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B. D. Bradley
R. E. Clapp
R. L. Petruschell

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B. D. Bradley*
R. E. Clapp
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The RAND Corporation, Santa Monica, California

PREFACE

This paper describes the objectives, concepts, and structure of a new Air Force force structure cost analysis model currently being developed by RAND. The need for highly flexible models of this type has been heightened by the maturation of the Department of Defense planning-programming-budgeting system. This system places heavy emphasis on long-range planning and the identification of preferred alternatives for meeting future military needs. The model now under development is intended to materially assist in the analysis of the resource implications of planning alternatives.

Traditionally, long-range military planning has been almost totally concerned with weapons and other tactical systems. Non-tactical activities -- including logistical support -- comprising a very significant portion of the Air Force have largely been neglected. Support has typically been considered either as a function of the weapons, often arbitrarily, or projected on some other equally arbitrary basis. The new model, however, is intended to deal much more meaningfully with support activities *per se*. This includes not only properly identifying support costs to weapons, but also explicitly considering support activities as planning problems.

To provide a setting for the new model, this paper describes the nature of the long-range planning process, the role of cost analysis,

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and some general characteristics of modeling. The concepts underlying the model and their application in the analysis process are also discussed. Among these are the concepts of alternative planning end products (including support activities), fixed and variable resources and costs, incremental resources and costs, identification of investment (one time) and operating (recurring) costs and the use of generalized estimating relationships.

The selection of an appropriate cost element and program element (end product) structure, the framework of the model, is a critical step. Considerable attention is given to the description and rationale of the proposed framework, particularly the use of organizations as key building blocks. The paper also discusses how the framework will be used to guide the research for the model and ultimately serve as the primary output format. A key idea is the way in which the resources and costs, and the factors affecting or generating them, are to be identified within the framework.

Planners seldom state their problems in terms directly amenable to cost analysis; hence, the model must accommodate to both planner and cost analyst. The paper describes how this is to be accomplished through the use of submodels and discusses some of the corollary benefits of this approach.

INTRODUCTION

For more than a year, the RAND Cost Analysis Department has been laying the foundation for a new force structure cost analysis model. In keeping with RAND's interest, the model is to be oriented toward the long-range planning process: a tool for estimating resource requirements of proposed future alternative forces. The reasons for building a new force structure model are numerous and diverse. Some stem from a desire to improve and update our estimating technology; others reflect the new environment set by the Department of Defense programming system. Fundamental, however, is the belief that an increasing number of planning studies should be done in the setting of force structure analysis. It is futile to speculate on the cost of a new proposal without assessing its expected interaction with other Air Force activities. Too often planning studies are completed without full reference to the force in being, leading to distortion in both cost and effectiveness calculations.*

We have also come to the belief that both long-range planners and cost analysts should broaden their perspectives in dealing with non-tactical activities. Typically, support costs have been regarded as a necessary evil in examining alternative weapons. Support is often arbitrarily treated as a function of the weapon, occasionally is neglected entirely or perhaps projected in a proportional or level-of-effort fashion. It is important to the proper evaluation of the cost of weapons alternatives, however, that the attendant impact on support activities be expressed realistically.

Support and administrative activities are infrequently themselves made the subjects of long-range planning studies. Unless directly connected with weapons decisions, non-tactical activities -- including logistical support -- are often neglected despite their demand on Air Force resources. These activities now account for more than half of the currently projected Air Force budget and personnel authorizations. One of the objectives of the new model is to provide a means of dealing more effectively with support activities, either as related to weapons or as direct subjects for long-range planning.

The setting in which this model will be used can perhaps best be established by examining the long-range planning process. For Air Force planning, long range implies five, ten, or even fifteen years into the future. This lengthy time horizon comes about because of the extended lead time typical of most new weapons. Action must be taken

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*Force structure analysis is important for other reasons as well. The Air Force relies upon, and pays for, the military capability of the entire force. Planners must attempt to achieve the most effective over-all mix of weapons and other systems within the limits of available resources. In this context, analysis of individual systems is probably best suited to suboptimization of system configurations or sensitivity analysis. Analysis of individual systems is also useful in establishing their gross requirements as inputs to the broader force structure analysis. Generally, however, the cost of a system alternative can be properly described only with reference to the remainder of the force.

well in advance of anticipated needs if shortages and military "gaps" are to be avoided. Briefly, the task of the planner is as follows:

First, he must determine what his long-range problems are likely to look like. Usually, these problems concern the means of countering an enemy threat. For non-tactical activities, the problem may be the necessity to support the weapons and other tactical systems required to meet the military threat.

