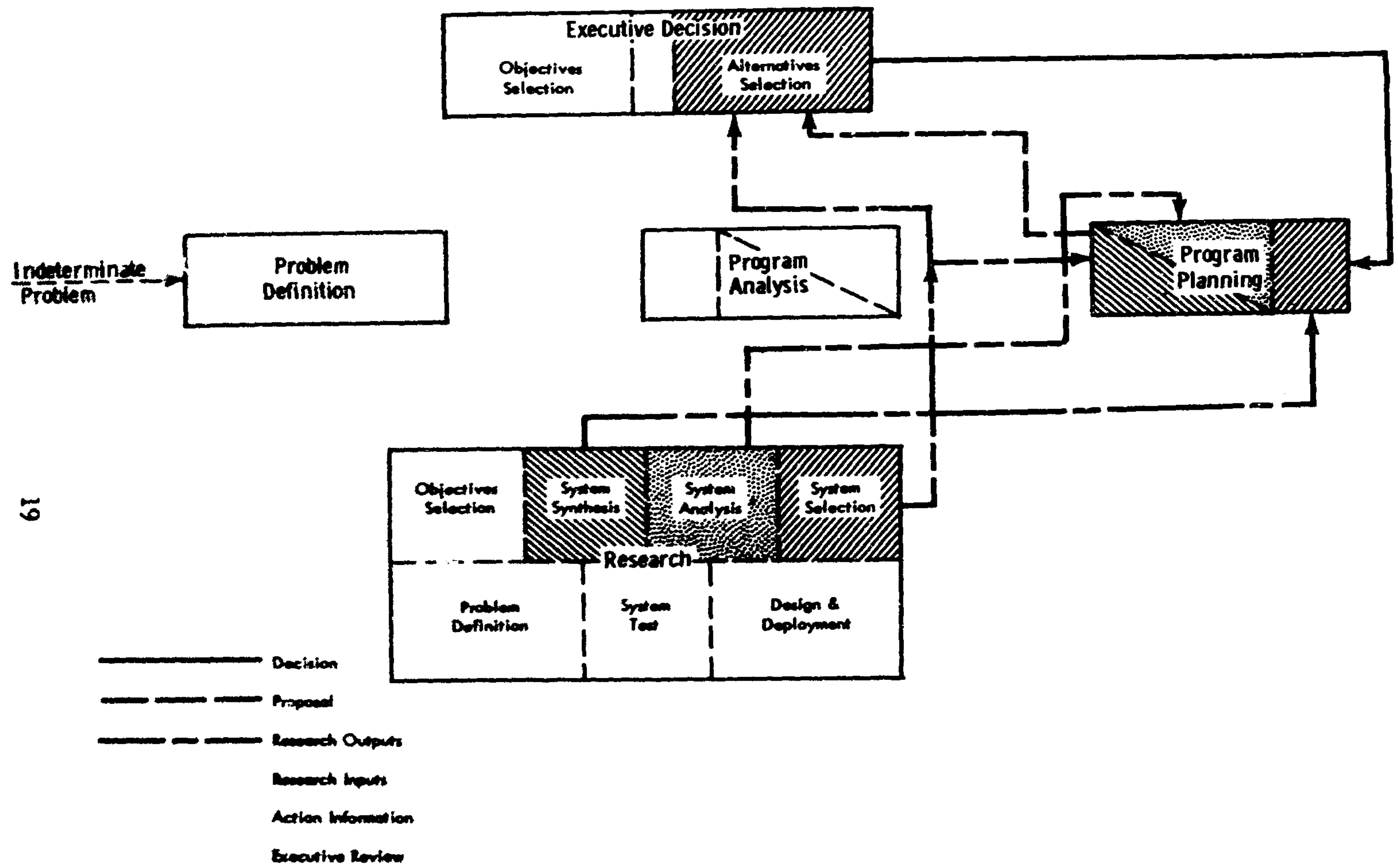


Fig. 2.6 PROGRAM PLANNING

2.7 SYSTEM DESIGN

Given specific program goals, it is necessary to design the specific system that will be deployed to meet these goals. System design involves three activities, as shown in Figure 2.7, each of which affects and is affected by the others. In this function, alternatives should be synthesized, analyzed, evaluated, and presented for executive decision, much as in the program analysis and program planning functions, but at a finer level of detail.

a. Hardware Design: the technical design and specification of the inanimate things in the system--structures, equipment, supplies, forms, and so on--that become parts of it or are used in its functioning. Of course, all hardware design need not follow program planning; much of it will precede program analysis.

b. Organization Design: (1) the specification and arrangement of the people in the system--their skills and abilities, authorities and responsibilities--in hierarchic order, (2) the specification of the channels of authority and communication, and (3) the assignment of items of hardware to specific persons or groups.

c. Operations Design: the design and specification of the actions to be taken by the people using the hardware in the system.

2.7.1 SYSTEM DESIGN RESEARCH

System design is the technical design and specification of hardware, operations, and organization for a system to be deployed. At this level of detail, there are still alternative designs. These can be analyzed and evaluated in the same general way as program and system alternatives are, although the framework and details of the analysis may differ. Therefore, some of the research support for program analysis and program planning may apply in system design. However, the major research support for system design lies in the area of technical data and design methods.

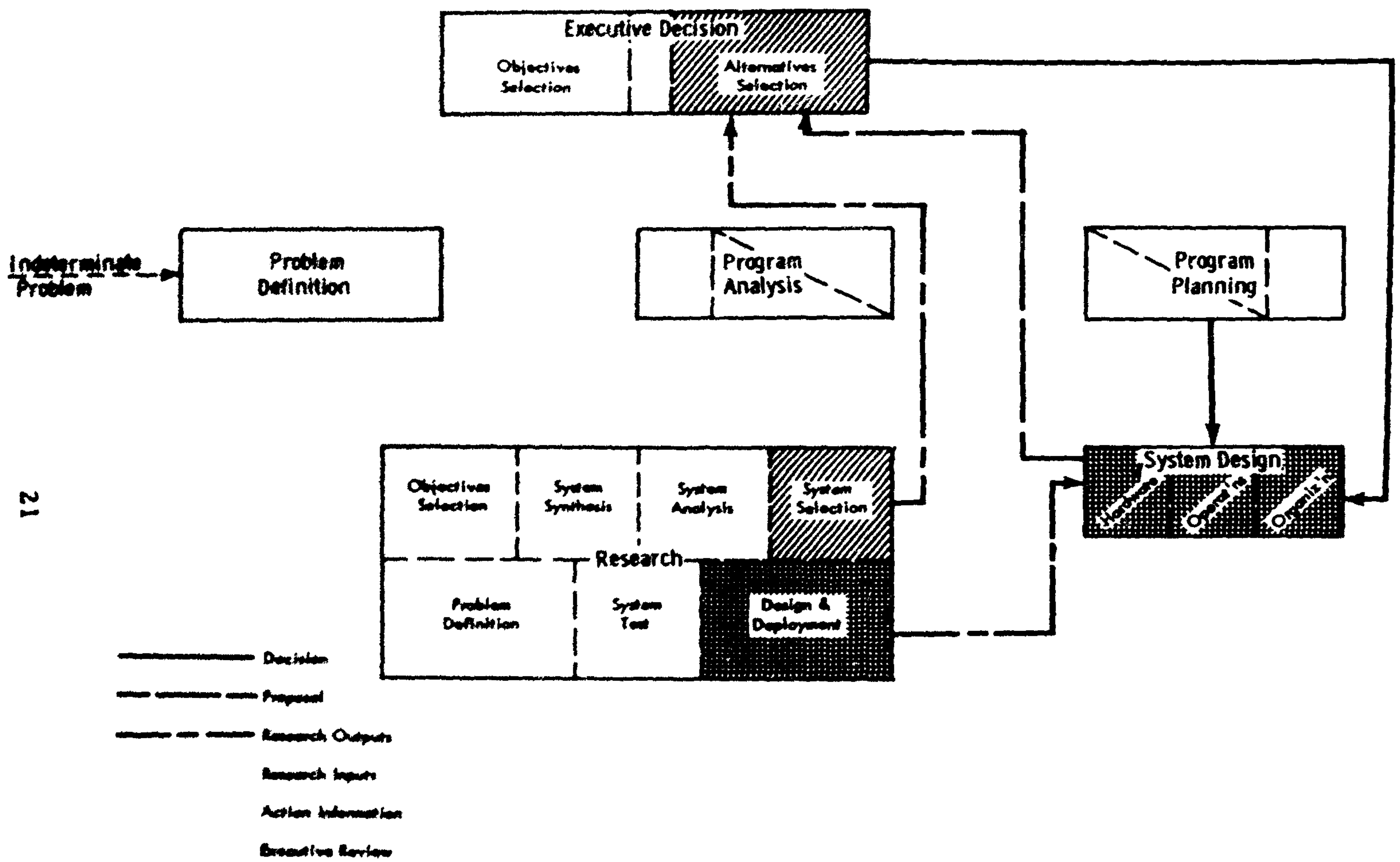


Fig. 2.7 SYSTEM DESIGN

The research support for system design lies in three areas:

a. Cost: data on costs and methods for estimating costs of alternatives. Costs are measured in many ways, e.g., dollars, man days of effort, units of other resources, loss of acceptability, and so on. System design research demonstrates which kinds of cost apply as well as how to measure them.

b. Effectiveness: data on effectiveness and methods for estimating it and for achieving given levels of it. Effectiveness is a measurement of the results obtained from the employment of something measured in terms consistent with its stated mission. Research on system design is concerned with the relationship between design and effectiveness in two ways:

(1) The development of data and methods for designing to achieve a given level of effectiveness.

(2) The development of data and methods for estimating the effectiveness of a given design.

In this paper the term "effectiveness" is used to include both aspects.

c. Feasibility: data on feasibility and methods for estimating relative feasibility of alternatives. Feasibility can be absolute, e.g., a piece of equipment may be infeasible because the required material cannot be obtained. It can be relative, e.g., a design may be feasible only if its cost is within what is politically acceptable to the appropriating body, or an action may be feasible only if the attendant circumstances make it psychologically acceptable. System design research must demonstrate which feasibility considerations apply as well as provide data and methods.

2.8 SYSTEM DEPLOYMENT

The specific design for the selected system is translated into reality by the function we call deployment. System deployment involves three activities, parallel to the three in system design as shown in Figure 2.8, and again related to each other, at least to the extent of consideration of consistent time-phasing of readiness. Again alternatives should be synthesized, analyzed, evaluated, and presented for executive decision.

a. Hardware Procurement: in this analysis, the procurement function takes other forms in addition to purchase. The term is used to include also: storage, issue, distribution, and installation of equipment, furnishings, and supplies. It also includes construction of facilities and the identification of existing facilities, equipment, supplies, and so on as parts of the civil defense system. The National Fallout Shelter Survey is an example of this last use of the term.

b. Staffing: the recruitment of staff and their training for their assigned functions in the system organization, as spelled out in the operations plans.

c. Operations Plans: the function of spelling out, in writing, the actions that the people in the system will perform including alternatives where appropriate for contingent situations and criteria for choice among these alternatives.

2.8.1 SYSTEM DEPLOYMENT RESEARCH

Research support for system deployment includes methods for development and evaluation of alternatives for such activities as surveys, construction, selection of staff, training, operations, decision rules, and so on, and technical information and data for developing, evaluating, and conducting these activities. Since, as will be seen later, system deployment is so closely related to system design, the research support for the two can be treated as one category: system design and deployment research.

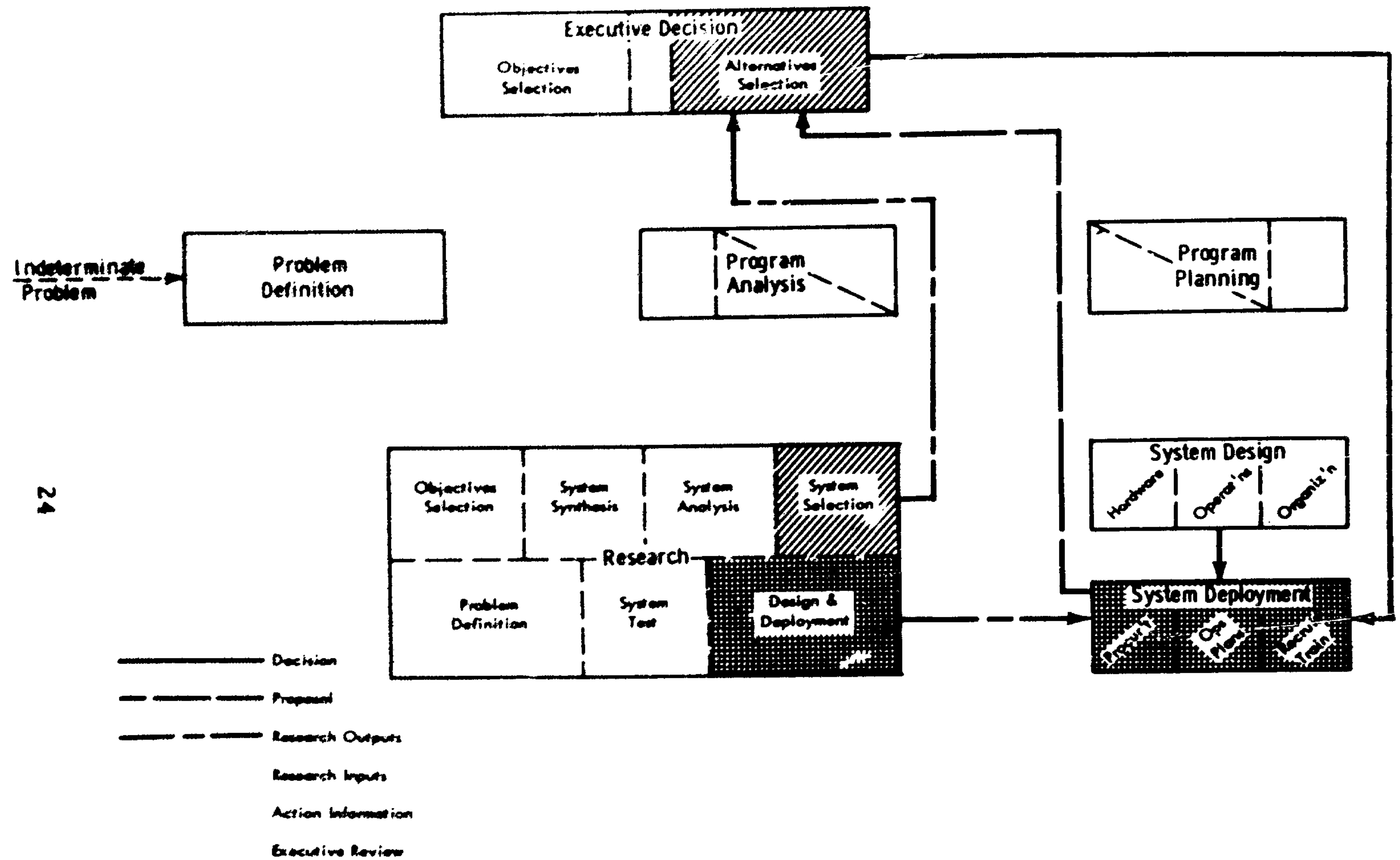


Fig. 2.8 SYSTEM DEPLOYMENT

2.9 OPERATIONS

This is the functioning of the civil defense system in the actual emergency. This function is different in nature from those discussed above because they are all preparatory for this one. In other words, they are carried on within the building system. Operations are carried on by the operating system and they include some functions similar--but not necessarily parallel--to those in the building system. This activity is included here for completeness, i.e., to carry the process from the indeterminate problem to its eventual solution as shown in Figure 2.9, although it is not essential to the discussion.

In the emergency situation, actions can be taken that appear identical to those described for the building system. This can lead to useless philosophical discussions of what is building vs. what is operating. The term "increased readiness" is used to signify a rapid buildup of capability in the emergency, and this is defined to be a function of the operating system. Therefore the physical staffing of an EOC or the "crash" building of shelters would be operating system functions in the emergency although they would be building system functions if conducted before the emergency. The point is important only when considering what should be in an operations plan.

2.9.1 OPERATIONS SUPPORT RESEARCH

Research can support operations by supplying technical data for use in analyzing operational problems, synthesizing solutions, and deciding among alternatives, especially where such data would not normally be provided in operations plans, standard operating procedures, and the like. Since these data can also be used in system design, a special category for operations is not needed, and this research is included in the system design and deployment category.

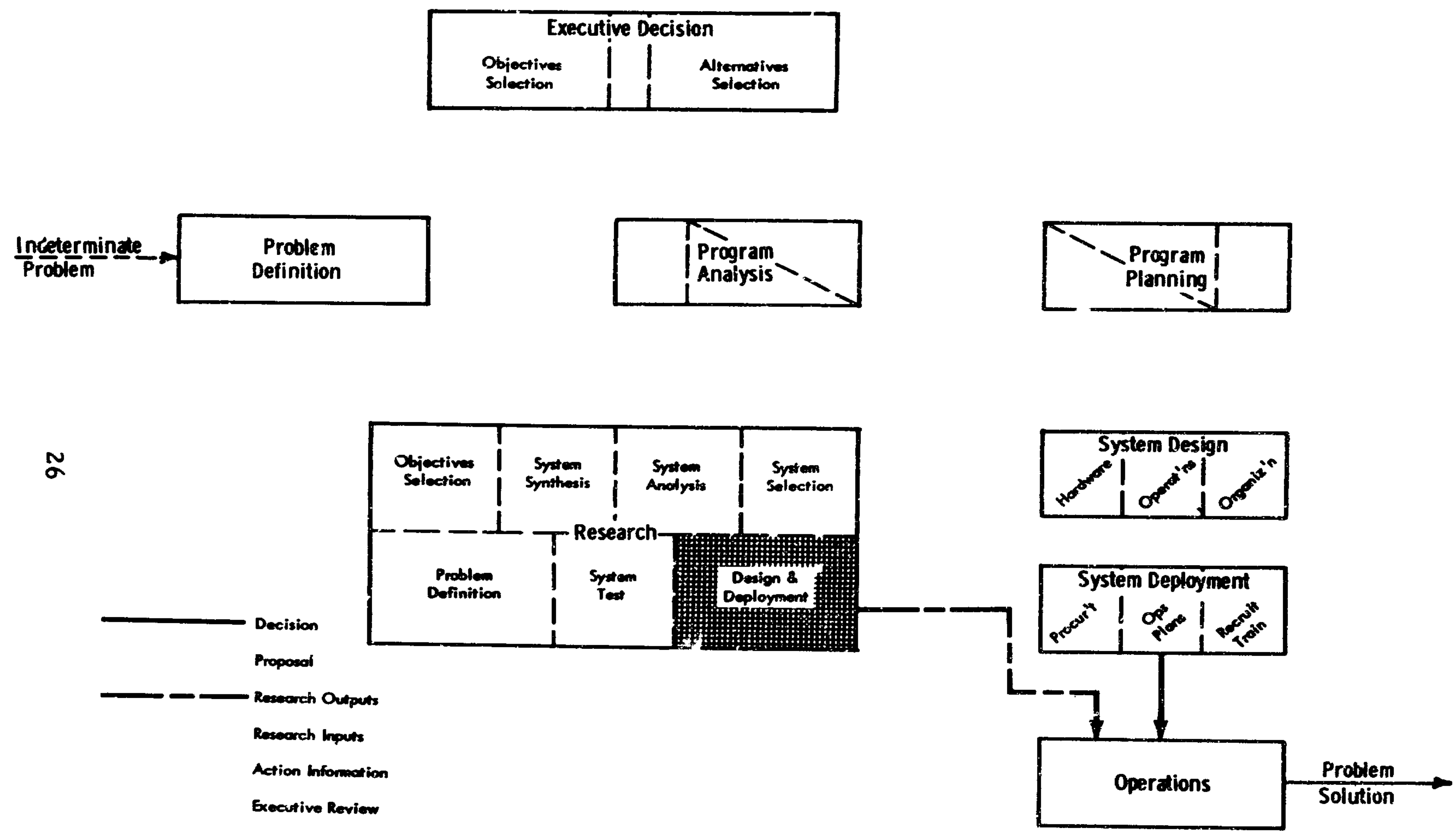


Fig. 2.9 OPERATIONS

2.10 SYSTEM EXERCISE AND TEST

Once an operating system is deployed, it is started up, from time to time, in a hypothesized operational environment, and operated for a time under observation. If the primary purpose of this operation is training, it is called an exercise. If its primary purpose is evaluation, it is called a test. Testing may also be simulated, i.e., the system as well as the situation can be hypothetical. This latter type of testing is appropriate to evaluations of proposed systems.

Exercise and test may be functions of either the building or the operating system. In this case, exercise and testing of operating system components not normally functioning as such can be termed building system functions. On the other hand, exercise and tests of operating system components normally deployed and functioning as such would be operating system functions.

2.10.1 SYSTEM TEST RESEARCH

Research can support system test activities by providing prototype test designs and both exercise and test by providing information and technical data for the construction of realistic scenarios for the play.

2.11 DYNAMICS OF THE SYSTEM

All of the major functions of the building system can be placed within the boxes shown in Figure 2.10. In addition, activity flows among these boxes. Some of it was indicated by the lines and arrowheads in Figures 2.2 through 2.10. For use here, there are three kinds of dynamics: action flow, action information, and research information.

2.11.1 ACTION FLOW

This is the mainstream of activity from problem definition to problem solution. The intended objectives of civil defense are achieved along this channel. Within action flow, there are two types of dynamics, complementary but different, as shown in Figure 2.11.

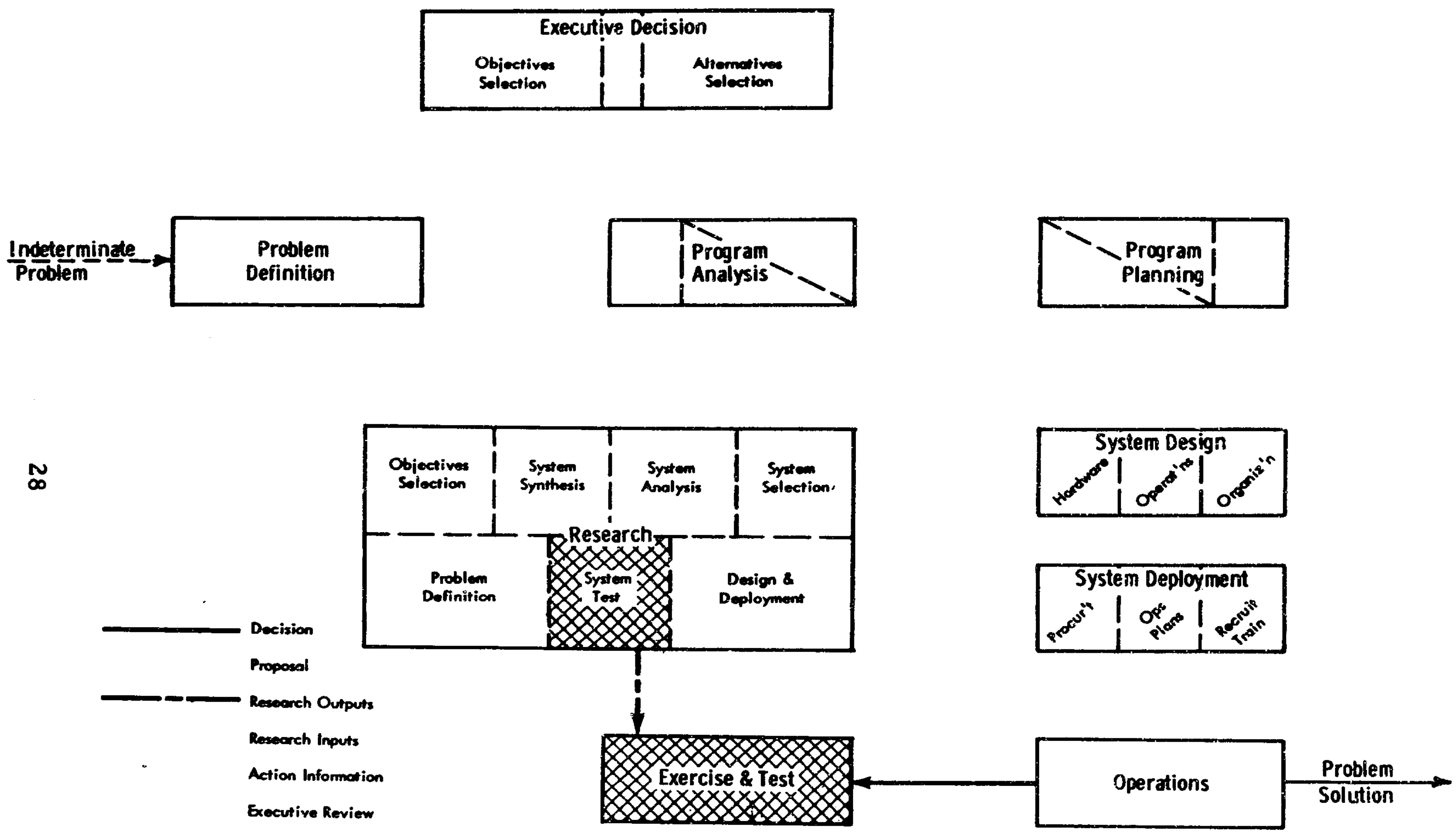


Fig. 2.10 EXERCISE AND TEST

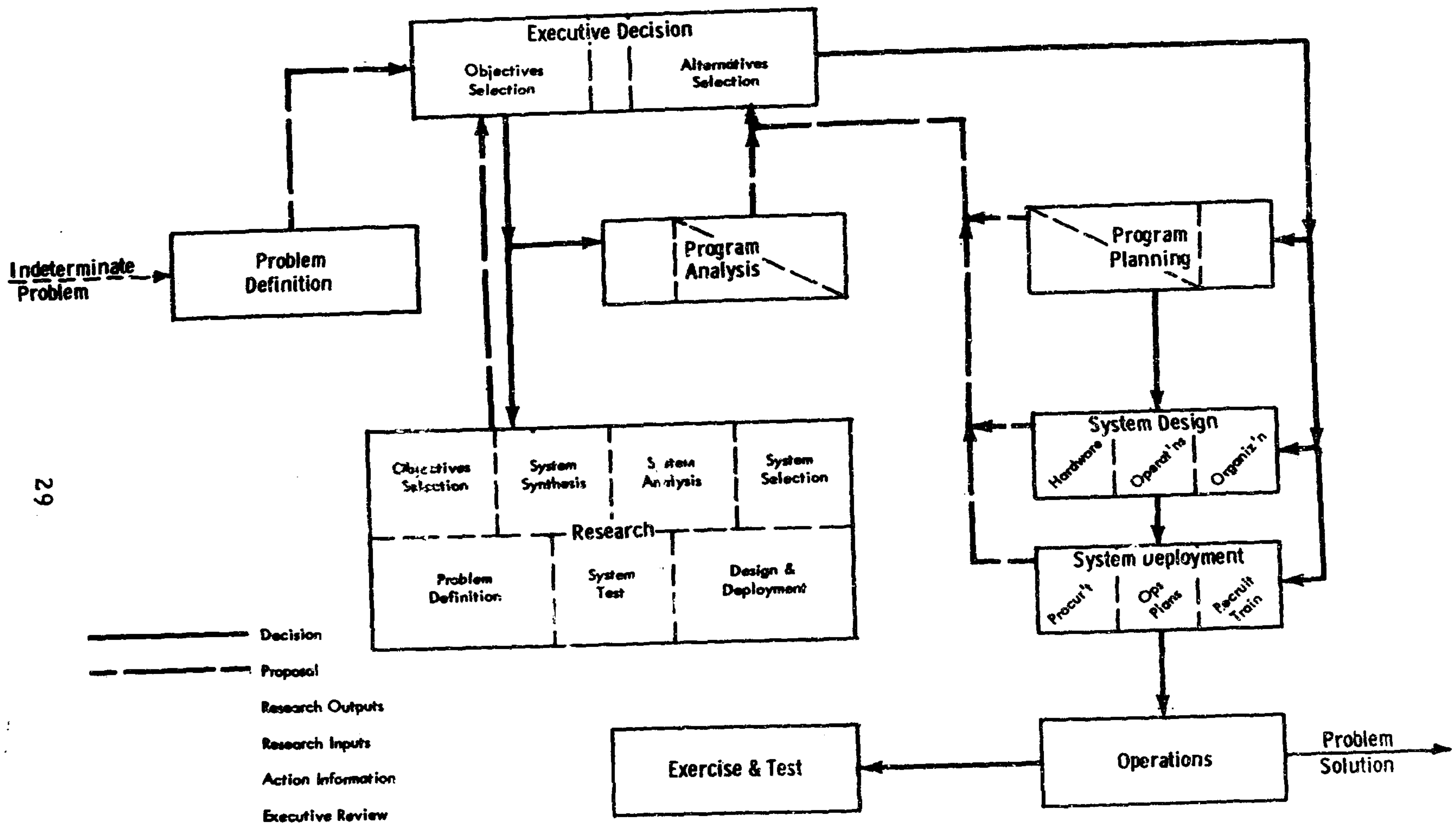


Fig. 2.11 ACTION FLOWS

a. Proposal. From the various activities, alternatives are proposed to the executive for his selection of the preferred option. These proposals can be, and are, made from every activity as shown on the model by the dashed lines. For example, identified problems are offered for selection of those to be solved,and deployment alternatives are offered for selection of the course of action to be followed.

b. Decision. After the executive has chosen or decided, his decision is promulgated along the solid lines. For example, the problems selected for solution are made known to the program analysis activity, and the decision as to deployment alternatives are made known to the system deployment activity. In addition, decision flow can occur in a different form when, for example, a program plan moves from the program planning activity to system design,or a system design moves from the system design activity to system deployment. In either of these latter examples, an executive decision in alternatives selection may or may not intervene depending on the circumstances of the particular event.

2.11.2 ACTION INFORMATION

Information flows among the major activities. This flow can be in the same direction as the action flow, but generally it is not. Information generally flows back along the action channel. In this light, there are two types of action information as shown by the lines and arrowheads in Figure 2.12.

a. Executive Review. The executive function is not completed by the promulgation of a decision. The executive must review the effects of the decision to observe whether his action has been correct and the problem solved or whether a new one has been created. This requires a flow of information back to the executive. For example, a completed design would be reviewed by the executive to determine whether it was in accord with his decision as to the selected alternative. He would also review the completed design to determine whether it came out as he envisioned it when he made the decision. For this, a flow of information would take place from the system design activity to executive decision.

b. Data and Requirements. Every activity within civil defense requires data of the type that are obtainable and obtained in the functioning of civil defense. For example, a great deal of information was gathered in the shelter survey--a system deployment function--that is used in other functions. In addition, the conduct of the activities leads to identification of needed new actions and changes in previous actions. For

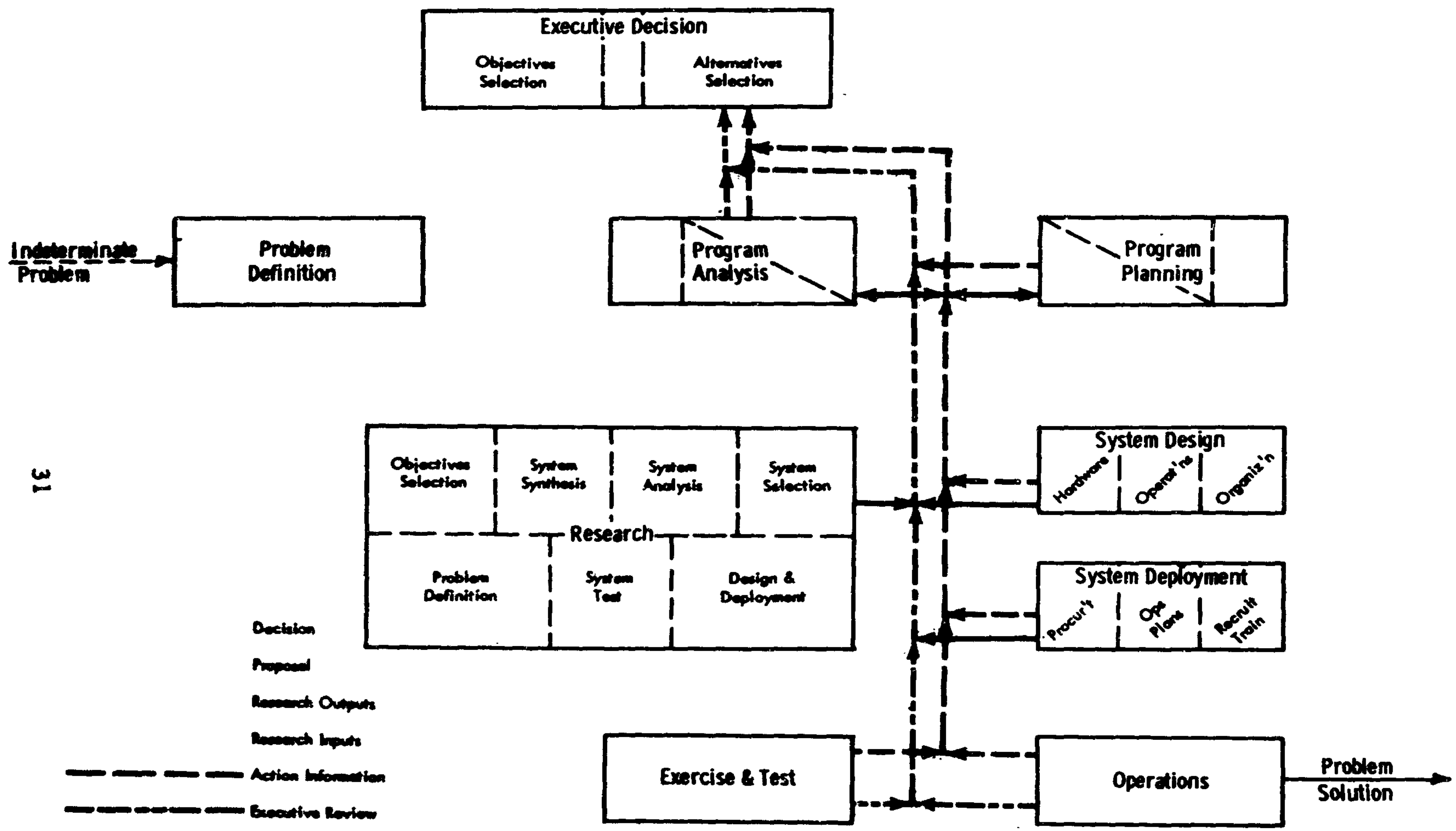


Fig. 2.12 ACTION INFORMATION FLOWS

example, in the placing of supplies in the marked shelters--a system deployment function--it was found that the space requirement for water storage often limited the capacity of a shelter. This indicated the desirability of a change in the system design. Therefore, flows of data and of statements of requirements must be provided.

2.11.3 RESEARCH INFORMATION

Research produces information; it adds to the store of knowledge. Some of this information is needed and is directly usable chiefly within research. This will be discussed later. But most of the research output is used in one or more of the action functions. In addition, research can benefit from an identification of information needs. Again, this allows us to identify two types of dynamics as shown in Figure 2.13.

a. Research Outputs. As the picture of civil defense activity developed in Figures 2.2 through 2.10, a parallel internal structure developed for the research function. At the same time, the principal flows of research output to action functions were indicated. For example, the output of problem definition research flows to the problem definition activity. Similarly, the outputs of system synthesis, analysis, and selection research flows to the program analysis, program planning, and alternatives selection activities.

Thus it can be seen that the output of some research categories feeds into more than one activity. The reason for this lies in the fact that some, if not all, activities repeat at different levels of planning detail. Repetition also occurs at various echelons of the organization. In other words, the structure is shown in Figures 2.1 through 2.10 as two-dimensional, while to be complete, even in this concept, it would have three or more dimensions.

An important point can be made here. The concept of a research output flow to the action functions in civil defense should bring out, in an abstract way, the difference in roles between research and the action functions. Research provides information for, and assistance in, the conduct of the action functions. It neither conducts them nor takes responsibility for them.

b. Research Inputs. Just as data flows among the action functions, data from them is usable in research. A number of research studies have used data from the shelter survey. For example, a finding that the shelter potential of existing spaces was often limited by a lack of

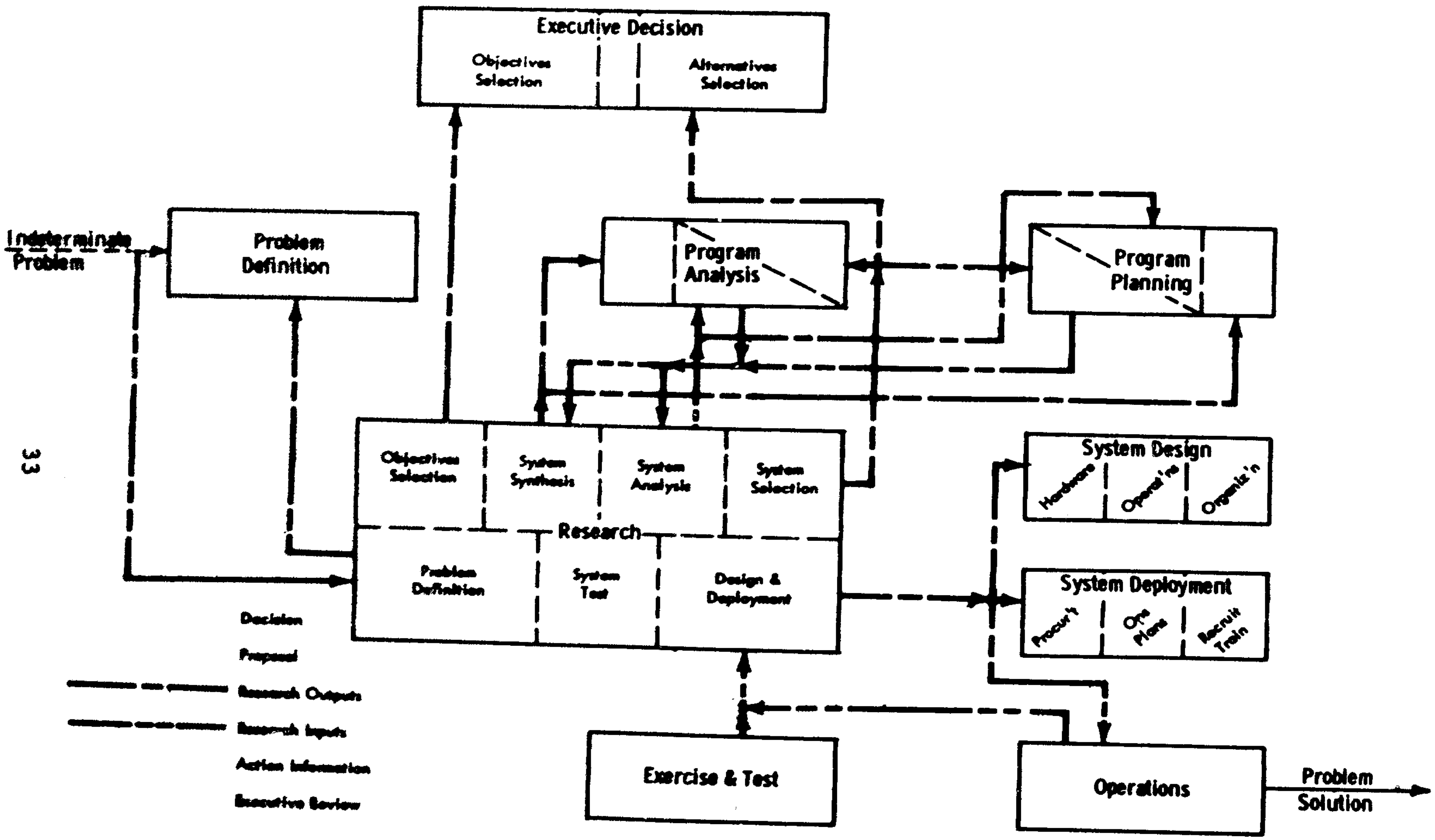


Fig. 2.13 RESEARCH INFORMATION FLOWS

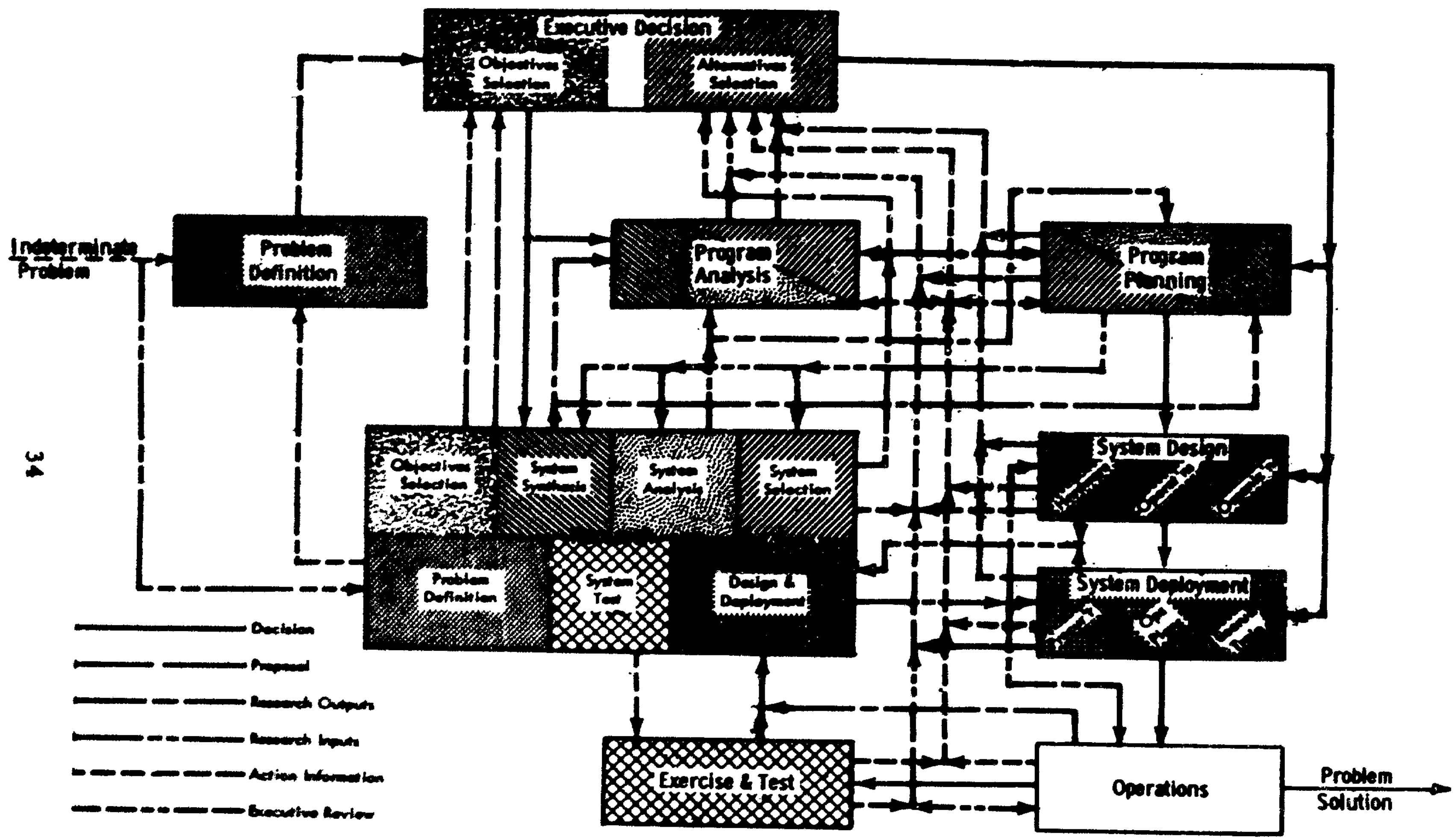


Fig. 2.14 BUILDING SYSTEM ACTIVITIES

mechanical ventilation led to selection of an objective to develop a cheap ventilation system and to a preliminary investigation and design of such a system. The action functions also pose question for answer by research. Notable examples of this are the studies of assignment to shelter, local planning methods (Montgomery County), and response to warning.

2.12 THE COMPLETE PICTURE

In Figure 2.14 there have been added information flows from Figures 2.11, 2.12 and 2.13 to the picture developed in Figure 2.10 in order to indicate all of the dynamics among the functions discussed above. Figure 2.14, then, represents the complete picture of civil defense as we have developed it for this discussion. However, before leaving it, two of its elements should be expanded to point up interesting relationships.

The first of these is in Executive Decision. This encompasses two functions: objectives selection and alternative selection. The picture as drawn omits an important relationship between these two functions. Figure 2.15 shows their internal dynamics within the envelope of executive decision.

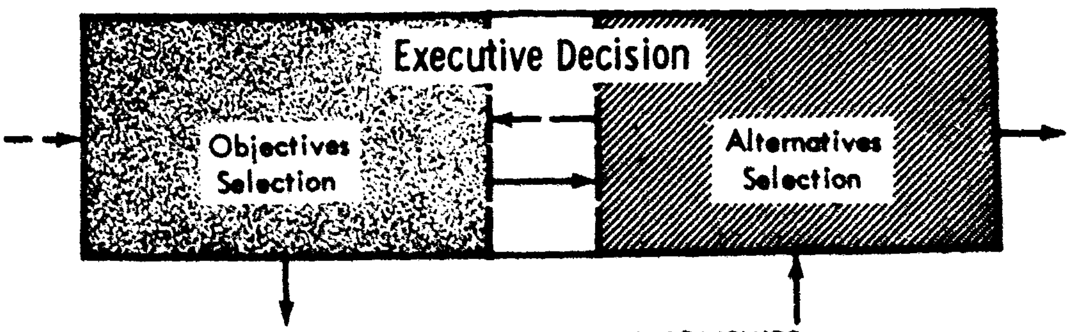


Fig. 2.15 FEEDBACK RELATIONSHIPS IN EXECUTIVE DECISION

This shows that a decision made in objectives selection goes not only to program analysis for action but also within executive decision to alternatives selection for information that applies in the evaluation of proposed alternatives. It shows, too, an information flow from alternatives selection back to objectives selection. This means that the executive's evaluation of proposed alternatives may not result in a selection of any of them. It may result in a decision to select different objectives, in which case the decision would be promulgated from

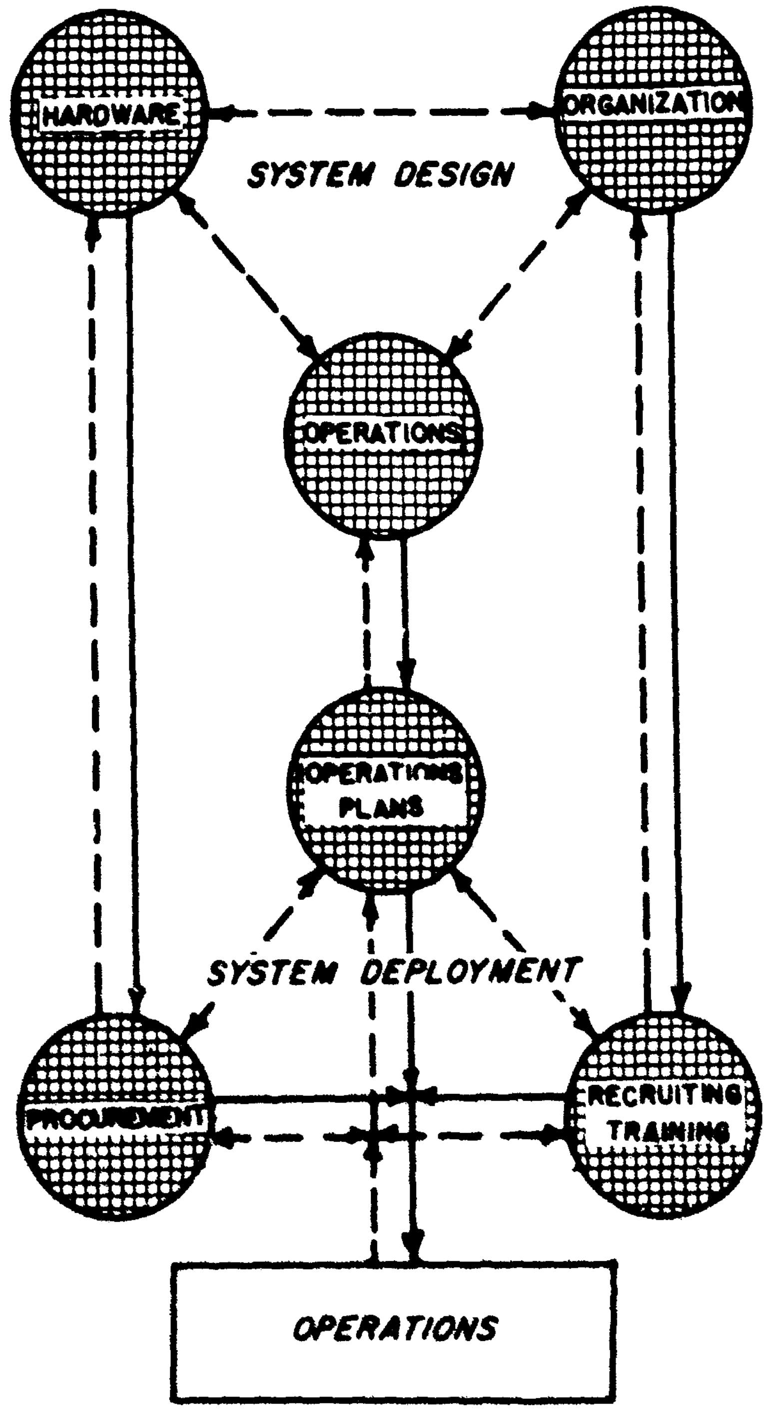


Fig. 2.16 RELATIONSHIPS IN SYSTEM DESIGN AND DEPLOYMENT

objectives selection rather than from alternatives selection. Some recycling of action would then occur. Other recycling can also occur but that can be traced in the model as shown in Figure 2.14.

The second is in the system design and system deployment activities. We mentioned before that hardware, organization, and operations plans are involved in both functions and are related amongst themselves. These relationships are expanded in Figure 2.16. This shows that there must be a flow of information among the three elements of system design and of system deployment. These are closed feedback loops in both directions and suggest that iteration is required to obtain suitable relationships.

It also shows that decision flows from each element of system design to the corresponding element of system deployment and that information flows back along the same channel. But from system deployment the flow of decision--in the form of a deployed system--to operations is in a single channel, as is the flow of information back. This serves to bring out the necessity for correlation among the three elements of system design and deployment.

SYSTEM ANALYSIS AND INTEGRATION MATRIX			OPERATING SYSTEM						BUILDING SYSTEM					
			DETERMINANTS				INTEGRATORS		DETERMINANTS				INTEGRATORS	
			OUTPUTS	INPUTS	CONSTRAINTS	COMPONENTS	FUNCTIONS	CONTROLS	OUTPUTS	INPUTS	CONSTRAINTS	COMPONENTS	FUNCTIONS	CONTROLS
OPERATING SYSTEM	DETERMINANTS	OUTPUTS												
		INPUTS												
		CONSTRAINTS												
	COMPONENTS													
	INTEGRATORS	FUNCTIONS												
		CONTROLS												
BUILDING SYSTEM	DETERMINANTS	OUTPUTS												
		INPUTS												
		CONSTRAINTS												
	COMPONENTS													
	INTEGRATORS	FUNCTIONS												
		CONTROLS												

Fig. 3.1 CIVIL DEFENSE SYSTEM ANALYSIS MATRIX

III. THE RESEARCH SYSTEM

3.1 SYSTEMS ANALYSIS FRAMEWORK

The picture of the civil defense building system drawn in terms of its activities and dynamics--as in Figure 2.14--suffices for defining the terms and showing relationships between research and the activities it supports. It is not sufficient for use as a framework, for analysis of the research program by itself because it does not provide an insight into the research program structure. For this a device for categorizing the research in terms of research technology is needed. Using the two together will permit the flow from the technical area of research into the building system activity that research is intended to support.

The OCD research program is structured on a systems basis. In other words, the program is designed to produce a flow of information into analyses of component systems (warning, shelter, etc.) and from them into analyses of total civil defense systems. It also provides a flow of information about research requirements in the opposite direction. In a real sense, the research program is a massive, detailed analysis of civil defense systems, and its analysis may be treated as a system analysis.

Essentially, a system analysis is a study of relationships--between the parts and activities within the system--and the effect of these relationships on the functioning of the system. The matrix representation of a system analysis shown in Figure 3.1 1/ is a device for locating these relationships and for tracing their subsequent effects. This is a symmetrical matrix generally useful for studying relationships in, and for controlling, systems analyses.

3.1.1 THE SYSTEMS ANALYSIS MATRIX

Not all of this matrix framework is required for analysis of research using the method proposed in this paper. It it were used

1. Called a "Systems Analysis and Integration Model (SAIM)"; see Albert Shapero and Charles Bates, Jr., A Method for Performing Human Engineering Analyses of Weapons Systems, Wright Air Development Center Technical Report 59-784 (Wright-Patterson AFB: September 1959).

by itself for controlling the analysis of research, all of it would be required. But used together with the framework shown in Figure 2.14, only part of it is required. The discussion that follows, explains the [illegible] 2.14, and demonstrates how part of the matrix suffices for the present purpose.