Second, the planner must identify the means of achieving the capability needed to cope with the anticipated problems. Typically, there are several alternative means of achieving the desired capability open to the planner.

Third, the planner must make a choice from among the possible alternatives, selecting the preferred course of action. Numerous factors bring about the necessity for choice. These include the military capability and effectiveness of each alternative; their technological feasibility and timeliness; their probable political and social consequences; and, of course, the resources required to implement the alternatives. Calculation of resource requirements or costs is the portion of the long-range planning process with which we are concerned.

If national resources were unlimited, cost would be of little importance in selecting military alternatives. Funds and other resources could be devoted to a number of promising developments, each directed at achieving a single capability. Resources, however, are not unlimited and must be allocated among several competing objectives. The choice of any given alternative carries a cost in opportunities foregone in other areas. In this situation, efficient allocation of the available resources is of paramount importance. Cost analysis is playing an increasingly key role in the planning process. The complexity and growing number of planning problems in which cost analysis plays a part demand broader perspectives and new tools. The new force structure model, and the concepts, techniques and relationships to be embodied within it, is a step toward meeting this demand.

The new model which we are postulating is intended to aid in the long-range planning of force structure proposals and alternatives.

It is to be a device for assuring comparability of estimates among alternatives, focusing on critical resource requirements, so that judgements of feasibility and relative preference can be made. The long-range orientation of the model, and the macro modeling and estimating techniques used for future proposals, preclude all but consistent and relative, rather than absolute, estimates. Physical resources and money requirements (costs) generated by the model will not be substitutes for or rivals to the more detailed, more absolute characteristics of near future programming and conventional budgeting.

Some general characteristics of modeling should also be borne in mind. Models are abstractions -- hopefully reasonably well suited for the problem at hand -- of real phenomena. According to one definition, a model is a simplified, stylized representation of real world events, which is used to gain insight into cause and effect relationships known to exist in the real world.* The "cause" terms in our model are the planners' specifications; the "effects" are the requirements for resources. To make the model manageable, we must select for generalization only those real-world relationships which are central to the purpose and scope of force structure analysis. Relationships not meeting the central criterion, and those too complex to permit generalization and abstraction, will be ignored or treated superficially. To do otherwise would compound our research task beyond manageable proportions.

Model building also tends to focus attention on similarities and common aspects of relationships, rather than disparities of detail. As an example, large groups of Air Force personnel might be treated alike for estimating pay, although obviously each man may have a different rank, skill classification or number of dependents. Similar broad generic characterizations are used throughout the model building process.

Compression of detail is related also to the nature of the planning process for which the model is intended. Planning is concerned with

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*This definition was suggested by Charles Baker of the RAND Computer Sciences Department.

future events and the future is fraught with uncertainty -- technological, military, political, and human. Because of this uncertainty, the most we can expect of our planning estimates -- particularly those for the distant future -- are broad indications, a distinction perhaps between black and white, but not shades of gray. It is not practical to model below the level of uncertainty, and we are usually more certain about aggregates than we are about details.

The uncertainties of the future are joined in the model with statistical uncertainty. Much of the model will consist of statistical relationships and inferred values, each carrying a likelihood of statistical error. These combined uncertainties not only argue against unwarranted detail, they also suggest caution in the interpretation of results. Estimates produced by the model will be indications of the central tendency of a wide range of possible outcomes.