The rows and columns of the matrix represent the system and its environment, reduced to their elements in whatever level of detail is appropriate for the analysis in which it is being used.[1/] As shown here, it represents both the Operating and Building systems. For each it identifies

a. Determinants: the elements of the environment which determine the system by (a) demanding outputs from it, (b) controlling inputs to it, and (c) imposing constraints upon it.

b. Components: the physical parts of the system.

c. Integrators: actions that bring the components together so as to produce outputs, further subdivided into (1) functions: the actions that directly produce outputs and (2) controls: the actions that direct or restrain the functions.[2/]

The sense normally attributed to this model is as follows: Each cell--intersection of a row with a column--is taken to mean a possible interaction of the row element with the column element in which a change of one or more characteristics of the row element would directly cause a change in one or more characteristics of the column element. In practice, when such an interaction exists and is significant for the analysis, a suitable mark is placed in the cell.

Here "significant" means that the functioning or effectiveness of the system would be sensitive to the interaction. In other words, if a small change in the characteristic of the row element would make a large

---

1. As used here, very little detail is required. It will be seen later on that analysis of the research program requires a great deal more detail.

2. For a detailed discussion of the elements of the analysis see: John F. Devaney, Systems Analysis in Civil Defense, Research Memorandum (Office of Civil Defense: 1963).

change in some characteristic of the column element, the interaction would likely be significant. On the other hand, if any amount of change in the characteristic of either element did not appreciably affect the performance of the system, the interaction might not be significant. The application of the term is often a matter of judgment. An interaction that might be "significant" in an expensive, penetrating analysis might be "not significant" in a low-budget analysis.

The row/column interactions may be of many types depending on what characteristics of the elements are involved. Here "characteristics" mean attributes of the element in terms of the system analysis: design, effectiveness, performance requirements, cost, feasibility, and so on. This is an important point because it is of the essence of system analysis to define the interaction: what its nature is and if possible, what the quantitative relationship is. It is eminently possible that one row/column cell may contain several different interactions--more than one of them significant.

To make the point clear, take two row and column elements: warning and shelter. This gives two cells -- warning/shelter and shelter/warning -- in a symmetrical matrix. The following types of interaction can then be identified:

a. Warning/shelter.

(1) The effectiveness of the warning system directly affects the effectiveness of the shelter system because the warning system can affect the number of people occupying the shelters.

(2) The effectiveness of the warning system can affect the design of the shelter system because the available travel time afforded by warning affects the permissible travel distance and, in turn, the spacing and required capacity of the shelters.

(3) The effectiveness of the warning system can affect the performance requirements for the shelter system by affecting travel time and distance as in (2) to such an extent that, for example, at one level of warning effectiveness the shelters might be required to protect against all effects--initial effects and fallout--and at another level, only against fallout.

b. Shelter/warning.

(1) The design of the shelter system can affect the performance requirements for the warning system; for example, shelters well located, in relation to the people, might not require as quick a response by the warning system as shelters not well located in relation to the people.

(2) The performance requirements for the shelter system can affect the performance requirements for the warning system; for example, when shelters are required to protect against initial effects, which arrive quickly, the warning system is required to respond quickly, but when the shelters are required to protect only against fallout, which arrives relatively slowly, the warning system response requirement can possibly be relaxed somewhat. (This is an example of a test for internal consistency in a system design.)

As shown in Figure 3.1, the matrix device can be used to examine the relationships between two or more systems as well as within one system. Therefore, it can be used to control the analysis of one component system (shelter, warning, etc.) or a part of a component system. It can be used for combinations of component systems. And it can be used for examing the relationships between operating system and building system functions for component systems, combinations of component systems, and total civil defense systems.

3.2 RESEARCH CATEGORIES IN THE SYSTEMS ANALYSIS MATRIX

The next step is to locate the research categories defined in Chapter II and shown in Figure 2.14 on the systems analysis matrix, Figure 3.1. The same technique applies here as in Chapter II, locating the building system activity and relating the supporting research directly to the activity it supports. In other words, take it that each cell in the matrix represents not only a relationship but also the research into that relationship. And since the matrix can represent every relationship within civil defense and between civil defense and its environment, it can also represent all civil defense research.

3.2.1 OPERATING SYSTEM.

While the concern here is directly with the activities of the building system, they must be considered in the light of the operating system. In chapter II a feedback relationship was shown to exist between the two systems: the operating system imposing requirements on the building system and the building system feeding back readiness in return. If the operating system existed today, the studies leading to the determination of requirements would be done within it, and it would state the requirements. But only the building system exists today, so it must do the studies and state the requirements for the operating system. Therefore, while these activities are described in operating system terms, it remains that they are performed by the building system.

a. Problem Definition

The primary mission of civil defense was shown before to be accomplished by the operating system and the subordinate mission of building the operating system to be accomplished by the building system. Performance requirements for the operating system are established by selection from problems arising in its environment that are to be solved in the event of attack and from feasible solutions for them. Performance requirements for the building system are established on the basis of considerations of (1) the performance requirements for the operating system, (2) the problems to be solved in the building of the operating system to fill these requirements, and (3) feasible solutions for these building system problems. Therefore, while any evaluation of civil defense must consider both operating and building system feasibility, the definition of problems must start in operating system terms.

Problem definition research examines the relationships in the environment from which problems arise. If this definition is applied to the systems analysis matrix (Figure 3.1), relationships are found in the environment in the determinants vs. determinants area. And since we are starting in the operating system, problem definition research is mapped in the area of operating system determinants as shown in Figure 3.2. The analysis elements in the operating system determinants for the total civil defense system are shown in greater detail in Appendix A.

b. Objectives Selection

The objectives selection function produces a statement of mission and general performance requirements. Components and functions are designed and built to fill these requirements. The subsystems within civil defense must have missions and performance requirements that derive from the general statement. In Figure 3.3, these relationships fall in the operating system area of outputs vs. the subsystems(Components and integrators). The analysis elements for operating system

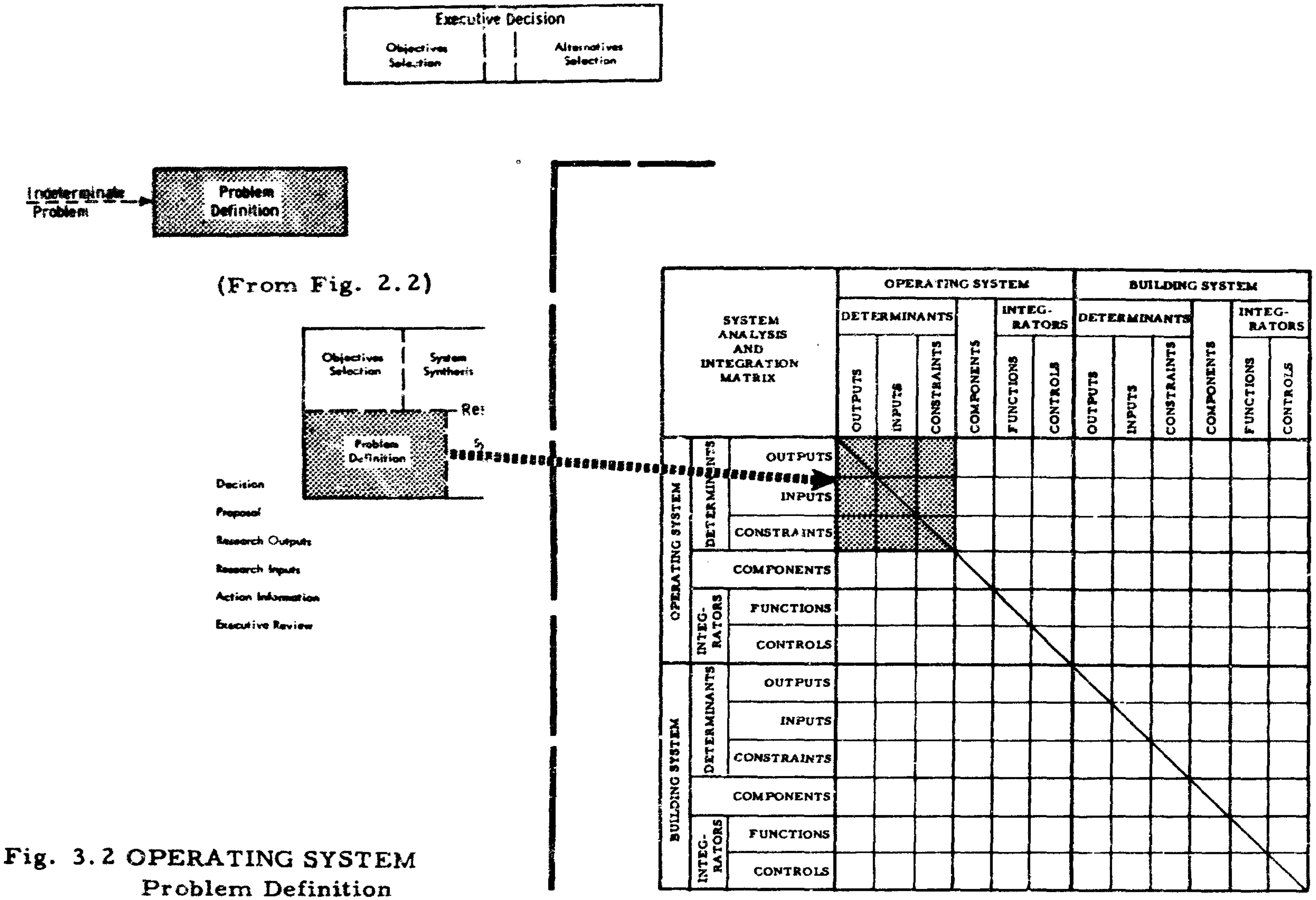


Fig. 3.2 OPERATING SYSTEM
Problem Definition

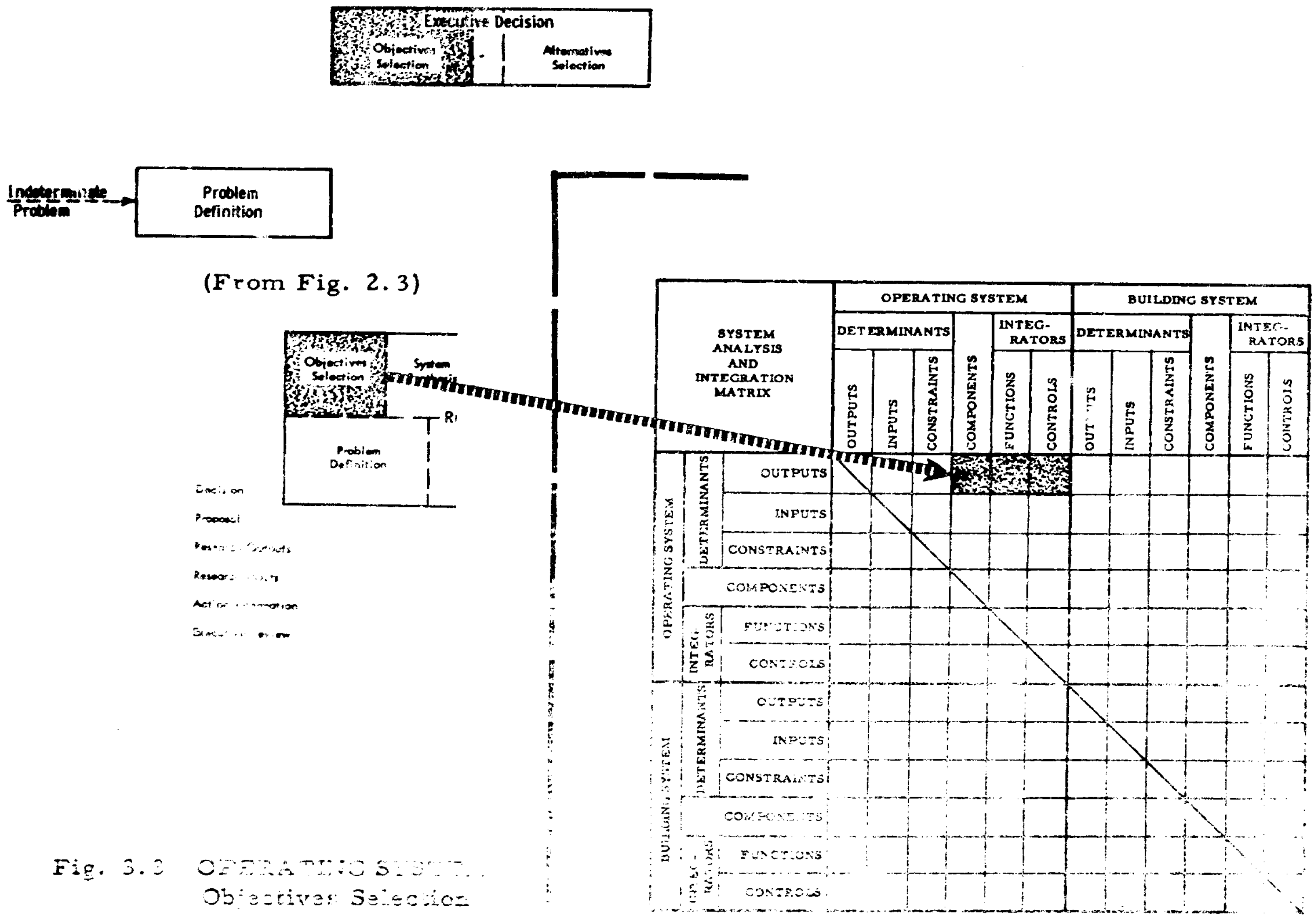


Fig. 3.3 OPERATING SYSTEM
Objectives Selection

components and integrators of the total civil defense system are shown in detail in Appendix A.

c. System Synthesis, Analysis, and Selection.

The system synthesis function involves applying the statements of mission and performance requirements from objectives selection within the limitations imposed by the determinants (inputs and constraints, to the invention of alternative systems (components and integrators). One can map these relationships for System Synthesis Research in the operating system area of inputs and constraints vs. components and integrators for the operating system as shown in Figure 3.4.

The systems invented in the system synthesis function are analyzed in the systems analysis function. This involves study of the relationships among the subsystems (components and integrators) in order to deduce estimates of the outputs, or consequences, of the operation of each of the alternatives. These relationships are found in the operating system component and integrators vs. components and integrators area of Figure 3.4.

The system selection function involves evaluation of the analyses and supports one or more decisions in the alternatives selection function. The evaluation consists largely of comparing the output of each alternative system with the defined problem to judge how well it performs. The decision may be to select one of the systems for further development. It may be to compromise the objective selection by selecting new objectives. Or it may be to do both. These relationships are found in the operating system components and integrators vs. determinants area of Figure 3.4.

As indicated before, the civil defense diagram (Figure 2.14) is two-dimensional representation of what could be a multi-dimensional model. Several of the dimensions are indicated in the repetitive flows in some of the action channels, as when alternatives are presented for executive decision in increasingly finer detail. Similarly, the systems analysis matrix could be multi-dimensional. For example, in terms of the total civil defense system, the research described and mapped above on Figure 3.4 would support the action process in program analysis, program planning and alternatives selection as shown in Figures 2.5 and 2.6.

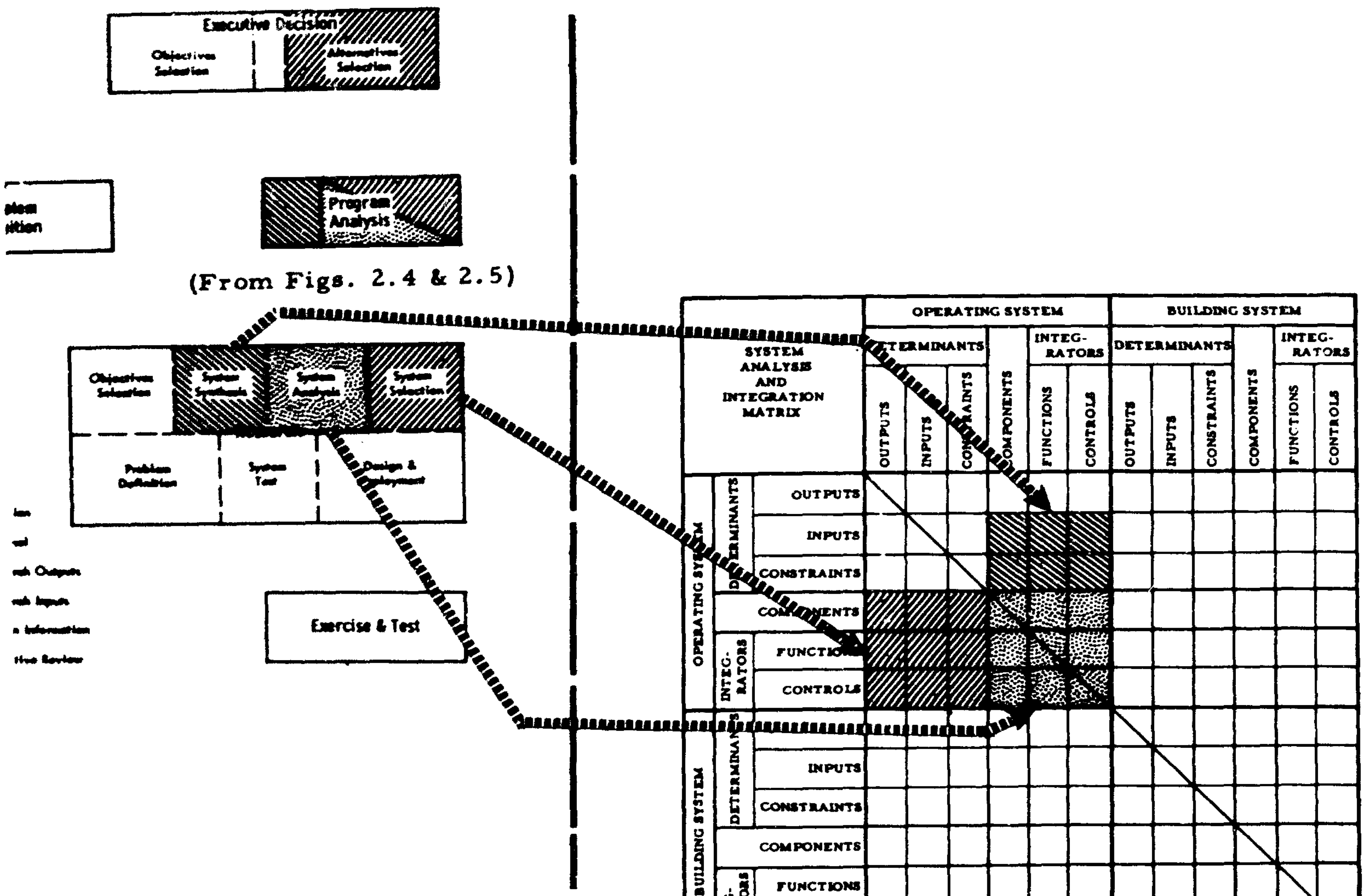


Fig. 3.4 OPERATING SYSTEM
Program Analysis and Program Planning

3.2.2 BUILDING SYSTEM

The remaining research areas to be shown on the systems analysis matrix support activities performed by the building system for the accomplishment of its own mission: to build an operating system that will fulfill the mission and meet the performance requirements established for it. And just as the purposes of the building system all relate to the operating system, so also does the research support for the building system relate to the operating system. In other words, when research examines methods for designing a shelter ventilating system, the shelters are components of the operating system even though the designing is a building system function.

Because of this dominance of the operating system over the building system the values of all of the elements of the operating system analysis become or control the determinants for the building system. In an analysis of the civil defense, these relationships need to be examined and resolved. But this amount of detail is not needed for the present purpose: the design of a framework for analyzing research. Instead, it is found that all of these determinant impositions are subsumed in the operating system's statement of mission and performance requirements for the building system. This allows analysis of research without completely analyzing the civil defense system--one of our objectives.

And because of the dominance of the operating system over the building system, research that supports building system functions is categorized in terms of how it affects the operating system. In other words, research that supports system design--a building system function--is that supporting design of the operating system. Research into design of the building system itself is taken to be a matter of examining the feasibility of building a given operating system design.

a. Problem Definition

The building system must function in its own environment; it has its own problems that must be defined. This problem definition research is found in the building system determinants vs. determinants area as shown in Figure 3.5. These building system problems constrain the feasibility of building an operating system and research into them supports the system selection function. The net effect of this further problem definition may well be to require a reiteration of the program analysis and program planning functions and a compromise of the statement of mission and performance requirements for the building system. The

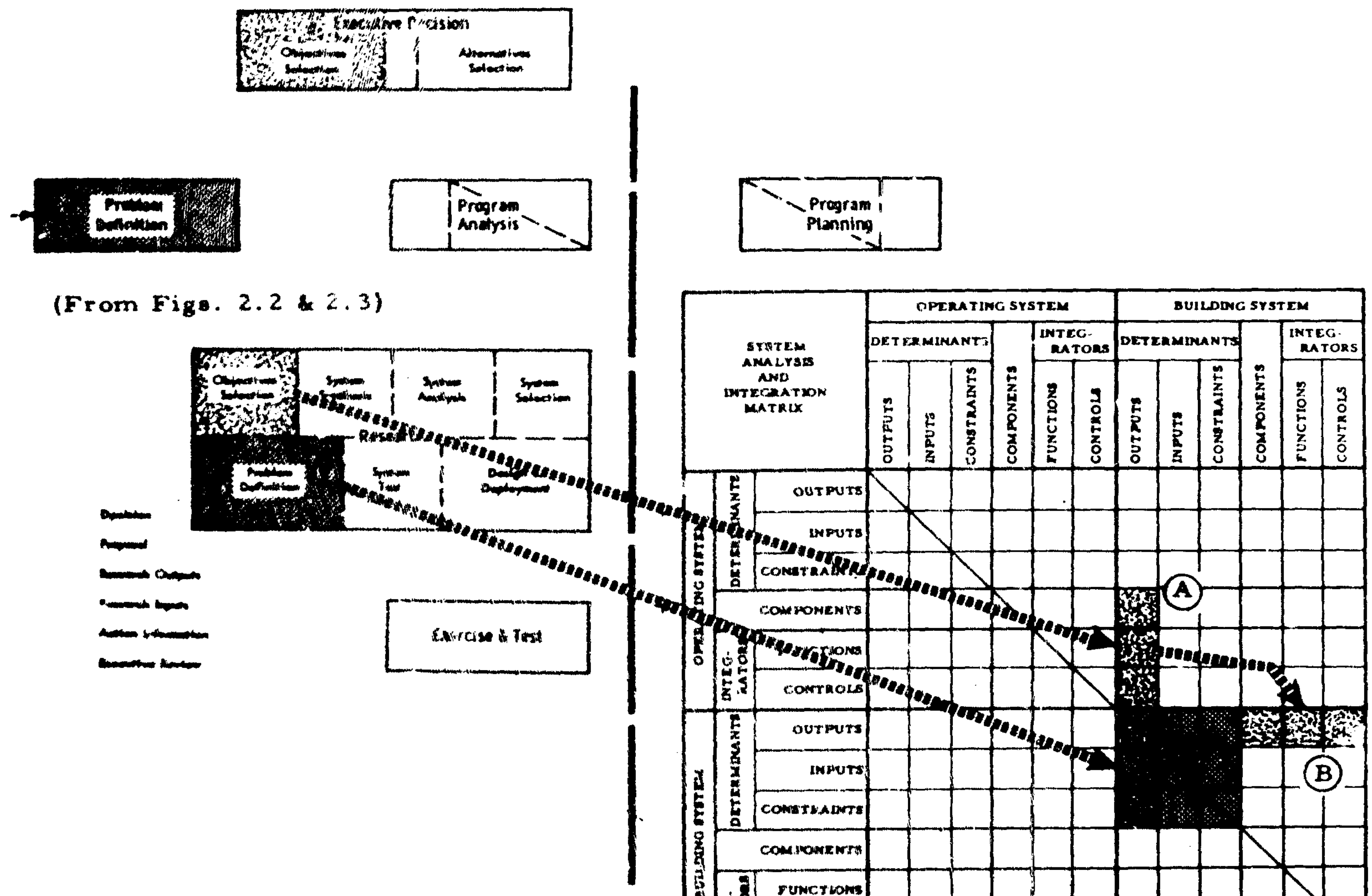


Fig. 3.5 BUILDING SYSTEM
Problem Definition and Objectives Selection

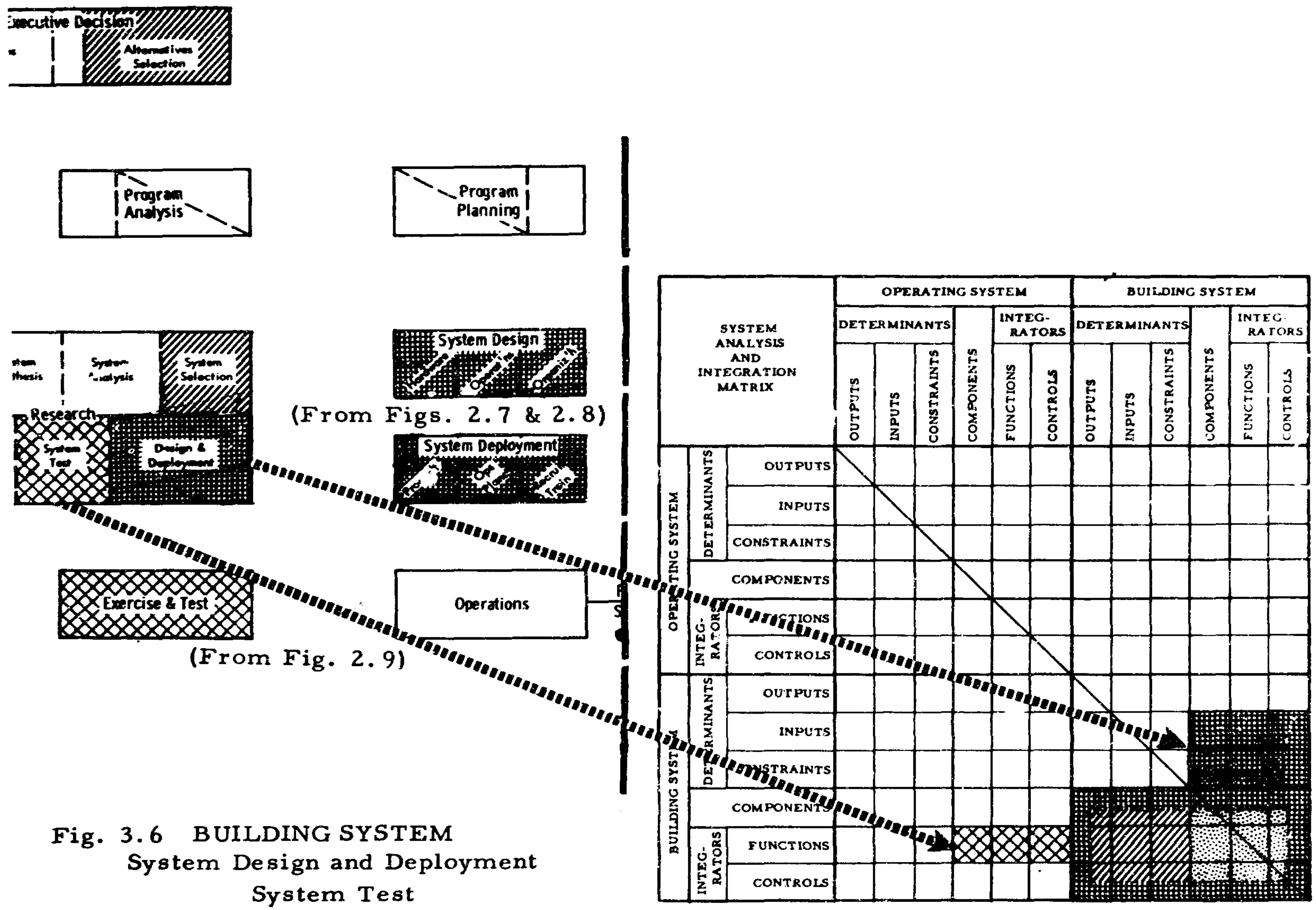


Fig. 3.6 BUILDING SYSTEM
System Design and Deployment
System Test

analysis elements in the building system determinants are shown in greater detail in Appendix A.

b. Objectives Selection

The product of alternatives selection after the program planning activity is the statement of outputs to be produced by the building system. At that level of detail, outputs would be established for each of the functional and control subsystems of the operating system. One sees these relationships in the operating system components and integrators vs. the building system outputs area at (A) in Figure 3.5.

The outputs specified to be produced by the building system define its mission and performance requirements, that is, select objectives for its components and integrators. Therefore, objectives selection appears again in the building system area of outputs vs. components and integrators at (B) in Figure 3.5. The analysis elements of the building system components and integrators are shown in more detail in Appendix A.

c. System Design and Deployment

The system design and deployment functions of the building system are accomplished by its components and integrators using its inputs subject to its constraints. These relationships are found, and system design and deployment research can be mapped, in the building system inputs and constraints vs. components and integrators area as shown in Figure 3.6. In addition, the building system functions, especially those in system design, are controlled by the operating system inputs and constraints operating through the objectives selection function. This is included in (B) in Figure 3.5.

Alternatives were seen above to be possible in system design and system deployment. These require system analysis and system evaluation for decision. One sees this system analysis research and system selection research in the building system components and integrators vs. components, integrators and determinants area respectively and can map them as shown in Figure 3.6. However, this research is within the context of system design and deployment and we show it that way.

d. System Test

When a civil defense operating system is operated under observation in a hypothetical environment for evaluation, what is really being evaluated

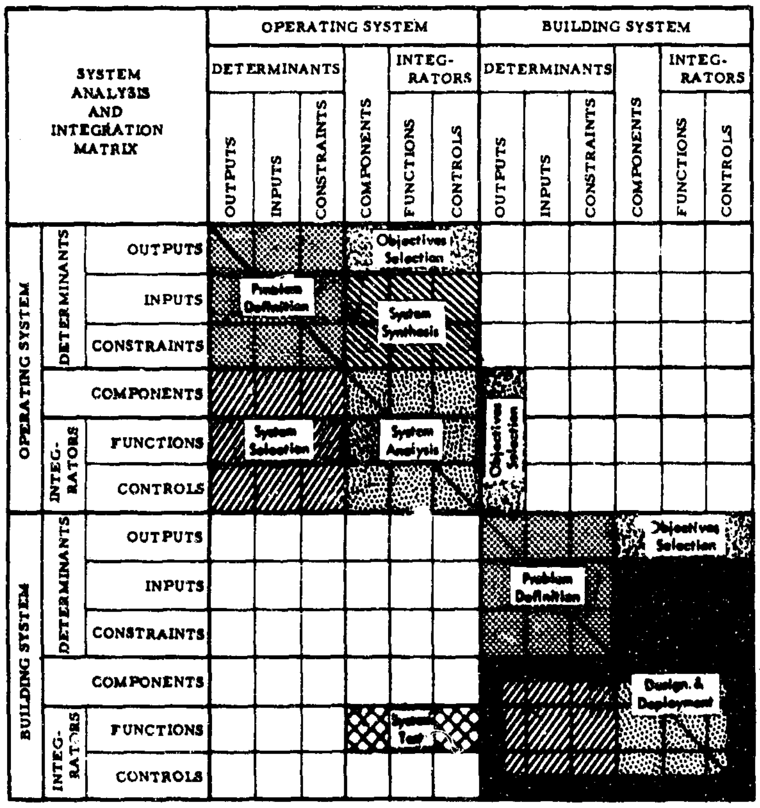


Fig. 3. CIVIL DEFENSE ANALYSIS RESEARCH SUPPORT

is the effectiveness of the building system in producing the required components and functional capability of the operating system. This comes from the fact that no civil defense operating system normally exists as such. These relationships appear in the building system functions vs. the operating system components and integrators area and one can map system test research as shown in Figure 3.6. If the experiment is extended to evaluate the performance of the deployed operating system, the extension is analogous to the system analysis and system selection functions, and it would be mapped as shown in these areas in Figure 3.4.

3.3 SUMMARY

Figure 3.7 summarizes all the mapping described above. It accounts for all the research support indicated in Figure 2.14. This leaves some areas blank in Figure 3.7. The fact that these cells are blank does not indicate that no direct interaction exists. In some cases, direct relationships are readily apparent. For example, a public attitude constraint on the organization of the building system may make infeasible the procurement--and, in turn, the availability--of some component of the operating system. This is a direct interaction in the building system constraints vs. operating system components area.

This does not invalidate the statement that the mapping in Figure. 3.7 accounts for all the research support indicated in Figure 2.14. What is being done here is correlating the two models of civil defense intending to use the two together. We do not show flow lines on Figure 3.7; we can use those shown in Figure 2.14. Therefore, when as in the above example, an infeasibility appears in an analysis (in Program Analysis, Program Planning, System Design, System Deployment, or in the research supporting any of these) sufficient feedback loops are available, as in Figures 2.12 and 2.13, for its effect to be applied.

Therefore, while relationships might be shown somewhat differently if Figure 3.1 were being used for some other purpose--ef. g., an analysis of the combination of the operating system and the building system--its use here in conjunction with Figure 2.14 is workable. The SAIM (as in Figure 3.1) is a device to assist the analyst. And as far can be seen, there are no rules for its use that absolutely exclude all others. Each different purpose for which it is used requires the statement of rules consistent with the purpose.

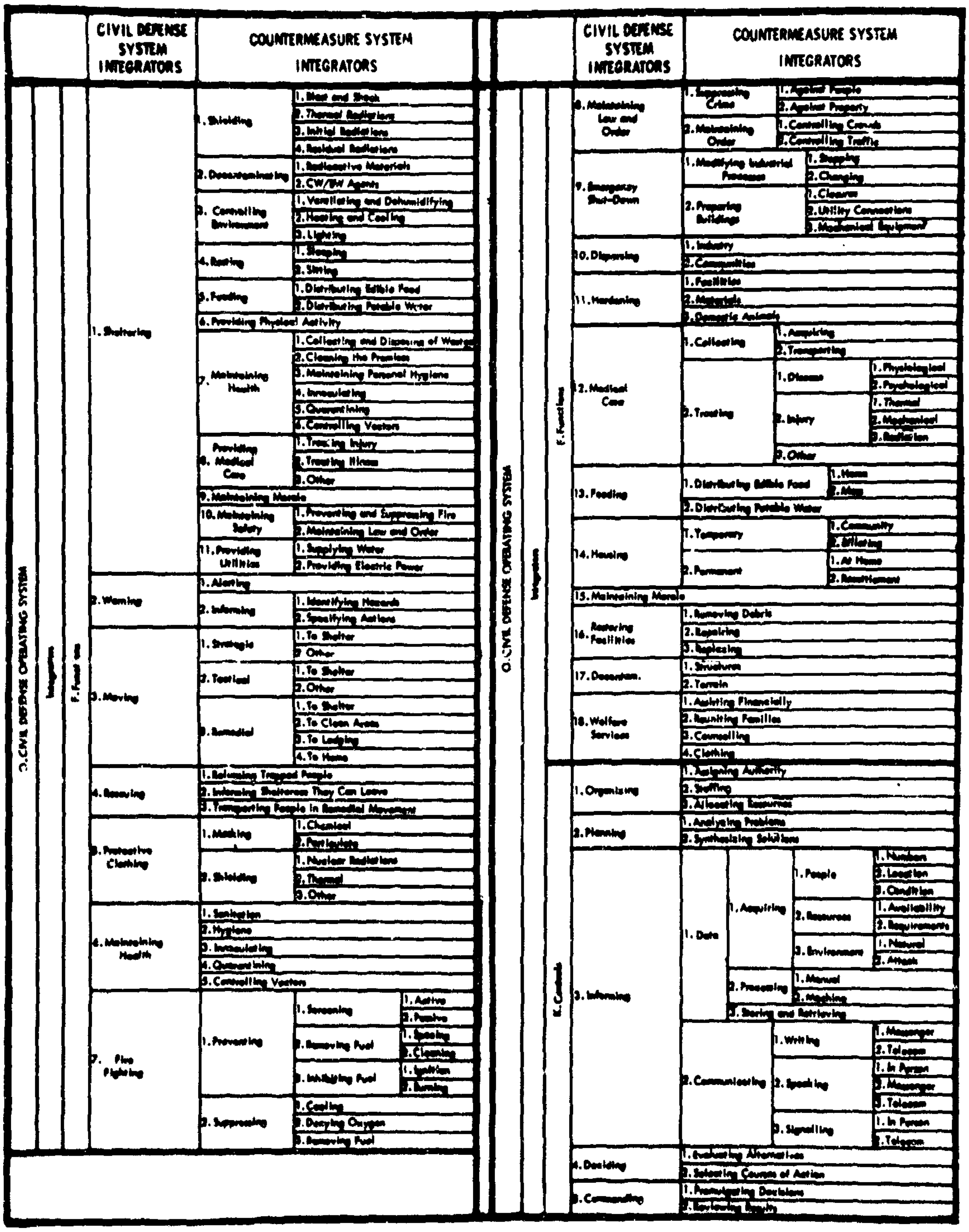


Fig. 4.1 OPERATING SYSTEM INTEGRATORS

IV. RESEARCH ANALYSIS FRAMEWORK

4.1 SIMPLIFYING THE FRAMEWORK

With correlation of the system analysis framework to the building system activity framework in Chapter III, it is now possible to take any piece of the research program and to trace its output to the activity it supports directly and so to its final effects on the civil defense program and on the effectiveness of the civil defense system. To do this requires, of course, that the matrix be constructed in much finer detail. To show all of the relationships in the total operating system in reasonable detail requires about 170 lines as compared to 6 in Figure 3.1. Similarly, a relatively complete matrix for the shelter system alone would be on the order of 300 lines.

To construct a complete analysis matrix--or series of them--in this level of detail is a major undertaking in itself, and to use it in analyzing research would also be a major undertaking. Fortunately, it is not necessary to construct the complete matrix in order to do a reasonable job of research analysis now. However, it seems that the matrix framework must be constructed sometime in the eventual development of the art of analyzing civil defense systems, and the detailed matrices will become available. In addition, the state-of-the-art in analysis of research itself can be expected to advance, possibly to the extent that quite detailed analyses will become commonplace.

Simplifying of the application of the matrix framework to the analysis of research is found in Figure 3.7 which shows all of the classes of research--problem definition, etc. In it, all of the elements of the system analysis are shown to be related to the integrators--functions and controls--of either the operating system or the building system. Therefore, if one fixes for a piece of research: (1) its research class, (2) the operating system integrator to which it relates, and (3) the building system integrator to which it relates, what kind of research it is and where it fits have been defined.

4.2 SYSTEM INTEGRATORS

To do this requires the listing of the functions and controls for the total operating system--listed in the column headed, "Civil Defense System Integrators" in Figure 4.1 [1] and for the building system as

1. See John F. Devaney, Systems Analysis in Civil Defense, Office of Civil Defense Working Paper (Washington: 1963).

B. Building System	F. Functions	System	1. Designing	
			2. Testing	
		Program Designing and Planning		
		3 Facilities	1. Designing and Specifying	
			2. Survey	
			3. Marking	
			4. Improving	
			5. Constructing and Maintaining	
			6. Testing	
		4. Equipment	1. Designing and Specifying	
			2. Procuring	
			3. Stockpiling	
			4. Distributing	
			5. Installing and Maintaining	
			6. Testing	
		5. Supplies	1. Designing and Specifying	
			2. Procuring	
			3. Stockpiling	
			4. Distributing and Maintaining	
			5. Testing	
		6. Operations	1. Designing and Specifying	
			2. Testing	
		7. Organizing	1. Authority	1. Assigning
				2. Channelling
			2. Staff	1. Recruiting
				2. Training
				3. Assigning
			3. Procedures	1. Designing
				2. Testing
		8. Informing the Public		
	K. Controls	1. Organizing	1. Assigning Authority	
			2. Staffing	
			3. Providing Facilities	
			4. Providing Equipment & Supplies	
			5. Providing Operating Doctrine	
		2. Planning Policy	1. Analyzing	
			2. Synthesizing	
		3. Informing	1. Research	
			2. Data	1. Acquiring
				2. Processing
				3. Storing & Retrieving
			3. Communicating	1. Writing
				2. Speaking
		4. Deciding	1. Evaluating Alternatives	
			2. Selecting Courses of Action	
		5. Commanding	1. Promulgating	
			2. Evaluating Results	

Fig. 4.2 BUILDING SYSTEM INTEGRATORS

shown in Figure 4.2. In addition, it requires constructing listings of the functions for each of the countermeasure systems as shown in the column headed, "Countermeasure System Integrators" in Figure 4.1. The listing of controls for each of the countermeasure systems should be identical to that for the total opera ing system in Figure 4.1, and the listing need not be repeated.[1]

4.3 SYSTEM INTEGRATOR SUPPORT CLASSIFICATION

By comparing the scope of work for a piece of research with the definitions for the various functions and controls it is possible to identify the functions (or controls) of the building and operating systems that it supports. These can be tabulated as shown in Figure 4.3, the details of which will be explained later in this paper.

Work Unit	System Integrator Support		
	Building System	Operating System	
		CD	Counter
xxxxx	F.4.1	F.1	F.3.2
xxxxx	F.7	F.12	K.1
xxxxx	F.1.1	K.3	F.1.1.3.2

Fig. 4.3 SAMPLE SUPPORT CODING

4.4 BUILDING SYSTEM ACTIVITY SUPPORT CLASSIFICATION

Similarly, by comparing the scope with the research definitions (Chapter II) it is possible to categorize the research in building system activity terms. This categorization can be added to the identifications

1. The purpose of the identity in pattern for controls in the total system and the component systems stems from the fact that the successful functioning of the total system will depend to a large degree on the integration of the control system throughout. Identical coding of research into the control systems for all the component systems and the total system should make it easier to correlate the separate efforts.

derived above to give a description in terms of the kind of research involved and the activities it supports. The examples in Figure 4.3 are expanded in Figure 4.4 to show how this would look.

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
xxxxx	F.4.1	F.1	F.3.2			x	x	x	x	x	x						
xxxxx	F.7	F.12	K.1	x												x	
xxxxx	F.1.1	K.3	F.1.1.3.2	x						x							

Fig. 4.4 SAMPLE WORK UNIT CLASSIFICATIONS

4.5 RESEARCH PROGRAM STRUCTURE

As said in Chapter III, the OCD research program is structured on a systems basis. Cognizance over research on various systems is assigned to four Divisions. In addition, each Division is assigned cognizance over research into one or more characteristics of the environment for civil defense, e.g., weapon effects, public attitudes, and so on.

In gross terms these assignments are as follows:

Division	Research Cognizance
Shelter Research (SR)	Shelter systems; blast and initial radiations.
Support Systems Research (SS)	Emergency operations and preattack preparedness systems; mechanical systems such as warning and communications; thermal and electromagnetic pulses.
Post-attack Research (PA)	Postattack operations systems; residual radiations.
Systems Evaluation Research (SE)	Total civil defense systems and combinations of component systems; strategic studies; vulnerability analyses; general system constraints.

For programming and control, these four research areas are further divided--in consonance with the Defense Research and Engineering system--into projects, tasks, and work units. The work unit is a separate piece of research; the task is a collection of work units concerned with a limited subject matter; the project is a collection of tasks concerned with a larger subject matter. These parts of the research program are given coded identification numbers constructed as follows:

Research Area	x000
Research Project	xx00
Research Task	xxx0
Research Work Unit	xxxx

In addition, a work unit being accomplished by contract is assigned a suffix letter so that almost all work unit numbers will appear as, e.g., 1157C.

The research area coding has a 1:1 correlation with the assignments to the Research Divisions:

1000 - Shelter Research
2000 - Support Systems Research
3000 - Postattack Research
4000 - Svstems Evaluation Research

The structure of the OCD research program--to the project level --is shown in Figure 4.5. A listing of project and task titles is given in Appendix C. Descriptions of active work units are published elsewhere in Research and Technology Resumes, DD Form 1498.

4.5 SUMMARY

All that has been said in this paper up to here is background. It has presented two analytic frameworks, defined their terms, and correlated them. It has shown how the two frameworks can be used to categorize research. And it has described the structure of the research program. The remainder of the paper will demonstrate the application of the analytic framework to analysis of the research program. It will also suggest some uses for such analyses.

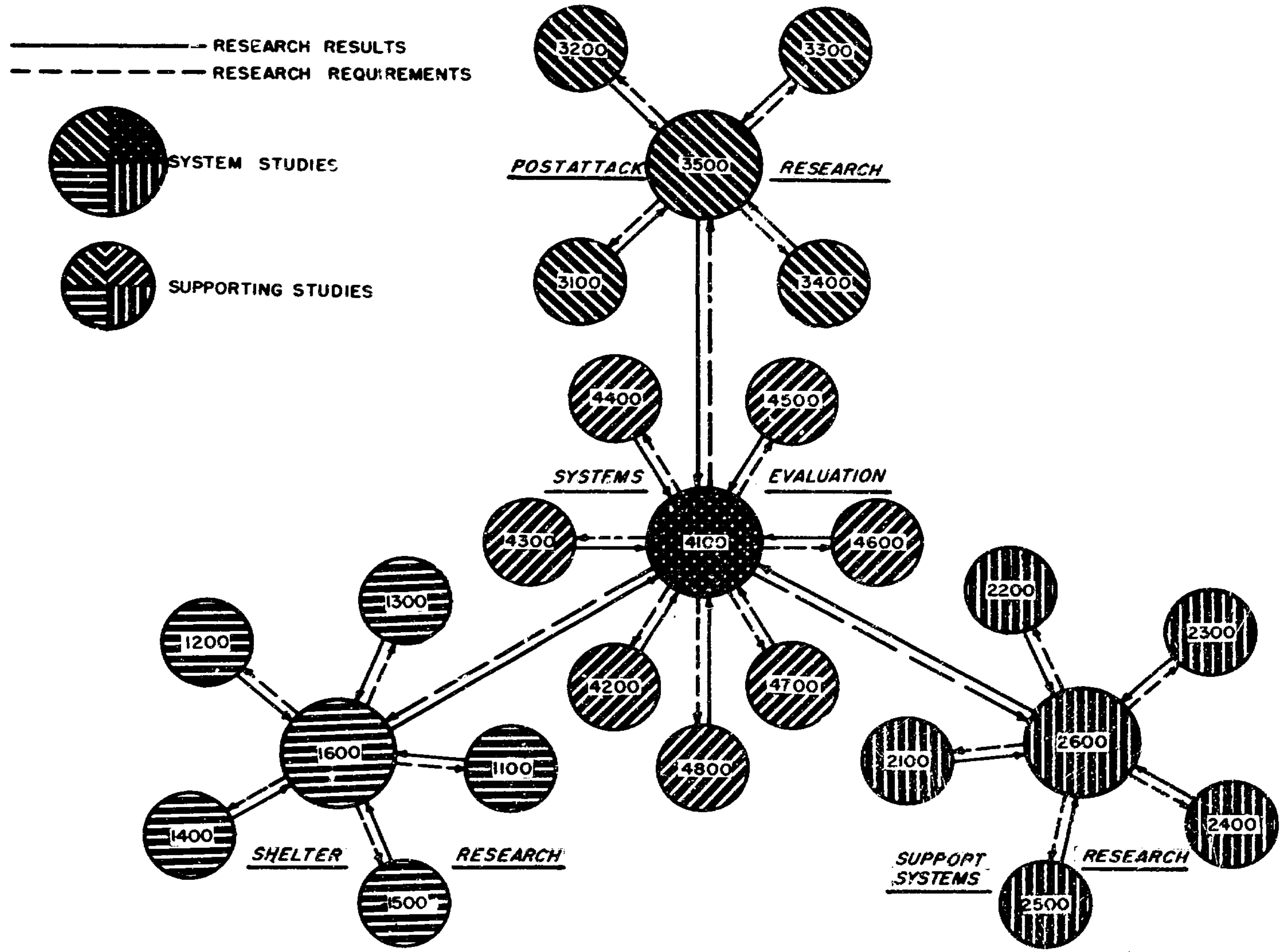


Fig. 4.5 OCD RESEARCH PROGRAM STRUCTURE

V. ANALYSIS OF THE RESEARCH PROGRAM

5.1 ANALYSIS NEEDS

Research is evaluated for two main reasons:

a. To find out what research needs to be done and what the relative priorities are. This is the "state-of-the-art" review. It involves a comparison of (a) what is known with (b) what needs to be known. Research needs are disclosed in this comparison.

b. To find out what new information produced by research is usable in the activities research is intended to support and where and how this information should be applied.

In addition, the OCD research program needs to be evaluated to determine (1) that the information produced will support OCD activities and (2) that the information can and will flow from the technical studies to the system studies as the program structure intends. This difference is drawn between evaluation of research and evaluation of the OCD research program to point up that the program review can be, and should be, only a part of the state-of-the-art review.

Evaluation starts with a determination of what is there to be evaluated. An evaluation of research must start with a determination of what information has been and is being produced, i.e., the research must be analyzed.

Analysis is the separation of a whole into its constituent elements as a method of studying the nature of a thing or of determining its essential features.[1] It requires methodical approach, i.e., systematic, orderly probing. Very few men can keep track of all the pieces and where they are in an anlysis by memory alone, and they generally waste time and effort trying to do it. It is best for every analyst to have a frame on which to hang the "constituent elements" as they separate them. And we hold as a general proposition: The better the framework, the easier the analysis. Then, granted a need for analyzing research, a framework for the analysis is needed.

---

1. The American College Dictionary, Random House, (New York: 1960).

5.2 SCOPE OF THE ANALYSIS

At issue here is: What is the whole to be separated into its constituent elements? Four choices seem available:

a. All research completed in the past. (A state-of-the-art reveiw.)

b. Research completed in the pst plus the ongoing work. (A basis for programming the next year's work.)

c. Past research plus that ongoing and that planned for the next year. (A basis for long-range--say 5-year--planning.)

d. Past research plus that ongoing, programmed, and planned. (A basis for judgment as to how well research can produce the needed answers.)

Of the four, b and c appear most likely to be done, although all four could be needed at one time or another. These two can support regularly recurrent activities in research planning and programming. It does not seem likely that a would be done in preference to b. And d would likely be done only if a special, comprehensive study of civil defense research were to be undertaken.

The analysis of past research is included in all four options, and it would be done in the first analysis, no matter which option is chosen. This part of the analysis would ordinarily not need to be redone in subsequent analyses. A requirement for reanalysis of past research would be needed only if new, unforeseen questions arose. Then it would be necessary to analyze only for the answers to the new questions.

5.3 ROLE OF THE ANALYTIC FRAMEWORK

Specifying the role of the analytic framework in the analysis may eliminate some misunderstanding if done before demonstrating its use. Far too often, attention to the detail of the framework and the mechanics of its use divert attention from the essence of the analysis.

The framework is a device used in the analysis. Its purpose is to assist. Of itself it gives no answers. On the contrary, one of its uses is to raise questions whose answers are derived in the analysis. It provides a logically connected set of pegs on which to hang parts of different nature or having different essential features. But the number of pegs is limited. Therefore, it forces attention to similarities and thence to relationships, one of the objectives of the research program structure.

The analytic framework for analyzing research, then, is a device for recording the constituent elements and their classification in terms of their nature and essential features; nothing more, nothing less.

5.4 DEMONSTRATION OF THE ANALYTIC METHOD

5.4.1 EXTENT OF THE DEMONSTRATION ANALYSIS

The active OCD research program as of 30 June 1967, was elected for demonstration of the method. This is of lesser extent than any of the scopes suggested above; it is the "ongoing work" part of 5.2 b. Any of the four done completely would have taken too long and would have been larger than needed for a demonstration.

5.4.2 CLASSIFYING THE RESEARCH

We turn now to the process of classifying the research in our demonstration sample. To record the classifications, the form shown in Figure 5.1 was developed. This form permits recording the minimum amount of information necessary for classification of the research and for its analysis.

The classification--which was done by the research analysts in the OCD Research Directorate--involved reading the available documents that describe the work to be done and comparing their language with the definitions for the various items to be recorded. These documents include (1) contract and sub-contract scopes of work, (2) work plans, (3) progress reports, resumes (DD form 1498), and so on. In interpreting the language of these documents, the research analysts also applied their unwritten knowledge of the work--what was intended and what was being done.

The DD 1498 for Work Unit 1214A shown in Figure 5.2 is used to demonstrate the classification method. And since the analysis treats only what is being done, the concern is only with the descriptive language found in Items 12, 21, 23, 24, 25, and 26 of the DD 1498.

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
		CD	Counter			Sy	An	Se	10 Hdwe			11 Ops			12 Org		
									C	E	F	C	E	F	C	E	F
1	2	3	4	5	6	7	8	9	13	14	15						

1. Enter work unit number
2. Enter code number for Building System function or control (See Figure 4.10)
3. Enter code number for Operating System function or control. (See Figure 4.9)
4. Enter code number for Component System function or control. (e.g., See Figure 4.11)
5. Problem Definition
6. Objectives Selection
7. System Synthesis
8. System Analysis
9. System Selection
10. Hardware
11. Operations
12. Organization
13. Cost
14. Effectiveness
15. Feasibility

(Items 5–15:) Enter mark where appropriate

Fig. 5.1 WORK UNIT CLASSIFICATION FORM

RESEARCH AND TECHNOLOGY RESUME	1.	2. GOVT ACCESSION	3. AGENCY ACCESSION	REPORT CONTROL SYMBOL
			DA-OA-8769	

4. DATE OF RESUME	5. KIND OF RESUME	6. SECURITY	7. REGRADING	8. RELEASE LIMITATION	9. LEVEL OF RESUME
01 06 66	D Change 28 04 66	U RPT U WK	N/A	GA	A.Work Unit

10a CURRENT NUMBER/CODE	10b PRIOR NUMBER CODE
2500301V 1200. 10. 14A	No Change

11. TITLE: (U) Experimental Verification of Habitability of Identified Shelters

12. SCIENTIFIC OR TECH. AREA	13. START DATE	14. CRIT. COMPL. DATE	15. FUNDING AGENCY
001200 Air conditioning, heating, lighting & ventilation; 013300 Protective Equipment		01 67	DA Other

16. PROCURE. METHOD	17. CONTRACT/GRANT	18. RESOURCES EST.	a. PROFESSIONAL MAN-YEARS	b. FUNDS (In thousands)
B. Contract	a. DATE; b. NUMBER B-64220(4949A-16)-US; c. TYPE M. CPFF; d. AMOUNT 122,244	PRIOR FY		
		CURRENT FY		

19. GOV'T LAB INSTALLATION/ACTIVITY	20. PERFORMING ORGANIZATION
NAME Office of Civil Defense	NAME General American Transportation Corp.
ADDRESS Pentagon, Washington, D. C.	ADDRESS MRD Division, 7501 North Natchez Avenue, Niles 48, Illinois
RESP. INDIV. Buchanan, J. O., Dr.	INVESTIGATORS PRINCIPAL / ASSOCIATE G. Engholm, C. A. Madson
TEL 202-695-6679	TEL 312-647-9000 TYPE U.N.

21. TECHNOLOGY UTILIZATION	22. COORDINATION
Air Conditioning; Ventilation	SRI

23. KEYWORDS Cooling and ventilating equipment; temperature control; environmental tests; thermodynamics; heat transfer; ventilation fans

24. (U) Evaluate parameters that determine resulting environment of identified shelters. Develop a rationale for estimating minimum equipment requirements. Obtain and correlate experimental data in support of current or modified computational methods or for direct use as empirical information.

25. (U) Through series of tests simulated occupants, study both natural ventilation and forced air ventilation in above ground level and below ground level identified shelters.

26. (U) 12 65 to 06 66 A summary report of four natural ventilation tests long prepared. This report will include a digital computer program for predicting adequacy of natural ventilation and an overall evaluation of natural ventilation for shelters. Future plans include testing to evaluate evaporative coolers as a shelter air conditioning device.

27. COMMUNICATIONS SECURITY	28.	29. OSD CODE	30. BUDGET CODE
☐ a. COMSEC OR COMSEC RELATED ☒ b. NOT RELATED		AR	8

31. MISSION OBJECTIVE	32. PARTICIPATION
Civil Defense Shelter Requirements	N/A

33. REQUESTING AGENCY	34. SPECIAL EQUIPMENT
N/A	N/A

35. EST. FUNDS (In thousands)	36.
CFY+1 N/A	

DD FORM 1 AUG 64 1498

Fig. 5.2 SAMPLE DD1498 FOR WORK UNIT 1214A

a. Building System Function or Control. The language of the DD 1498 for WU 1214A is compared with the titles in Figure 4.2 1/The DD 1498 language does not include words that specifically and conclusively identify the work with any of the building system functions. However, equipment is mentioned sufficiently to signify--in our judgment--that this research is intended to support some building system function related to equipment. The words "estimating minimum equipment requirements" in the second sentence of Item 24 of the DD 1498, are taken to describe the final concern of this work unit. We identify this as the "designing and specifying" function, code F.4.1.

Tests and testing are also mentioned in the DD 1498 and would seem to indicate that the work also supports the building system "testing" function, code F.4.6. However, the context seems to describe research to provide data for design, selection, or specification of equipment not yet installed. It seems, then, the terms "tests" and "testing" to have the sense of "experiments" and not the observation of procured equipment for comparison against standards as envisioned in F.4.6. Therefore, the coding, F4.1, is put in column 2 of the work unit classification form (Figure 5.1.)

b. Civil Defense Operating System Function or Control. The language of the DD 1498 is compared with the titles in the "Civil Defense System" column of Figure 4.1. In this case, the identification is simple. The word "shelters" in the first sentence of Item 24 and no mention of any other operating system function or control is taken as conclusive that this research specifically relates to the sheltering function and, therefore, the operating system coding F.1 is put in column 3 of the work unit classification form.

c. Countermeasure System Function or Control. The next step is to compare the DD 1498 language with the titles in the Countermeasure System column of Figure 4.3.2/

In Item 24, the words "environment of" and in Item 12, the words, "heating, lighting, and ventilation" appear. These indicate that the research is in the area of the major countermeasure system function, controlling environment, F.3.

1. These titles are used in substantially their dictionary definitions and have not been specially defined.
2. These titles have not been specially defined as they would be in a system analysis. However, they are expressive enough for this demonstration.

In Item 23, the words, "cooling" and "ventilating," signify that the research is in the areas of the detailed functions, ventilating and dehumidifying, F.3.1, and heating and cooling, F.3.2. Nowhere in the description of the research is there any reference to lighting. Therefore, it appears that the countermeasure function coding is F 3.1/2,[1] and this countermeasure system coding is put in column 4 of the work unit classification form.

d. Research Class. The process of classifying by type of research support can be done in two ways. One can take each research type definition and search the description of the research--Items 24, 25, and 26 of the DD 1498 in our example--for comparable language. Or, alternatively, we can read the research description, sentence by sentence, comparing its language to that of the definitions. The choice seems a matter of personal preference; the second seems preferable.

In Item 24, first sentence, the words "Evaluate parameters that determine resulting environment" are taken to mean an analysis of characteristics of the natural environment that will lead to the possible definition of a deficiency to be corrected, a need to be filled. One can say then that WU 1214A includes problem definition research and put an x in column 5 of the work unit classification form (Figure 5.1.)

If in Item 24, second sentence, the words "Develop a rational for estimating" really mean "develop a method for estimating," the work would support the identification of desirable outputs and, again, would include problem definition research. If, on the other hand, the words "Develop a rationale for...minimum equipment requirements" contain the meaning of the sentence, the research would support the choice of problem to be solved and WU 1124A would include objectives selection research. The research analyst, reading of the scope of work for this work unit, concludes that the intent is to do the objectives selection research. Therefore, an x is put in column 6 of the work unit classification form.

The third sentence describes research into the natural environment and, again, fits the problem definition classification.

---

1. To simplify the coding we use the slash symbol, "/" to signify "and", and follow it by however many digits change. For example, a work unit concerned with Distributing Potable Water and Supplying Water would be coded: F.5.2/11.1.

The language of Item 25, taken in the context established by Item 24 as intended, adds nothing definitive in terms of classifying the research.

The three sentences of Item 26 can be taken together. In the second sentence, the words "digital computer program for predicting adequacy" indicate estimating effectiveness and, in the absence of other language, "natural ventilation" and "natural ventilation for shelters" indicate hardware. The third sentence also indicates effectiveness of hardware. Therefore, it appears that WU 1214A includes system design and deployment research in the specific area of effectiveness of hardware. Therefore, an x is put in column 14 of the work unit classification form (Figure 5.1.)

This accounts for all the research included in WU 1214A as of 30 June 1967, as described in the DD 1498. All of the entries for Work Unit 1124A would then appear as in Figure 5.3.

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
		CD	Counter			Sy	An	Se	Hdwe			Ops			Org		
									C	E	F	C	E	F	C	E	F
1214A	F.4.1	F.1	F.3.1/2	x	x					x							

Fig. 5.3 CLASSIFICATION OF WORK UNIT 1214A

This process is repeated for each work unit in the OCD research program as of 30 June 167. When all of the classifications have been recorded, the forms appear as in Appendix B. Taken together, Appendix B is a coded description of the FY 1966 Shelter Research program, obtained by separating the research into sets of constituent elements. This is analysis in its most elementary form. But it is only a first step in the process of analysis as a method of study.

5.4.3 DELINEATING RELATIONSHIPS

Once having separated the research into its constituent elements, the next step is to demonstrate relationships. The goal is to show what are related and how they are related. The purpose is to provide a convenient basis for finding the answers to such questions as:

- Are the necessary relationships accounted for?

- Are the existing relationships proper?

- Do the existing relationships provide the necessary channels for information flow?

It is not the purpose in delineating relationships to identify or define all the questions to be asked. But the process of demonstrating existing relationships will, almost inevitably, suggest questions to be asked.

The relationships that can be shown are limited, of course, by the form and framework of the analysis. In other words, so long as the framework developed earlier in this paper is used, a limit is put on the relationships that can be delineated and the questions posed. However, until some experience has been gained in use of the method, we are not prepared to concede that this limitation is bad, nor to claim it is good.

The relationships that can be delineated are identified in the column headings of Figure 5.1. Conceivably one can combine the data in any or all sets of columns. But it seems that only a very few combinations will prove beneficial. Which these are is left to future development.

The needs for analysis set out at the beginning of this Chapter can be met substantially by relating the data on operating CD system integrator (column 3), operating component system integrator (column 4), and research class (columns 5 through 12) in Figure 5.1. Thus one can assemble the various kinds of research for each component of each of the major countermeasure and control systems and do it in such a way as to be able to trace the flow of research outputs into the system studies.

Before demonstrating how the grouping of like items can be done, it will be well to simplify the process some by identifying ntural groupings of research classes.

a. Problem definition (PD) and objectives selection (OS) are closely related because objectives are selected from consideration of defined problems. One research study can support both activities if properly laid on and done. Therefore, work units performing PD and OS research will be listed together for each countermeasure or control for each major operating system.

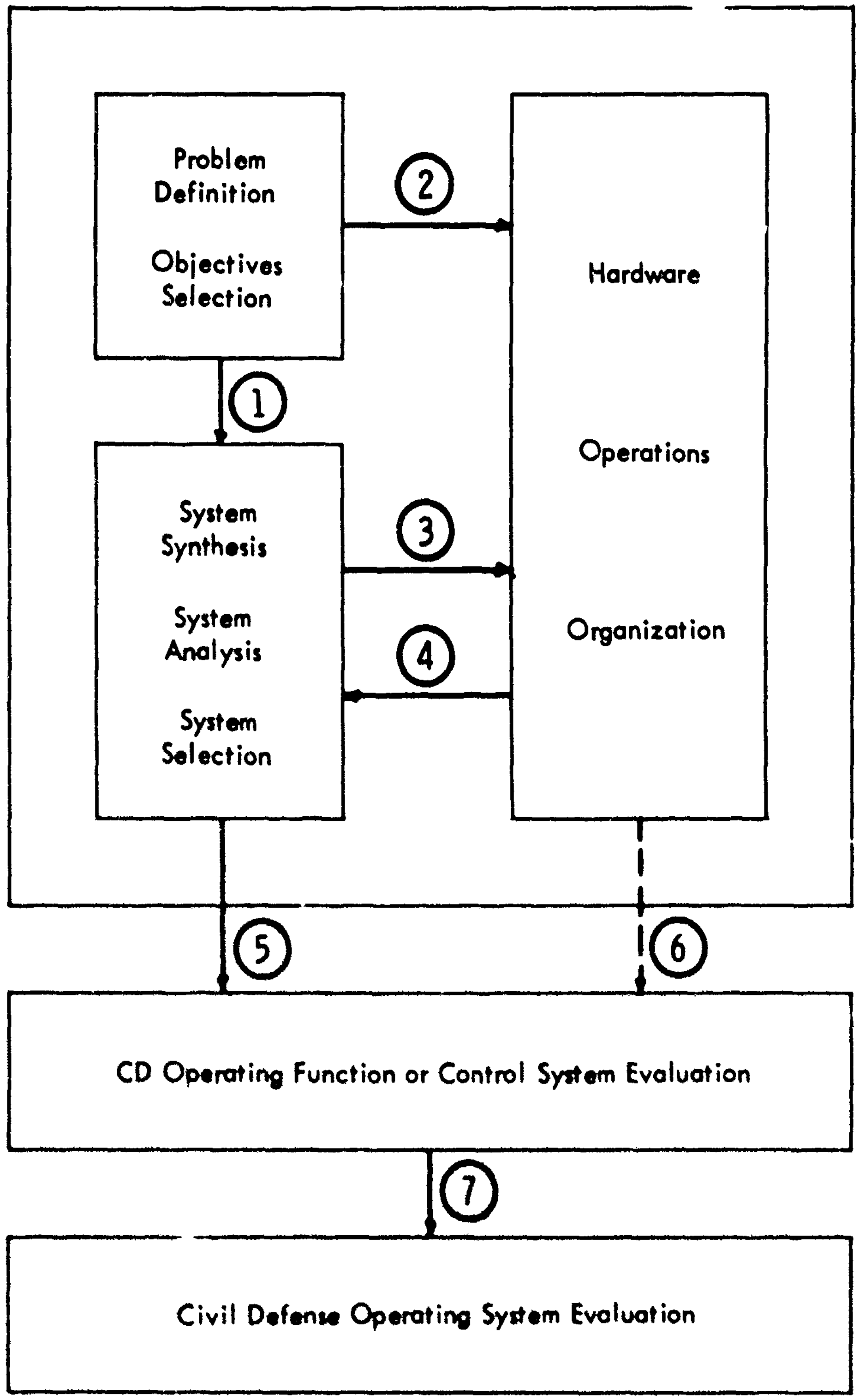


Fig. 5.4 RESEARCH INFORMATION FLOWS

b. System synthesis (SSy), system analysis (SAn), and system selection (SSe) are parts of the analysis technique called systems evaluation. A complete evaluation should include all three parts. So work units performing SSy, SAn, and SSe research will be listed together for each countermeasure or control for each major operating system.

c. The close relationships between hardware, operations, and organization activities in system design and deployment were demonstrated in Chapter 2. The research into these items should also be closely related. Therefore, all work units involving hardware, operations, and organization for each countermeasure function and control of each major operating system will be listed together.

The information flows among these groups can be found in Figure 2.14. However, Figure 2.14 is somewhat complex (and cluttered), and the flows are not too easily seen. They are brought out here in a simplified form to demonstrate them.

Figure 5.4 applies to the flow of information among studies for what we call here component of a countermeasure system, e.g., shielding, controlling environment, and so on, in Figure 4.1. In that context, the information flows are:

1. From problem definition (PD) and objectives selection (OS), descriptions of the major problems to be solved and of the goals intended to be achieved flow to the systems studies where alternative solutions are examined.

2. At a lower level--i.e., more in detail--descriptions of more specific problems and goals flow from PD and OS to the system design and deployment studies where alternative hardware (H), operations (O), and organization (Or) solutions are examined.

3. Indications of preferred solutions to problems in hardware, operations, and organization design flow from the systems studies to the design and deployment studies; in addition, the systems studies identify areas in which the available information on cost, effectiveness, or feasibility of hardware, operations, or organization is not sufficient to permit system studies of the desired quality.

4. Data on cost, effectiveness, and feasibility of alternative hardware, operations, and organization solutions are fed into systems

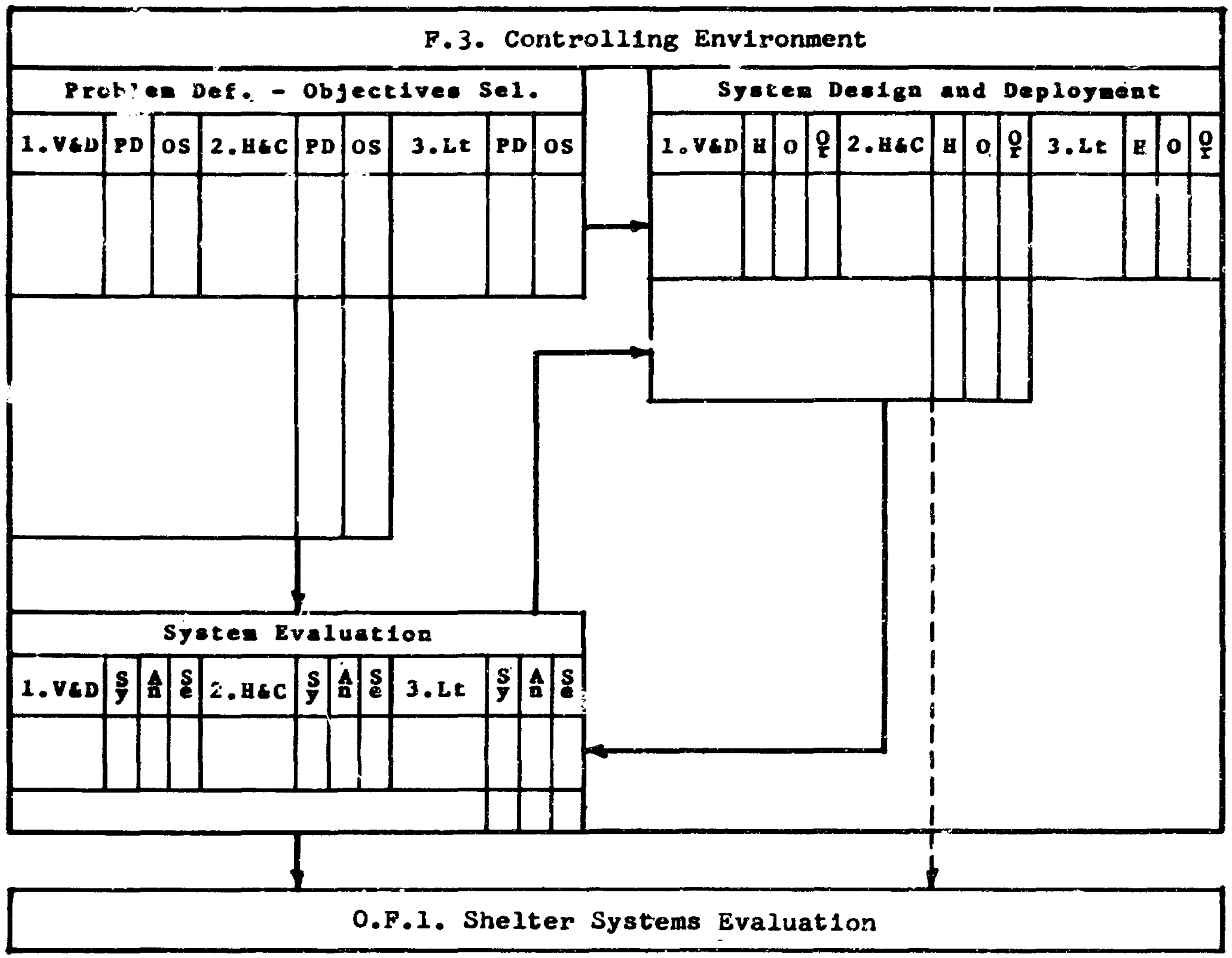


Fig. 5.5 RELATIONSHIPS DATA FORM

studies where they are used in examinations of alternative system arrangements to find (a) what appear to be the preferred solutions for hardware, operations, and organization, and (b) what are the cost, effectiveness, and feasibility of the alternative countermeasure system arrangements.

5 Information on cost, effectiveness, and feasibility of alternative component system flows to the system studies for the civil defense countermeasure system (function or control as listed in Figure 4.1) of which it is a component; from these studies come idntifications of the preferred component system designs and estimates of cost, effectiveness, and feasibility of alternative countermeasure (function or control) system designs.

6 In the event that no component system studies are being done (and this is possible although generally not desirable) data on cost, effectiveness, and feasibility of hardware, operations, and organization can be fed directly into countermeasure system studies.

7 Data on cost, effectiveness, and feasibility of alternative countermeasure systems are fed into evaluations of alternative civil defense operating system arrangements.

Given the decisions on grouping of work units and the identification of research information flows discussed above, we can now proceed to establish a pattern for recording the data in a way that will delineate the relationships. The basic pattern is shown in Figure 5.4. As a sample, Figure 5.5 shows the form for recording the data for the "controlling environment" component of the "sheltering" countermeasure system.

Figure 4.1 shows that the sheltering function F.3, controlling environment, has three subordinate functions related to:

F.3.1 Ventilating and Dehumidifying (V&D)
F.3.2 Heating and Cooling (H&C)
F.3.3 Lighting (Lt)

Figure 5.5 is constructed in the general pattern of Figure 5.4 but it is expanded internally to provide sets of columns for each of the subordinate functions. This is done to provide spaces for recording classification data in the detail in which they were recorded in Fig. 5.3.

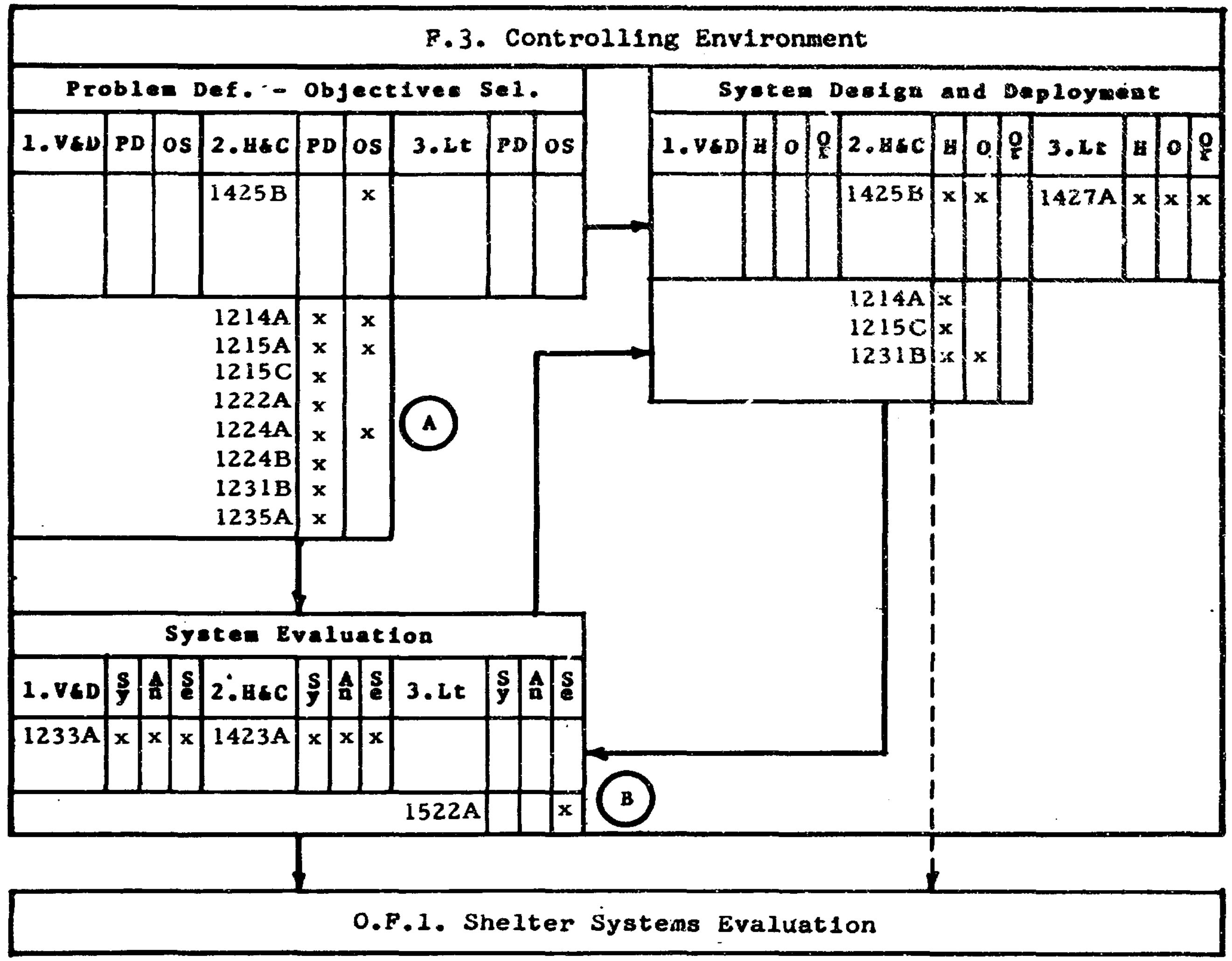


Fig. 5.6 RESEARCH RELATIONSHIPS DATA

In Figure 5.6, the data for Function, F.3, are recorded from Appendix B in the pattern established in Figure 5.5. This is a simple sort:retrieve:record process in which we look through the data in Appendix B, select those for which the coding begins "F.3" under "Counter", read out the marks from the "Research Class" columns, and record them in the appropriate places on Figure 5.6.

When the data in Figure 5.6 are recorded, it is found that the research in some work units involves more than one of the subordinate functions. And since our purpose here is to identify relationships, the diagram is modified somewhat to bring them out more plainly. for this a convention demonstrated at A and B in Figure 5.6 was adopted. In this convention, when a work unit involves more than one subordinate function, a block is provided across all columns for the subordinate functions involved and record the data at the right. In Figure 5.6, the block A contains data for work units involving two of the three subordinate functions; block B, for a work unit involving all three.

In this operation, every work unit appearing in Appendix B for component system F.3 of the sheltering countermeasure system must appear at least once in Figure 5.6. Sometimes work units appear more than once, for example,

- Work Unit 1623A appears in PD-OS and in the system studies (page 133),
- Work Unit 1124B appears in the system studies and in the system design and deployment studies (page 115),
- Work Unit 1214A appears in PD-OS and in the system design and deployment studies (Figure 5.6),

and sometimes a work unit appears in all three places for example, 1614B (page 115).

This multiple appearance of work units is not a defect in the analysis process. One of the objectives is to locate like units of research in the program without regard for their coding in the program structure. Neither does this multiple appearance indicate of itself a defect in the implementation of the research program. Quite often, the combining of different classes of research in a single work unit is more effective, more efficient, or both. On the other hand, multiple appearances of work units in Figure 5.6 should signal the question as to whether this was, or would be, preferred in terms of effectiveness, efficiency, or some other criterion.

The research relationships data for the shelter system functions and controls--other than Controlling Environment--are shown in Appendix D for the FY1966 program. Data recording forms are included for all for completeness even though some had no ongoing research in the FY1966 program.

The final step in delineating the relationships is the construction of a diagram for the whole countermeasure system. This is merely the arrangement of the completed relationships data forms (as in Figure. 5.6) in a convenient pattern and drawing of the flow lines (5 and 6 in Figure 5.4.) A schematic for such a diagram for the shelter research program is shown in Figure 5.7.

5.5 FURTHER ANALYSIS

Although it may seem that the analysis described above is in great detail, it will be found--probably quite often, that more detailed information is needed. For example, the classification of a piece of research --as WU 1221B in Figure 5.6--shows that it is defining a problem in heating and cooling of shelters. One kind has to do with physiological demands and responses of people; another with space requirements for equipment; a third with equipment operation and repair; and so on. The analyst cannot see in Figure 5.6 what problem is being defined, or whether the problem with which he is concerned is included. He must then search a little further.

In most cases, it will not be necessary to formally record such data, as on a more-detailed relationships data form. The analyst will usually be doing this detailed examination at the time he needs the data for immediate use. He will then use them and go on to something else. He will not need to go back and find them again. It would be pointless to expand the framework just to record these bits and pieces. A framework more detailed that the one described above (Figures 5.6 and 5.7) would be wondrous, fearsome, and self-defeating. Therefore, greater detail in the data recording as a general practice is neither proposed nor recommended.

On the other hand, it is recommended that, as the analyst becomes more familiar with the process, he delve deeper into the relationships so that he may better understand what he is about.

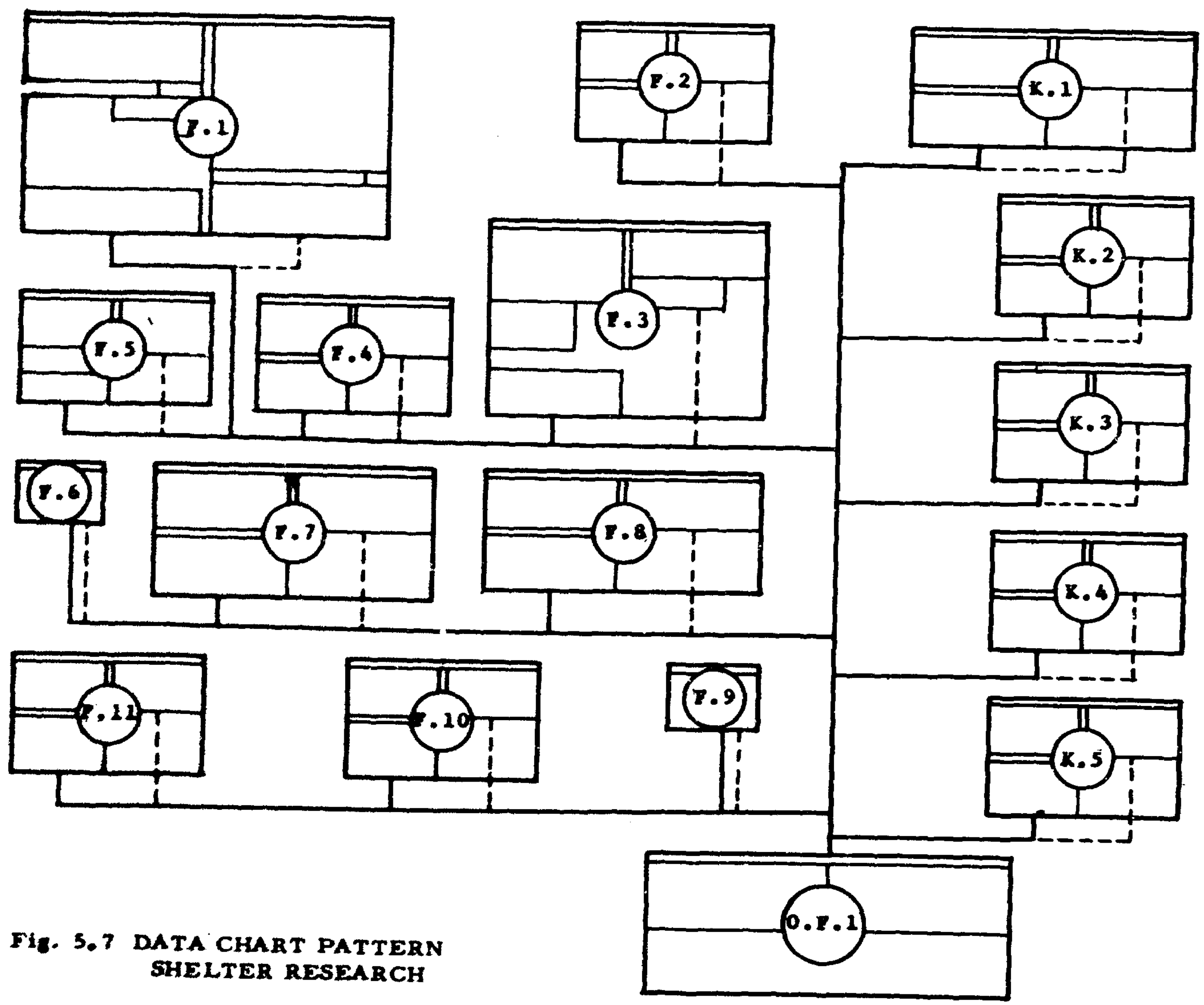


Fig. 5.7 DATA CHART PATTERN
SHELTER RESEARCH

VI. EVALUATION OF RESEARCH

6.1 OPERATIONAL QUESTIONS

Chapter V showed that research needed to be evaluated mainly to find (1) what research was needed and (2) where and how new information should be applied. It showed how research could be analyzed to obtain information about it for use in its evaluation. Here the discussion turns to suggestions as to the application of this information.

Civil defense research is conducted and its results are used in the building of the civil defense operating system. All of the activities of the building system must relate to the operating system in some way because the building system has no reason for existence other than to serve the operating system. All of the problems for the building system can be stated in terms of the operating system. And, since information needs are established by these problems, research requirements can be stated broadly in terms of the operating system.

The simplest, most direct way to state a problem is to ask a question. Building system information needs can be stated as questions asked in operating system terms. These are the "operational questions" that have been used in research planning and state-of-the-art reviews. They are the criteria against which research must be evaluated.

The analytic framework developed in this paper offers an improved basis for asking the operational questions. Each question can refer to a specific function or control of the civil defense operating system or of one of its countermeasure systems. The question can contain language that identifies it with a specific kind of activity as described in Chapter I and therefore, with a specific research class. If, then, research is also identified by function or control and by research class, the research output can be compared directly to the research requirement as stated in the operational question.

6.2 STATE-OF-THE-ART REVIEW

A state-of-the-art review (SOTA) starts with a list of operational questions. In a sense, this list contains all of the operational questions that research can produce information to assist in answering. But no one analyst is expected to address his attention all the questions. So the first step must be to state the limits of the review.

Here the analytic framework can first be applied. It is convenient --as a sort of shorthand--to speak of parts of the research program in terms of its coding: 1110, 4330 and so on. But this can be a dangerous convenience because, while it is intended that the program structure and the subject matter of the research be strictly related, the intent is not always achieved. For example, 1600 numbers appear on the data form for F.1, Shielding, (page 115) although this research is intended to fall in the 1100 series. Since the SOTA refers to subject matter, it would appear preferable to set its limits in terms of the civil defense system function(s) and/or control(s) or of the countermeasure system function(s) or control(s) it is intended to include.

If, then, the operational questions are written in terms of function (or control) and research class, they can be located on the analytic framework. When the research is also located by function (or control) and research class on the framework, the analyst has identified which research applies to each operational question and he can proceed with the evaluation.

How to conduct the evaluation is beyond the scope of this paper. The intent here is to aid the analyst by giving him a pseudo-mechanistic device for ordering his work. One can take with a good deal of confidence that he knows how to do his job.

6.3 DISSEMINATING RESEARCH RESULTS

This is as a mirror image of the state-of-the-art problem. In this case, the analyst has new research-produced information and his problem is: how to present it and to whom.

Again, the analytic framework can be useful. The new information is to go toward answering an operational question. Both the research and the question can be located on the framework. Once the appropriate operational question has been located, the proper method of presenting the new information should become apparent.

6.4 RESEARCH PROGRAMMING

Research programming is the process of projecting a present state-of-the-art to a future state-of-the-art by adding the results expected of a number of research efforts to be undertaken. In other words, the programmed research should assist in answering some operational questions that cannot be answered now. And since, as was said before, the OCD research program is of the nature of a massive system analysis, the programmed research should improve the ability to conduct the analysis.

These two objectives of research programming, while not identical, are closely related. The relationship appears chiefly in two ways:

(1) The systems analyses can identify the relative priorities of the answers to the several unanswered operational questions.

(2) The systems analyses can provide the channels by which the answers to the operational questions are applied in selection of objectives and action program design--sometimes loosely called: setting policy.

The analytic framework can assist in evaluation of research in the programming process. The state-of-the-art review has disclosed the operational questions to which better answers are needed. The analytic framework provides a means for specifying what element of the answer is to be improved. For example: in one it might be improved definition of the problem; in another, better estimates of the cost of hardware; in a third, better criteria for selection among alternative organizations.

On the other hand, the analytic framework might indicate the need for a research task that would provide a means for combining available information in such a way as to make it available in the proper form for use in major system analyses. For example, in the Shelter system control, K. 1, Organizing, (Page 127) a system evaluation might be required to make the available information usable in shelter system evaluations.

In any event, proposed research efforts must be susceptible to specific location on the framework. In other words, the work unit must fit in one or more locations on the relationships data forms with marks in the appropriate research class columns. This can provide two benefits:

(1) It allows the analyst to fix more clearly in his mind what specific area or areas will be covered by the research.

(2) It provides improved communication between the research analyst and the research manager as to the specific intent of the program.

6.5 RESEARCH MANAGEMENT

The accomplishment of a piece of research--no matter what the administrative arrangements--starts logically with a definition of what is to be done: a scope of work. Writing of a scope of work for research is always difficult because research by its nature goes into the unknown. But success or failure in a research effort may well depend on the scope defined for it.

The problem lies seldom in a too-severe restriction of the area of study because there is a general disinclination to stultify the research effort by denying freedom to investigate. Rather the problem too often lies in a failure to specify all the areas the researcher should investigate This allows the researcher himself to stultify the effort by inordinate attention to insignificant detail.

It may seem that there is a fundamental conflict between definition of the scope of research on the one hand and intellectual freedom in doing the research on the other. This conflict is more felt than real. Two alternative descriptors can be applied to almost every piece of research: breadth and depth. Generally, a subject may be studied:

(1) in breadth, meaning a shallow examination of a broad subject, or

(2) in depth, meaning a penetrating examination of a narrow subject.

Which of these descriptors is to apply is not be chosen by the personal preference of the researcher but is to be dictated by the need for information. Therefore, the choice is available to the programmer because it is the programmer who derives the information need. The programmer indicates his choice in the language of the scope of the work

Here, again, the anlytic framework can help. The spelling out of functions and controls in some detail at the countermeasure system level provides a basis for specificity in the description of the subject matter for the research. And the research classification provides a basis for indicating the breadth intended for treatment of the subject. The proposal is that the scope of work contain the specific language that identifies the function or control and the research class, both as identified in the analytic framework.

APPENDIX A

DETAILED SYSTEMS ANALYSIS FRAMEWORK

Chapter III discusses an analytic framework for civil defense that is termed a "System Analysis and Integration Matrix." Figure 3.1 shows a version of such a model in a form that gives very little detail about the elements of the analysis. It was sufficient in that form for its purpose: to illustrate the discussion it accompanied. However, for most purposes, a great deal more detail is required.

Figures A.1 thru A.8 contain detailed listings of the elements of the civil defense system analysis framework. Figures A.1 thru A.4 apply to the operating system; A.5 thru A.8, to the building system. Referring to Figure 3.1, Figure A.1 would replace the "outputs" and "inputs" of the operating system; Figure A.2, the "constraints"; Figure A.3, the "components"; and Figure A.4, the "functions" and "controls." Figures A.5 thru A.8 would similarly replace the blocks of the building system in Figure 3.1.

The amount of detail shown here may still not suffice for the purposes of analyzing research in some areas. For example, "K.3, Informing" in Figure A.4 appears to be in substantial detail. But, if we look at the element, "K.3.1.1.3.2, Acquiring Data about the Attack Environment," is taken and the number of different elements of the attack environment--characteristics of fire and the several types of nuclear radiations, for example--are considered, it is seen that it would require substantial subdivision for research analysis. And, in this case, not only would subdivision be required, but it would probably also involve more than one research analyst.

O. CIVIL DEFENSE OPERATING SYSTEM	D. Determinants	1. Outputs	1. Strategic Situation	1. Strategy of Potential Enemy	1. Objectives
					2. Capabilities
				2. Level of Conflict	1. Cold War
					2. Limited War
					3. General War
					4. Recovery
				3. US Strategy	1. Objectives
					2. Capabilities
			2. Civil Defense		1. Mission
					2. Performance Requirements
		2. Inputs	1. People	1. Numbers	
				2. Location	
			2. Social System	A. Agriculture, Forestry, Fisheries	
				B. Mining	
				C. Contract Construction	
				D. Manufacturing	
				E. Transportation, Etc.	40-47. Transport.
					48. Communications
					491. Electric
					492. Gas
					494-497. Water
					495. Sanitary
				F. Wholesale and Retail Trade	
				G. Finance, Insurance and Real Estate	
				H. Services	70. Hotels, etc.
					76. Repair
					80. Medical, etc.
					82. Educational
					88. Households
					Other
				I. Government	91. Federal
					92. State
					93. Local
					94. International
			3. Information		

Fig. A. 1 OPERATING SYSTEM DETERMINANTS (OUTPUTS AND INPUTS)

O. CIVIL DEFENSE OPERATING SYSTEM	D. Determinants	3. Constraints	1. People	1. Manpower	1. Skills
					2. Abilities
				2. Physiology	1. Demands
					2. Responses
				3. Psychology	1. Knowledge
					2. Beliefs
					3. Demands
					4. Responses
					5. Values
			2. Weapon Effects	1. Overpressure	
				2. Ground Shock	
				3. Dynamic Pressure	
				4. Radioactivity	1. Initial
					2. Residual
				5. Electromagnetic Radiations	1. Heat
					2. Light
					3. X-rays
				6. Chemical Agents	
				7. Biological Agents	
			3. Natural Environment	1. Geography	1. Topography
					2. Geology
				2. Weather	
				3. Climate	
				4. Energy	
				5. Time	
				6. Animals	1. Domestic
					2. Wild
				7. Minerals	
				8. Vegetables	1. Food
					2. Fiber
			4. Law	1. Statute	
				2. Common	
			5. Cost		
			6. Schedule	1. Requirements	
				2. Lead Time	

Fig. A. 2 OPERATING SYSTEM DETERMINANTS (CONSTRAINTS)

O. CIVIL DEFENSE OPERATING SYSTEM	C. Components				
		1. Governments	1. Federal	1. People	1. Executive
					2. Legislative
					3. Judicial
				2. Facilities	
				3. Other Resources	
			2. State	1. People	1. Executive
					2. Legislative
					3. Judicial
				2. Facilities	
				3. Other Resources	
			3. Local	1. People	1. Executive
					2. Legislative
					3. Judicial
				2. Facilities	
				3. Other Resources	
		2. Non-Government Organizations		1. People	
				2. Facilities	
				3. Other Resources	
		3. Individuals		1. People	
				2. Facilities	
				3. Other Resources	

Fig. A. 3 OPERATING SYSTEM COMPONENTS

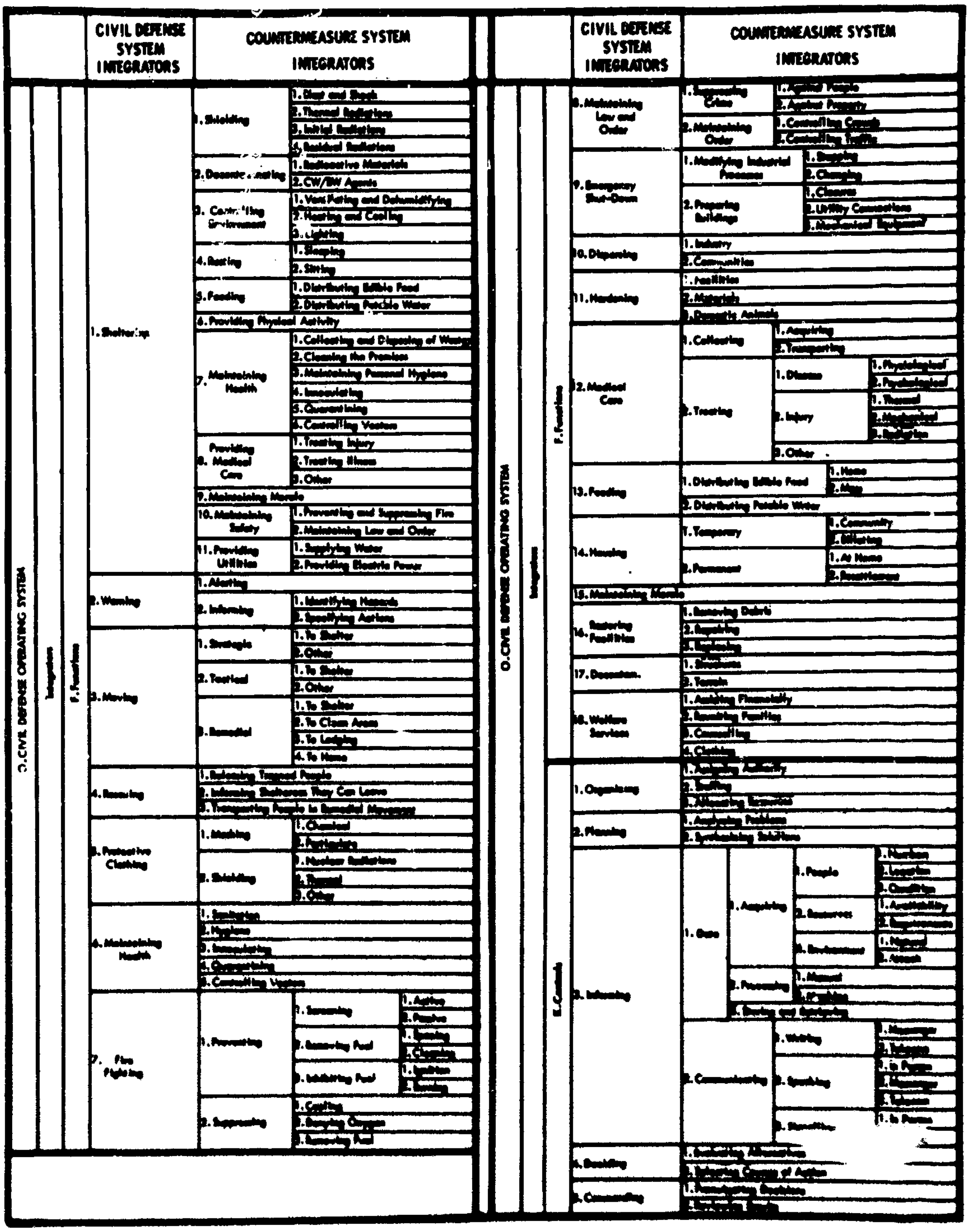


Fig. A.4 OPERATING SYSTEM INTEGRATORS

- B. CIVIL DEFENSE BUILDING SYSTEM
  - D. Determinants
    - 1. Outputs
      - 1. Mission
      - 2. Performance Requirements
        - S. Total Operating System
          - F. Functional Systems
            - 1. Sheltering
            - 2. Warning
            - 3. Moving
            - 4. Rescuing
            - 5. Protective Clothing
            - 6. Maintaining Health
            - 7. Fire Fighting
            - 8. Maintaining Law & Order
            - 9. Emergency Shut-Down
            - 10. Dispersing
            - 11. Hardening
            - 12. Medical Care
            - 13. Feeding
            - 14. Housing
            - 15. Maintaining Morale
            - 16. Restoring Facilities
            - 17. Decontaminating
            - 18. Welfare Services
          - K. Control Systems
            - 1. Organizing
            - 2. Planning
            - 3. Informing
            - 4. Deciding
            - 5. Commanding
    - 2. Inputs
      - 1. People
        - 1. Numbers
        - 2. Location
      - 2. Social System
        - C. Contract Construction
        - D. Manufacturing
        - E. Transportation Etc.
          - 40-47 Transport.
          - 48 Communications
          - 491 Electric
          - 492 Gas
          - 495 Sanitary
          - 494-497 Water
        - F. Wholesale and Retail Trade
        - G. Finance, Insurance and Real Estate
        - H. Services
          - 70 Hotels, etc.
          - 80 Medical, etc.
          - 82 Educational
          - 88 Households
          - XX Other
        - I. Government
          - 91 Federal
          - 92 State
          - 93 Local
      - 3. Information

Fig. A.5 BUILDING SYSTEM DETERMINANTS OUTPUTS AND INPUTS

B. CIVIL DEFENSE BUILDING SYSTEM	D. Determinants	3. Constraints	1. People	1. Manpower	1. Skills
					2. Abilities
				2. Physiology	1. Demands
					2. Responses
				3. Psychology	1. Knowledge
					2. Beliefs
					3. Demands
					4. Responses
					5. Values
			2. Weapon Effects	1. Overpressure	
				2. Ground Shock	
				3. Dynamic Pressure	
				4. Radioactivity	1. Initial
					2. Residual
				5. Electromagnetic Radiations	1. Heat
					2. Light
					3. X-rays
				6. Chemical Agents	
				7. Biological Agents	
			3. Natural Environment	1. Geography	1. Topography
					2. Geology
				2. Weather	
				3. Climate	
				4. Energy	
				5. Time	
				6. Animals	1. Domestic
					2. Wild
				7. Minerals	
				8. Vegetables	1. Food
					2. Fiber
			4. Law	1. Statute	
				2. Common	
			5. Cost		
			6. Schedule	1. Requirements	
				2. Lead Time	

Fig. A.6 BUILLING SYSTEM DETERMINANTS CONSTRAINTS

B. CIVIL DEFENSE BUILDING SYSTEM	C. Components	1. Governments	1. Federal	1. People	1. Executive
					2. Legislative
					3. Judicial
				2. Facilities	
				3. Other Resources	
			2. State	1. People	1. Executive
					2. Legislative
					3. Judicial
				2. Facilities	
				3. Other Resources	
			3. Local	1. People	1. Executive
					2. Legislative
					3. Judicial
				2. Facilities	
				3. Other Resources	
		2. Non-Government Organizations		1. People	
				2. Facilities	
				3. Other Resources	
		3. Individuals		1. People	
				2. Facilities	
				3. Other Resources	

Fig. A.7 BUILDING SYSTEM COMPONENTS

B. CIVIL DEFENSE BUILDING SYSTEM	F. Functions	1. System	1. Designing	
			2. Testing	
		2. Program Designing and Planning		
		3. Facilities	1. Designing and Specifying	
			2. Survey	
			3. Marking	
			4. Improving	
			5. Constructing and Maintaining	
			6. Testing	
		4. Equipment	1. Designing and Specifying	
			2. Procuring	
			3. Stockpiling	
			4. Distributing	
			5. Installing and Maintaining	
			6. Testing	
		5. Supplies	1. Designing and Specifying	
			2. Procuring	
			3. Stockpiling	
			4. Distributing and Maintaining	
			5. Testing	
		6. Operations	1. Designing and Specifying	
			2. Testing	
		7. Organizing	1. Authority	1. Assigning
				2. Channelling
			2. Staff	1. Recruiting
				2. Training
				3. Assigning
			3. Procedures	1. Designing
				2. Testing
		8. Informing the Public		
	K. Controls	1. Organizing	1. Assigning Authority	
			2. Staffing	
			3. Providing Facilities	
			4. Providing Equipment & Supplies	
			5. Providing Operating Doctrine	
		2. Planning Policy	1. Analyzing	
			2. Synthesizing	
		3. Informing	1. Research	
			2. Data	1. Acquiring
				2. Processing
				3. Storing & Retrieving
			3. Communicating	1. Writing
				2. Speaking
		4. Deciding	1. Evaluating Alternatives	
			2. Selecting Courses of Action	
		5. Commanding	1. Promulgating	
			2. Evaluating Results	

Fig. A.8 BUILDING SYSTEM INTEGRATORS

APPENDIX B

CLASSIFICATION OF THE OCD RESEARCH PROGRAM
30 June 1967

The pages that follow in this appendix contain the classification of the OCD research program, as of 30 June 1967, obtained by applying the method presented in this paper. This classification was made by the cognizant research analysts of the OCD Research Staff. To arrive at the classification they used their knowledge of the intent of the research as well as the information contained in all of the documentation in program papers, work plans, progress reports, and so on.

In deciding on the classification, the analysts made an effort to obtain as broad a coverage as the intent of the research warranted. This seems to be a desirable approach because, as we noted in Chapter VI, the stated scope of work for research often fails to specify all of the areas that should be investigated. By classifying the research in all of the areas it is intended to cover, it may prove easier to get sufficient coverage in the language of the scope of work.

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
1111A	F.3.1/2	F.1	F.1.4							x							
1111F	F.3.1/2	F.1	F.1.4							x							
1112A	F.3.1	F.1	F.1.3/4	x						x							
1112C	F.3.1	F.1	F.1.3/4	x													
1112E	F.3.1/2	F.1	F.1.4	x													
1112G	F.3.1/2	F.1	F.1.4	x													
1112H	F.3.1/2	F.1	F.1.4							x							
1113A	F.3.1/2	F.1	F.1.4							x							
1113B	F.3.1	F.1	F.1.3							x							
1115C	F.3.1/2	F.1	F.1.4							x							
1115D	F.3.1/2	F.1	F.1.4							x							
1116B	F.3.1/2	F.1	F.1.4							x							
1117A	F.3.1/2	F.1	F.1.4							x							
1117B	F.3.1/2	F.1	F.1.4							x							
1117C	F.3.1/2	F.1	F.1.4							x							
1121C	F.3.1	F.1	F.1.1							x							
1123C	F.3.2	F.1	F.1.1	x						x							
1123D	F.3.2	F.1	F.1.1	x						x							
1124B	F.3.1.1	F.1	F.1.1			x	x	x	x	x							
1125A	F.3.1	F.1	F.1.1/2/3	x			x										
1126A	F.3.1	F.1	F.1.1	x						x							
1126B	F.3.2	F.1	F.1	x						x							
1126C	F.3.2	F.1	F.1							x							
1127D	F.3.1/4	F.1	F.1.1	x													
1132A	F.1.1/4	F.1	F.10.1							x							
1133B	K.3.1	F.1	F.10.1	x													
1152H	F.3.1	F.1	F.1.1								x						

Work Unit	System Integrator Support			Research Class														
	Building System	Operating System		PD	OS	System			Design-Deployment									
									Hdwe			Ops			Org			
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
1153D	F.1.1	F.1	F.1.1								x						
1154C	F.3.2	F.1	F.1.4							x							
1155A	F.3.1	F.1	F.1.4	x						x							
1157B	F.3.1/2	F.1	F.1.1							x							
1157D	F.3.1	F.1	F.1						x	x							
1214A	F.4.1	F.1	F.3.1/2	x	x					x							
1215A	F.4.1	F.1	F.3.1/2	x	x				x	x							
1215C	F.4.1	F.1	F.3.1/2	x						x							
1222A	F.4.1	F.1	F.3.1/2	x													
1224A	F.4.1	F.1	F.3.1/2	x	x												
1224B	F.4.1	F.1	F.3.1/2	x													
1231B	F.4.5	F.1	F.3.1/2	x						x			x				
1233A	F.1.1	F.1	F.3.1			x	x	x									
1235A	F.1.1	F.1	F.3.1/2	x													
1311A	F.5.1/2/3	F.1	F.5.1							x	x						
1312A	F.5.3	F.1	F.5.1								x						
1314A	F.5.1	F.1	F.5	x						x							
1316A	F.5.1	F.1	F.5.1							x	x						
1321B	F.1.1	F.1	F.5.2			x	x	x									
1331C	F.1.1	F.1	F.7.1	x		x	x										
1341A	F.1.1	F.1	F.7.1/8.2	x													

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
1352E	F.5.1	F.1	F.7.2							x	x						
1413A	F.4.5/5.4	F.1	F.11.2	x					x		x						
1423A	F.4.1	F.1	F.3.2			x	x	x									
1425B	F.4.1	F.1	F.3.2		x				x	x			x				
1427A	F.4.1	F.1	F.3.3/11.2							x			x			x	
1433B	F.4.1	F.1	F.7.1/11.1						x	x							
1433C	F.4.1	F.1	F.11.1						x	x							
1517A	F.7.2.2	F.1	F/K					x					x				
1519A	F.6.1	F.1	K	x				x					x			x	
1519B	F.7.3	F.1	K	x													
1521A	F.1.2	F.1	F/K					x		x			x			x	
1522A	F.1.2	F.1	F.3					x		x	x		x			x	x
1535A	K.3.1	F.1	K	x									x			x	
1543A	F.7	F.1	K	x	x	x	x	x									
1613B	F.1.1	F.1	F/K	x	x	x	x		x	x							
1613C	F.3.1	F.1	F.1.1	x													
1614A	F.3.1	F.1	F.1.1	x	x		x			x							
1614B	F.3.1	F.1	F.1	x	x	x	x	x		x							
1614C	F.3.2	F.1	F.1	x	x					x							
1615A	F.1.1	F.1	F	x	x	x	x	x	x	x	x						
1618A	K.3.1	F.1	F.1						x	x							
1623A	F.1.1	F.1	F/K	x	x	x	x	x									

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
1624A	F.1.1	F.1	F/K	x	x	x	x	x									
1631C	F.1.1	F.1	F/K			x	x	x									

Work Unit	System Integrator Support			Research Class														
	Building System	Operating System		PD	OS	System			Design-Deployment									
		CD	Counter			Sy	An	Se	Hdwe			Ops			Org			
									C	E	F	C	E	F	C	E	F	
2111G	F.1.1	K.3	F.1	x									x					
2112A	F.6.1	K.3	F.1.1.3.2										x					
2121G	F.4.1	K.3	F.1.1.3.2							x								
2122C	F.4.1	K.3	F.1.1.3	x						x								
2122D	F.4.1	K.3	F.1.1.3.2	x														
2123A	F.4.5	K.3	F.1.1.3.2			x	x	x										
2131H	F.4.1	K.3	F.1.1.3.2								x							
2131I	F.4.1	K.3	F.1.1.3.2	x														
2133H	F.4.1	K.3	F.1.1.3.2						x	x								
2211C	F.1.1	K.3	F.2	x														
2212E	F.1.1	F.2	F/K			x	x	x										
2223A	F.1.1	K.3	F.2			x	x	x										
2224A	F.4.5	K.3	F.2.3							x								
2224A	F.4.1/5	K.3	F.2.3							x								
2224B	F.1.1	K.3	F.2.3	x		x	x	x										
2233F	K.3.1	F.2	F/K	x														
2313A	F.1.1	F/K	F/K			x	x	x										
2321A	F.1.1	F.9	F/K	x									x	x				
2411F	F.1.1	F.12	F/K							x			x			x		
2411G	F.1.1	F.12	F	x														
2411H	K.3.1	F/K	F/K	x														

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
2421E	F.1.1/5.1	F.12	F.2	x						x							
2421F	F.1.1	F.12	F.2	x		x	x	x									
2421G	F.1.1	F.12	F.2	x													
2421H	F.5.1	F.12	F.2							x							
2422A	F.1.1	F.12	K			x	x	x					x	x		x	
2422B	F.1.1	F.12	F/K			x	x	x					x	x		x	
2422C	F.1.1/7.2	F.12	F/K										x			x	
2431C	F.1.1	F.12	F.2	x													
2431D	F.1.1	F.12	F.2.2.3										x				
2431F	K.3.1	F.12	F.2.2.3	x													
2511B	F.1.1	F.4	F/K			x	x	x					x	x	x	x	x
2512A	F.1.1	F.4	F/K			x	x	x									
2521A	F.1.1	F.7	K.3.1.1.3.2			x	x	x									
2522D	F.1.1	F.7	K.3.1.1.3.2			x	x	x									
2522E	F.1.1	F.7	F/K			x	x	x									
2522F	F.1.1	F.7	F.2	x													
2522G	F.1.1	F.7	F.2			x	x	x					x	x	x	x	x
2525A	F.1.1	F.7	F/K			x	x	x				x	x	x			
2526A	F.1.1	F.7	F/K				x	x									
2526B	F.1.1	F.4/7	F/K			x	x	x									
2531A	F.1.1	F.7	F	x													
2531B	K.3.1	F.7	F	x													
2531C	F.1.1	F.7	F	x													
2532A	F.1.1	F.7	F	x		x	x										
2534B	F.1.1	F.7	F	x													
2534C	F.1.1	F.7	F	x													
2534D	K.3.1	F.7	F	x		x	x	x									
2534E	F.1.1	F.7	F	x													

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
		CD	Counter			Sy	An	Se	Hdwe			Ops			Org		
									C	E	F	C	E	F	C	E	F
2536A	F.1.1	F.7	F	x													
2536D	F.1.1	F.7	F	x													
2536E	F.1.1	F.7	F	x													
2536F	F.1.1	F.7	F	x													
2536G	K.3.1	F.7	F	x													
2536H	F.1.1	F.7	F	x													
2537A	F.1.1	F	F/K	x													
2538B	K.3.1	F.7	F	x													
2538C	K.3.1	F.7	F	x													
2542A	F.5.1	F.7	F.1.3							x							
2552C	F.1.1	F.7	F.1.1.1						x	x	x						
2554A	F.1.1	F.7	F.1.1.1			x	x	x									
2611A	F.1.1	K	F/K	x		x	x	x								x	
2611C	F.1.1	K	F/K			x	x	x								x	
2611D	F.1.1	F/K	F/K			x	x	x								x	

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
3111A	F.1.1	F/K	F/K	x													
3117C	F.1.1	F/K	F/K	x													
3117D	F.1.1	F/K	F/K	x													
3119A	F.1.1	F/K	F/K	x													
3122A	F.1.1	F/K	F/K	x													
3123A	F.1.1	F/K	F/K	x													
3125A	F.1.1	F/K	F/K	x													
3131C	F.1.1	F/K	F/K	x													
3133A	F.1.1	F/K	F/K	x													
3143A	F.1.1	F/K	F/K	x													
3143B	F.1.1	F/K	F/K	x													
3144C	F.1.1	F/K	F/K	x													
3145A	F.1.1	F/K	F/K	x													
3145B	F.1.1	F/K	F/K	x													
3146A	F.1.1	F/K	F/K	x													
3211B	K.3.1	F.17	F	x	x					x							
3211C	K.3.1	F.17	F	x	x					x							
3212A	F.1.1	F.17	F/K			x	x	x									
3213B	F.1.1	F.17	F			x	x										
3216A	F.1.1	F.17	F				x										
3216B	F.1.1	F.1	F.1.4	x			x										
		F.17	F	x			x										
3221B	F.1.1	F/K	F/K			x	x										

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
		CD	Counter			Sy	An	Se	Hdwe			Ops			Org		
									C	E	F	C	E	F	C	E	F
3223A	K.3.1	F/K	F/K	x													
3231C	F.1.1	F/K	F/K			x	x	x									
3233B	F.1.1	F.1	F.1.4	x			x										
		F.17	F	x			x										
3311B	K.3.1	F.16	F	x	x	x	x	x									
3312B	F.1.1	F/K	F/K	x													
3313B	K.3.1	F/K	F/K	x													
3322B	K.3.1	F/K	F/K	x													
3325B	F.1.1	F.16	F.1		x	x	x	x									
3331A	F.1.1	F.16	F	x	x	x	x										
3331B	F.1.1	F.16	F		x	x	x	x									
3331C	F.1.1	F.16	F		x	x	x	x									
3331D	F.1.1	F/K	F/K		x	x	x										
3412C	F.1.1	F.6	F	x													
3422A	F.1.1	F.13	F/K	x													
		F.14															
		F.18															
3423A	F.1.1	F.13	F	x		x											
3431A	F.1.1	F.12	F.2	x		x	x										
3432A	F.1.1	F.12	F.1/2		x	x	x	x									
3441A	F.1.1	F.6	F.1/5	x		x											
3513A	F.1.1	F/K	F/K	x													
3514A	F.1.1	F.3.3	F/K	x		x	x										

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		FD	OS	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
3516B	F.1.1	F/K	F/K	x													
3522A	F.1.1	F/K	F/K	x		x											
3531A	F.1.1	K	F/K	x		x											
3533A	F.1.1	K.2	F.1			x	x										
3534A	F.1.1	F/K	F/K	x													
3534B	F.1.1	F/K	F/K	x		x											
3534C	F.1.1	K.1	F.1	x		x											
3534D	K.3.1	F/K	F/K	x		x	x	x									
3535A	F.1.1	F/K	F/K			x	x	x									
3542A	F.1.1	F/K	F/K					x									
3543A	F.1.1	K.1	F.2			x	x	x									

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	OS	System			Design-Deployment								
		CD	Counter			Sy	An	Se	Hdwe			Ops			Org		
									C	E	F	C	E	F	C	E	F
4113C	F.1.1	F/K	F/K			x	x	x									
4113E	F.1.1	F/K	F/K			x	x										
4113F	F.1.1	F/K	F/K				x										
4114A	F.1.1	F/K	F/K			x	x	x									
4114E	F.1.1	F/K	F/K				x	x									
4115A	F.1.1	F/K	F/K			x	x	x									
4123B	K.3.1	F/K	F/K			x	x	x									
4131A	F.1.1	F/K	F/K			x	x	x									
4141B	F.1.1	F/K	F/K	x				x									
4151A	F.2	F/K	F/K	x													
4152A	F.1.1	F/K	F/K					x									
4162A	F.1.1	F/K	F/K			x	x	x									
4211D	F.1.1	F/K	F/K	x													
4312A	F.1.1	F/K	F/K	x													
4315A	F.1.1	F/K	F/K	x													
4321B	F.1.1	F/K	F/K	x													
4331C	F.1.1	F/K	F/K	x													
4333A	F.1.1	F/K	F/K	x													
4334A	F.1.1	F/K	F/K	x													
4334B	F.1.1	F/K	F/K	x													
4334C	F.1.1	F/K	F/K	x													
4341A	F.1.1	F/K	F/K	x													
4351A	F.1.1	F/K	F/K	x													

Work Unit	System Integrator Support			Research Class													
	Building System	Operating System		PD	US	System			Design-Deployment								
									Hdwe			Ops			Org		
		CD	Counter			Sy	An	Se	C	E	F	C	E	F	C	E	F
4361A	F.1.1	F/K	F/K	x													
4411C	F.7	F/K	K.1			x	x	x									
4431D	F.7.2.2	F/K	F/K													x	
4615A	F.1.1	K.3.1	F/K			x	x	x									
4631B	F.1.1	K.3	F/K			x	x	x									
4712A	F.1.1	F/K	F/K	x													
4811E	F.1.1	F/K	F/K	x	x			x				x	x	x		x	x
4812B	F.1.1	F/K	F/K	x	x			x				x	x	x		x	x
4813A	F.1.1	F/K	F/K	x	x			x				x	x	x		x	x
4815A	F.1.1	F/K	F/K	x	x			x				x	x	x		x	x
4831C	F.8	F/K	F/K	x	x	x	x					x	x	x	x	x	x
4832B	F.3.2	F.1	F	x	x			x				x	x	x	x	x	x

APPENDIX C

OCD RESEARCH PROGRAM STRUCTURE

The OCD research program is subdivided into four parts for programming and management. In consonance with the DDR&E pattern, these parts are further subdivided into Projects and Tasks. The lists following in this Appendix give the titles of all the Projects and Tasks now in the program.

OCD RESEARCH PROGRAM STRUCTURE

Code	Title
1000	**SHELTER RESEARCH**
1100	PROTECTION STUDIES
1110	Radiological Protection
1120	Blast Protection
1130	Thermal and Fire Protection
1140	BW/CW Protection in Shelters
1150	Materials, Techniques and Systems
1200	SHELTER ENVIRONMENTAL STUDIES
1210	Environmental Characteristics of Shelters
1220	Human Factors
1230	Environmental Materials, Procedures and Systems
1300	SUBSISTENCE AND HABITABILITY STUDIES
1310	Food Supply
1320	Shelter Water Supply
1330	Shelter Furnishings
1340	Medical Resources in Shelters
1350	Subsistence & Habitability Tests, Procedures and Systems
1400	PROTOTYPE DESIGN FOR SHELTER LIFE SUPPORT SYSTEMS
1410	Shelter Utility Services
1420	Shelter Auxiliary Systems
1430	Shelter Hardware Components
1500	SHELTER MANAGEMENT STUDIES
1510	Shelter Operational Studies
1520	Shelter Occupancy Studies
1530	Training & Guidance Material on Shelter Management
1540	Procedures & Systems for Planning Shelter Management
1600	SHELTER SYSTEMS STUDIES
1610	Shelter Concept Studies
1620	Evaluation of Partial Shelter Systems
1630	Area Wide Shelter Systems

OCD RESEARCH PROGRAM STRUCTURE

Code	Title
2000	<u>SUPPORT SYSTEMS RESEARCH</u>
2100	MONITORING SYSTEMS STUDIES
2110	Systems and Requirements
2120	Monitoring Operations
2130	Instruments and Material
2200	COMMUNICATIONS AND WARNING STUDIES
2210	Systems Studies
2220	Communications Studies
2230	Warning Studies
2300	REDUCTION OF VULNERABILITY
2310	Control of Target Configuration
2320	Damage Limitation
2400	EMERGENCY MEDICAL RESEARCH
2410	Emergency Health Problems
2420	Medical Support Studies
2430	Medical Aspects of Ionizing Radiation
2440	Medical Aspects of Chemical & Biological Warfare
2500	FIRE EFFECTS AND PROTECTION
2510	Rescue
2520	Damage Control
2530	Thermal and Fire Phenomena and Effects
2540	Thermal Hardening
2550	Active Thermal Countermeasures
2600	EMERGENCY OPERATIONS RESEARCH
2610	Emergency Operations, Doctrine & Organization
2620	Foreign Emergency Operations, Doctrine & Organization
2630	Legal Basis for Emergency Measures
2650	Disaster Research

OCD RESEARCH PROGRAM STRUCTURE

Code	Title
3000	POSTATTACK RESEARCH
3100	RADIOLOGICAL PHENOMENA AND EFFECTS
3110	Fallout Formation and Distribution Phenomena
3120	Radiation Fields
3130	Fallout Contamination Phenomena
3140	Biological Fate of Radioelements in Fallout
3200	RADIOLOGICAL COUNTERMEASURES, PROCEDURES AND PROCESSES
3210	Decontamination Methods, Development and Testing
3220	Peripheral Postattack Radiological Countermeasures
3230	Radiological Recovery Operations Analyses
3300	REPAIR AND RECLAMATION OF DAMAGED FACILITIES
3310	Prediction of Physical Damage and Debris
3320	Damage Repair and Debris Clearance Methods
3330	Repair and Reclamation Operations Analysis
3400	POSTATTACK MEDICAL, HEALTH & WELFARE OPERATIONS
3410	Postattack Health Assessment Procedures
3420	Postattack Dietary, Rehabilitation and Welfare Operations
3430	Medical Care Operations, Concepts and Procedures
3440	Sanitation, Waste Disposal, Pest & Vector Control
3500	POSTATTACK SYSTEMS STUDIES
3510	Assessment of Postattack Environment
3520	Recovery of Societal Elements: Requirements & Methods
3530	Management of Postattack Operations
3540	Postattack Sociological & Psychological Studies

OCD RESEARCH PROGRAM STRUCTURE

Code	Title
4000	SYSTEMS EVALUATION
4100	CIVIL DEFENSE SYSTEMS ANALYSIS
4110	Development of Total CD System Evaluation Techniques
4120	Development of Local CD System Evaluation Techniques
4130	Evaluation of Crisis-oriented CD Systems
4140	Evaluation of Quick-response CD Systems
4150	Analysis of Constraints on CD Systems
4160	Active/Passive Defense Studies
4200	STRATEGIC ANALYSES
4210	Projections of the Strategic Environment
4220	Relationships in National Security
4300	VULNERABILITY AND REQUIREMENTS RESEARCH
4310	Vulnerability to Weapons Effects
4320	Indirect Effects of Nuclear Attack
4330	Vulnerability of Public Utility Systems
4340	Total Vulnerability Analysis
4350	Vulnerability of Producing Systems
4360	Vulnerability of Distribution Systems
4400	ORGANIZATION AND TRAINING RESEARCH
4410	Evaluation of Civil Defense Organization
4420	Improved Training Effectiveness
4430	Development of Training Programs & Methods
4500	PLANNING SUPPORT RESEARCH
4510	Development of Local Civil Defense Plans
4520	Development of Data Analysis Techniques
4530	Development of Tests and Test Methods
4540	Development of Management Planning Techniques
4550	NAS/NRC Committee on Civil Defense
4600	INFORMATION SYSTEM ANALYSIS
4610	Development of a Survival Estimating System
4620	Development of Vulnerability Factors
4630	Analysis of the Intelligence System
4700	PHYSICAL ENVIRONMENT STUDIES
4710	Nuclear Weapons Effects Studies
4720	Natural Environment Data Studies
4800	SOCIAL AND PSYCHOLOGICAL STUDIES
4810	Public Acceptance Studies
4820	Social Systems Under Stress
4830	Communication Processes in Civil Defense

APPENDIX D

SHELTER RESEARCH PROGRAM CLASSIFICATION

The research classifications shown in Appendix B for the shelter research program have been recorded on relationships forms similar to that in Figure 5.5. These completed forms are presented in this Appendix. They are printed on one side of the paper only, so that they may be cut out and assembled into a chart of the whole shelter research program, as shown in Figure 5.7.

The shelter research program was chosen for this demonstration because the analytic framework for the shelter system is substantially more developed than those for the others. To make the demonstration complete, relationships forms are included for all of the integrators of the shelter system, even for those for which no research is being done at present.

F. 1 SHIELDING

Problem Definition - Objectives Selection

1.B & S	PD	OS	2.TP	PD		3.IR		OS	4.RR	PD	OS
1123C	x								1112E	x	
1123D	x								1112F	x	
1126A	x								1112G	x	
1127C	x								1155A	x	
1127D	x								1159C	x	
1613C	x										
1614A	x	x									
						1125A	x				
									1112A	x	
									1112C	x	
									1126B	x	
									1614B	x	
									1614C	x	

System Evaluation

1.B & S	Sy	An	Se	2.TP	Sy	An	Se	3.	Sy	An	Se	4. RR			
1124B	x	x	x												
1614A		x													
								1125A		x					
												1614B	x	x	x

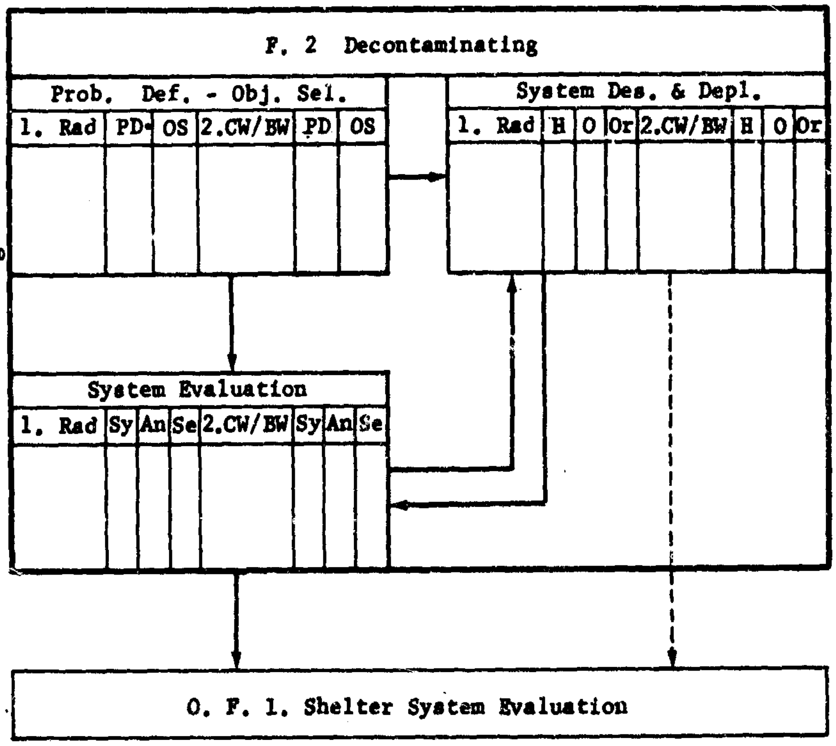
System Design & Deployment

1.B & S	H	O	Or	2. TP	H	O	Or	3.	H	O	Or	4. RR	H	O	Or
1121C	x											1111A	x		
1123C	x											1111F	x		
1123D	x											1112H	x		
1124B	x											1113A	x		
1152H	x											1115C	x		
1157B	x											1115D	x		
1614A	x											1116B	x		
1614C	x											1117A	x		
												1117B	x		
												1117C	x		
												1154C	x		
												1155A	x		
												1112A	x		
												1126C	x		
												1156A	x		
												1157D	x		
												1614A	x		
												1614B	x		
												1615A	x		
												1618A	x		

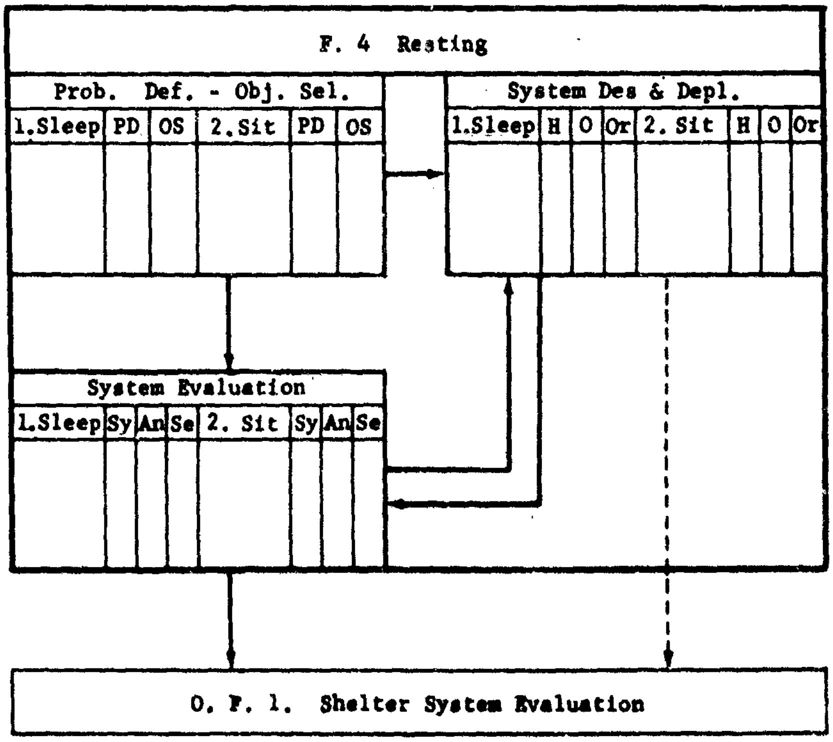
B & S = Blast and Shock
TP = Thermal Pulse
IR = Initial Radiations
RR = Residual Radiations

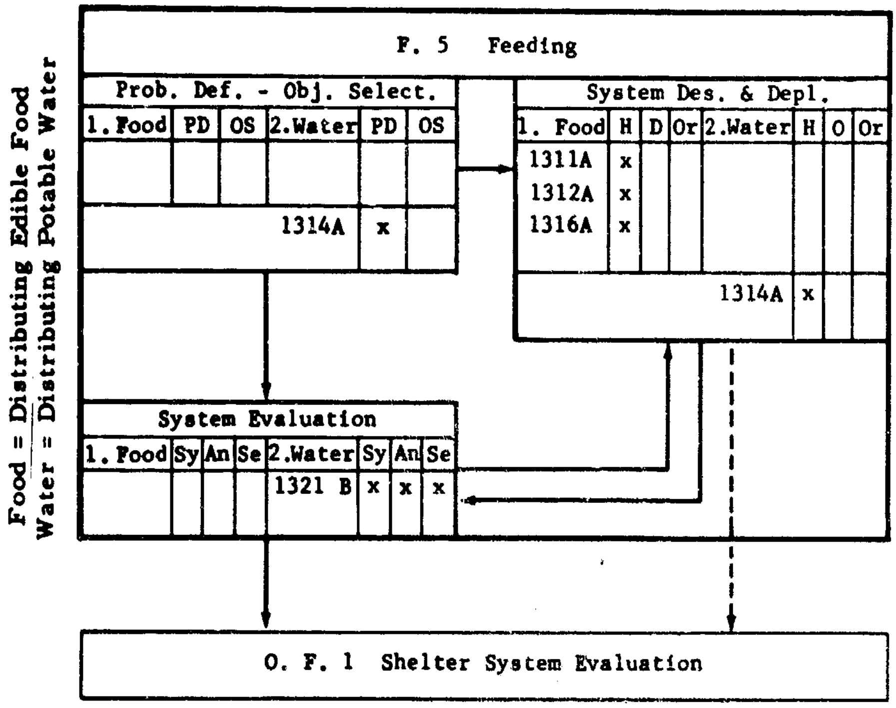
O. F. 1. Shelter System Evaluation

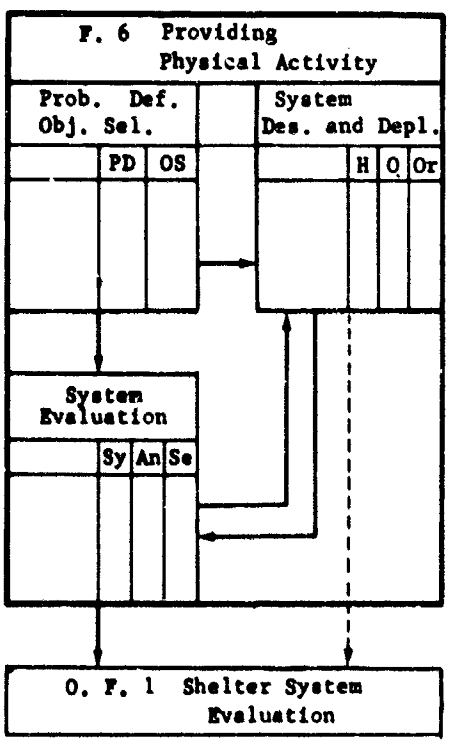
Rad = Radioactive Materials
CW/BW = Chemical and Biological Warfare Agents

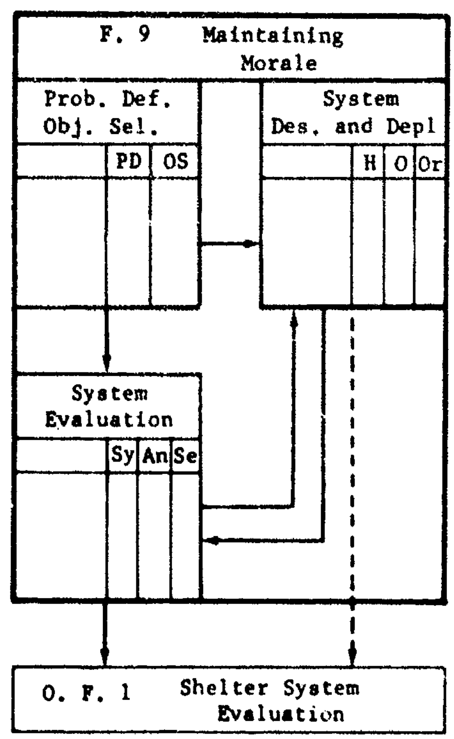


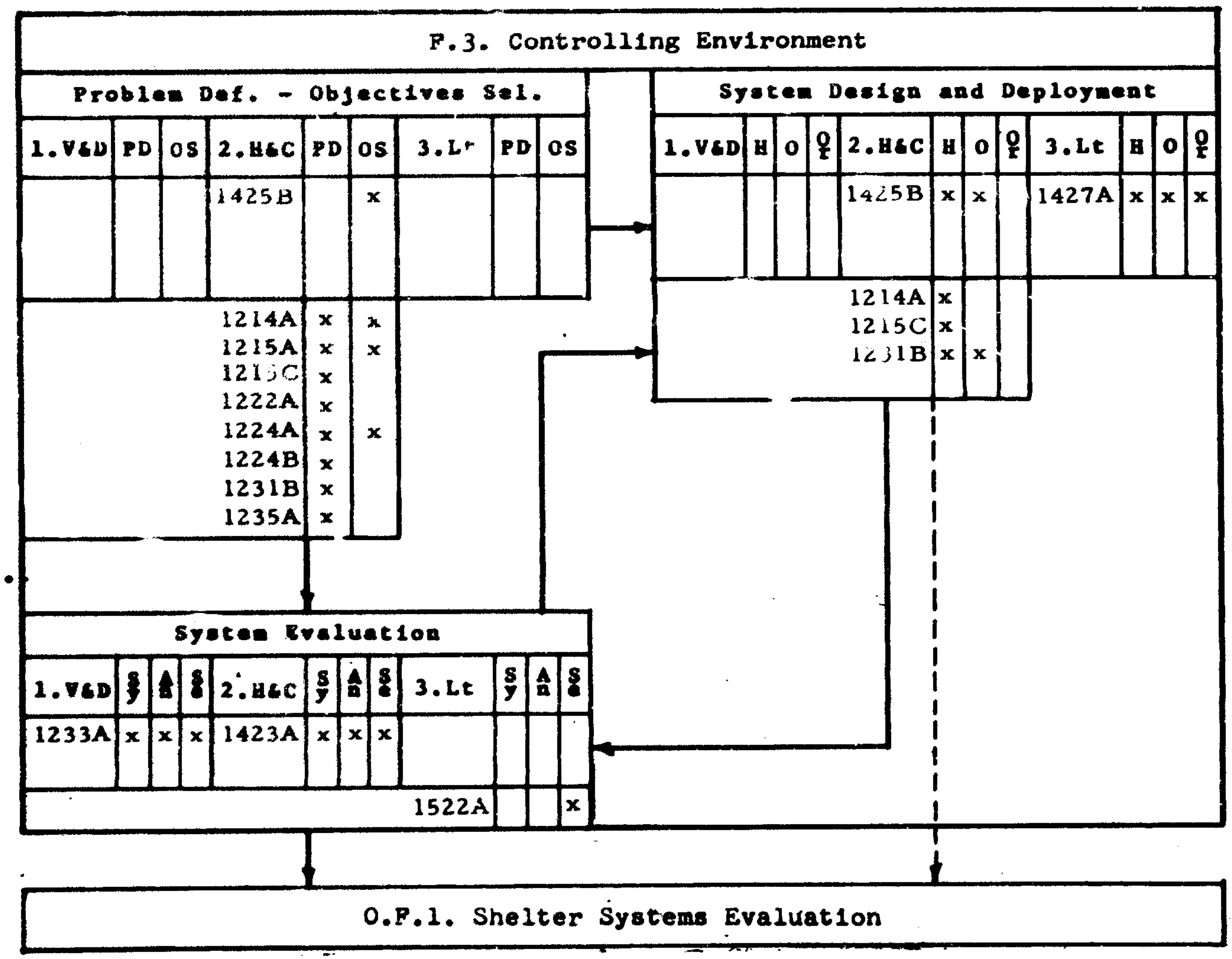
Sleep = Sleeping
Sit = Sitting




Food = Distributing Edible Food
Water = Distributing Potable Water
F. 5 Feeding
Prob. Def. - Obj. Select.
1. Food
PD
OS
2. Water
PD
OS
1314A
x
System Des. & Depl.
1. Food
H
D
Or
2. Water
H
O
Or
1311A
x
1312A
x
1316A
x
1314A
x
System Evaluation
1. Food
Sy
An
Se
2. Water
Sy
An
Se
1321 B
x
x
x
O. F. 1 Shelter System Evaluation


F. 6 Providing Physical Activity
Prob. Def. Obj. Sel.
PD
OS
System Des. and Depl.
H
O
Or
System Evaluation
Sy
An
Se
O. F. 1 Shelter System Evaluation


F. 9 Maintaining Morale
Prob. Def. Obj. Sel.
PD
OS
System Des. and Depl
H
O
Or
System Evaluation
Sy
An
Se
O. F. 1 Shelter System Evaluation


F.3. Controlling Environment
Problem Def. - Objectives Sel.
1.V&D PD OS 2.H&C PD OS 3.Lt PD OS
1425B x
1214A x x
1215A x x
1215C x
1222A x
1224A x x
1224B x
1231B x
1235A x
System Design and Deployment
1.V&D H O Of 2.H&C H O Of 3.Lt H O Of
1425B x x
1427A x x x
1214A x
1215C x
1231B x x
System Evaluation
1.V&D Sy An Se 2.H&C Sy An Se 3.Lt Sy An Se
1233A x x x
1423A x x x
1522A x
O.F.1. Shelter Systems Evaluation

F. 7 Maintaining Health

Problem Definition - Objectives Selection

1. WD	PD	OS	2. Clean	PD	OS	3. Hyg.	PD	OS
1331 C	x							
1341 A	x							
4. Inc	PD	OS	5. Qur	PD	OS	6. Vect	PD	OS

System Design & Deployment

1. WD	H	O	Or	2. Clean	H	O	Or	3. Hyg	H	O	Dr
1433 B	x			1352 E	x						
4. Inc	H	O	Dr	5. Qur	H	O	Or	6. VC	H	O	Dr

System Evaluation

1. WD	Sy	An	Se	2. Clean	Sy	An	Se	3. Hyg	Sy	An	Se
1331 C	x	x									
4. Inc	Sy	An	Se	5. Qur	Sy	An	Se	6. VC	Sy	An	Se

WD = Collecting and Disposing of Wastes
Clean = Cleaning the Premises
Hyg = Maintaining Personal Hygiene

Qur = Quarantining
Inc = Innoculating
VC = Controlling Vectors

O. F. 1 Shelter System Evaluation

F. 8 Providing Medical Care

Problem Definition - Objectives Selection

1. Inj	PD	OS	2. Ill	PD	OS	3. Oth.	PD	OS
			1341 A	x				

System Design & Deployment

1. Inj	H	O	Or	2. Ill	H	O	Or	3. Oth	H	O	Dr

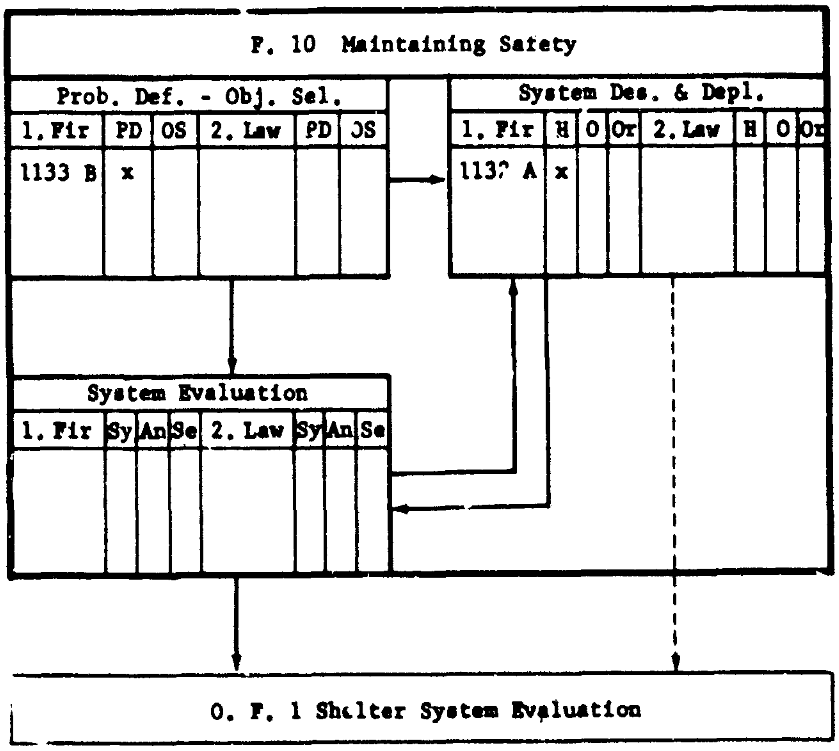
System Evaluation

1. Inj	Se	An	Se	2. Ill	Sy	An	Se	3. Oth	Sy	An	Se

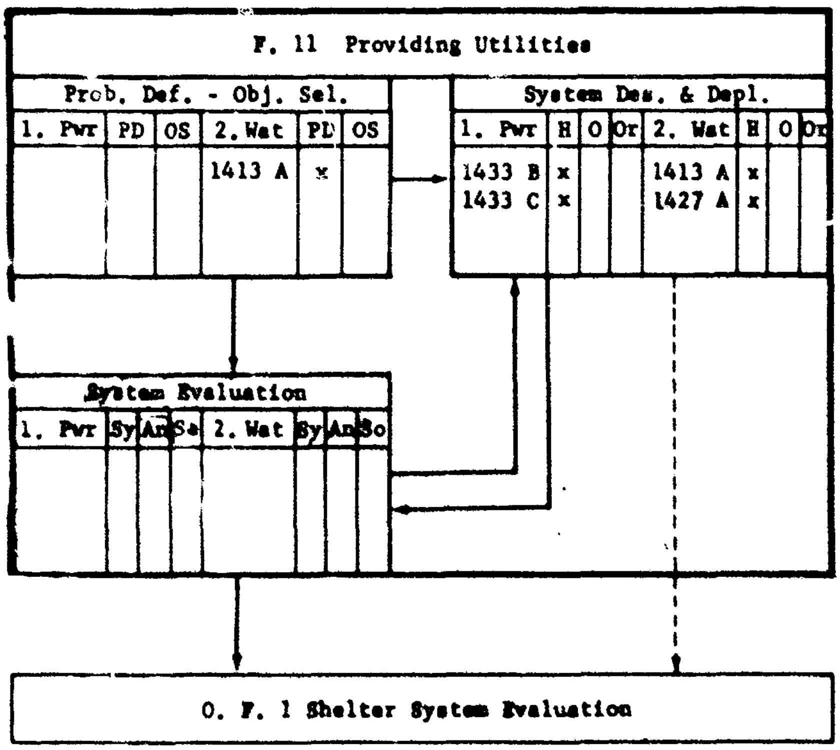
Inj = Treating Injuries
Ill = Treating Illness
Oth = Other

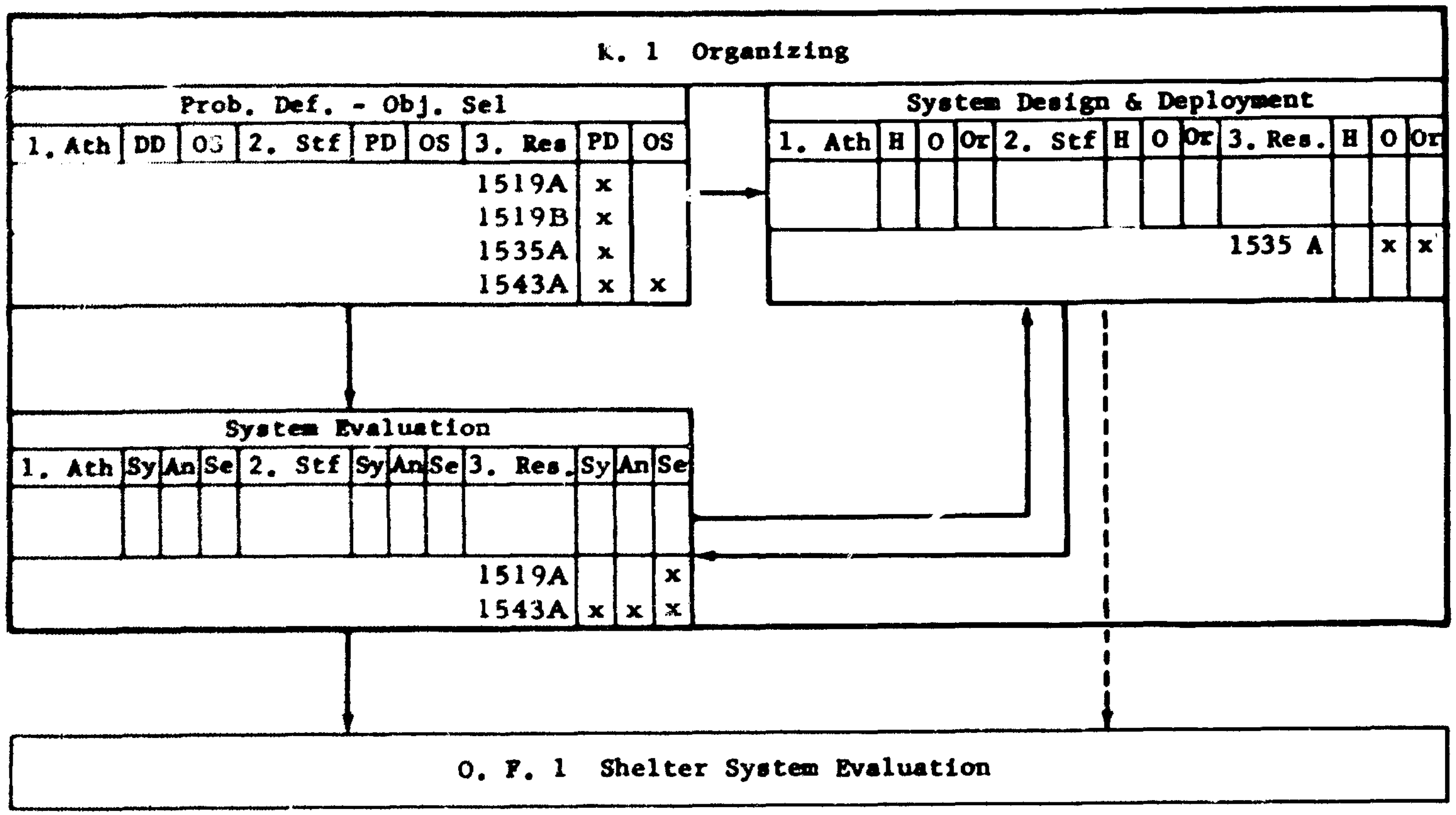
O. F. 1 Shelter System Evaluation

Fir = Preventing and Suppressing Fire
Law = Maintaining Law and Order

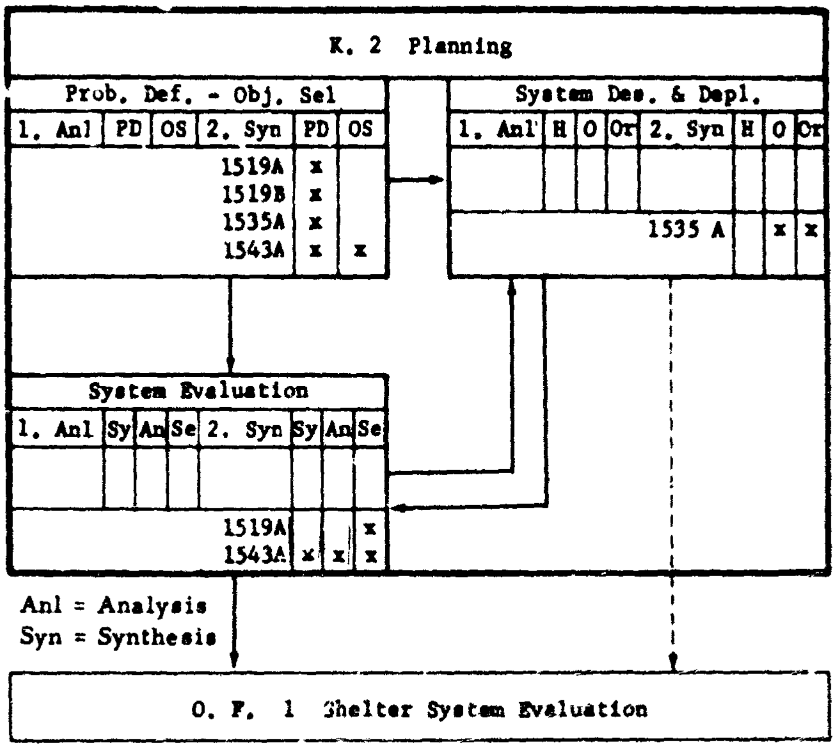


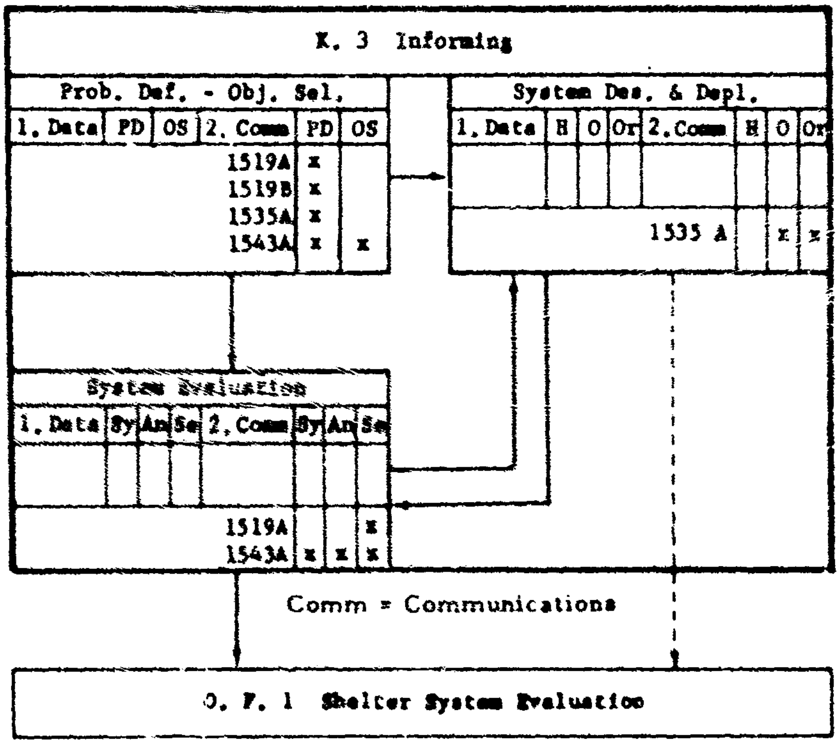
Wat = Supplying Water
Pwr = Providing Electric Power



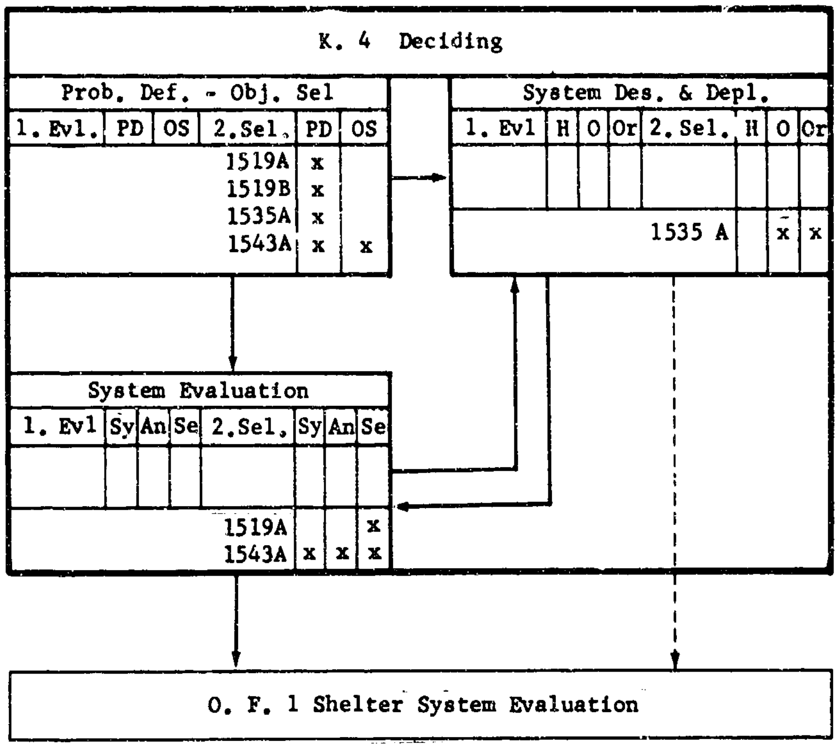


Ath = Assigning Authority
Stf = Staffing
Res = Allocating Resources

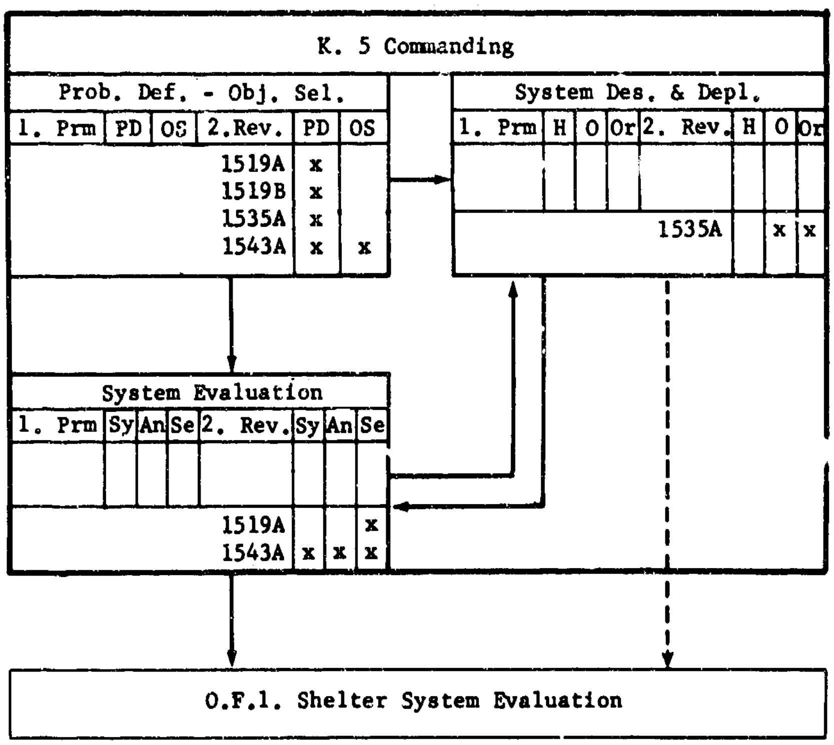

K. 2 Planning
Prob. Def. - Obj. Sel
1. Anl PD OS 2. Syn PD OS
1519A x
1519B x
1535A x
1543A x x
System Des. & Depl.
1. Anl H O Or 2. Syn H O Or
1535 A x x
System Evaluation
1. Anl Sy An Se 2. Syn Sy An Se
1519A x
1543A x x x
Anl = Analysis
Syn = Synthesis
O. F. 1 Shelter System Evaluation


K. 3 Informing
Prob. Def. - Obj. Sel.
1. Data PD OS 2. Comm PD OS
1519A x
1519B x
1535A x
1543A x x
System Des. & Depl.
1. Data H O Or 2. Comm H O Or
1535 A x x
System Evaluation
1. Data Sy An Se 2. Comm Sy An Se
1519A x
1543A x x x
Comm = Communications
O. F. 1 Shelter System Evaluation

Evl = Evaluating Alternatives
Sel = Selecting Courses of Action



Prm = Promulgating Decisions
Rev = Reviewing Results



O. F. 1 Shelter System											
	Prob.Def. Obj.Sel.		System Evaluation				Prob.Def. Obj.Sel		System Evaluation		
1. Blast	PD	OS	Sy	An	So	2. Fall	PD	OS	Sy	An	Se
1623 A	x	x	x	x	x	1631 C			x	x	x
						1517A					x
						1521A					x
						1613B	x	x	x	x	x
						1615A	x	x	x	x	x

O. F/K CD System Evaluation

Blast = Blast Shelter Systems

Fall = Fallout Shelter Systems

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