The new model will, of course, be quantitative. In common with all other quantitative models, it will be unable to cope with judgmental factors, except as they are embodied in relationships and inputs. For this reason, if for no other, the model will not generate the same cost or program estimates shown, for example, in the Force and Financial Program; and it cannot be expected to duplicate an Air Staff coordinated position on the cost of some weapon or force. The use of "throughputs" or other artificial devices to constrain the estimates generated with the model is generally to be avoided. One of the major features of a model is its analytical discipline -- the ability to prepare consistent, comparable, and documented estimates for a wide variety of alternatives. This feature is lost when artificial restraints are used unduly and answers are "fudged"; the model then tends to become an expensive typewriter, rather than an analytical device.*

Our ultimate goal is the development and implementation of a highly flexible force structure model, programmed for computer operation. Prior to implementation, however, the model building activity will

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*This does not mean, of course, that the model could not be used to prepare estimates for "fixed budget" force structure analyses; it only means that if a particular force level is unattainable with the given fixed budget, the <u>force level</u> must be modified.

serve a useful purpose itself. The exercise of modeling stimulates the accretion of knowledge and crystalizes both insight and experience. The lack of success often experienced in attempts to improve cost methods has been the failure to provide a unifying device -- a device for defining, guiding, documenting, and communicating research efforts.

The remainder of this paper is a description of the concepts and framework evolved over the past several months to guide the detailed development of the new force structure model. It is recognized from the outset that no single model, set of ideas, or conceptual framework will be sufficient for all purposes or persons. It is hoped, however, that we have provided a starting point from which constructive activity can begin.

CONCEPTS

The development of the force structure model rests on a conceptual foundation fundamental to cost analysis. Although the concepts are not necessarily new, the goal of a broader, more flexible model has led to some novel extensions in their application. Of particular importance is the treatment of Air Force non-tactical support activities.

The objective of a force structure model is to provide reliable resource estimates for the "end products" with which the planner deals. Typically, these end products have been restricted to weapons and support systems in direct support of major military missions -- strategic, defense, tactical, and airlift. Planners are necessarily most concerned with the potential capabilities of weapons, frequently to the neglect of other important activities. Many of the non-weapons activities, however, could and probably should be considered as analytical end products, at least in certain kinds of studies.

As an example, a planner might concern himself with the most efficient utilization of maintenance personnel, equipment, and facilities. During periods of scarcity of high-quality maintenance resources, the treatment of maintenance activities, the related policies, and alternative costs as planning end products could be very useful. It can easily be hypothesized that changes in maintenance policy resulting from such a study would have major implications. Similarly, training and personnel policies, basing schemes, command administration, and numerous other activities could be treated as end products subjected to the analytical rigor too often reserved only for weapons studies.

Supporting the concept of multiple types of end products in the new force structure model is another analytical concept: fixed and variable resources and costs. It is easily demonstrated that large portions of Air Force activities are partially or totally insensitive to weapon system plans or decisions -- that is, they are not primarily a function of the weapons force mix, although some of them may be related to total force size. The insensitive support activities may be regarded as "fixed," relative to weapons decisions. Activities demonstrating a reaction to the same decisions are "variable." Base support manning requirements offer an example of this phenomenon. A significant complement of civil engineers, food service personnel, air police, and the like are necessary for each major air base, regardless of its activity or size. The remainder of the base support personnel "vary" as activity rates and numbers of other personnel are increased or decreased. Transient aircraft maintenance, command administration, and Headquarters USAF, are other examples of activities largely fixed relative to weapons planning and decisions.

These and other support activities are regarded largely as fixed only because weapons are typically the planning end product. With the use of other end products, fixed activities and their resource requirements may become variable. The fixed complement of base support personnel, for example, would be sensitive in a study for which the bases themselves were the end product. It is probable that all Air Force activities are variable to certain policy, managerial or other non-weapons decisions.

Whatever the particular end products, it is important that an appropriate and proper identification of resource requirements be made. "Appropriate and proper" suggests that there be a minimum of arbitrary allocations in determining resource requirements. Support costs, as an illustration, should be attributed to weapons only as they are found to vary with the major weapons decisions. Thus in addition to an interest in support activities as potential end products, we are vitally concerned with gaining better understanding of the relationship between these activities and weapons. The meaningfulness of force planning is heavily influenced by the proper identification of all resource requirements -- for both weapons and support activities.

The kinds of resource requirements with which the planner and analyst must be concerned are time-phased net or incremental requirements. That is, the requirement for additional resources in each future year under study. The determination of incremental resources for alternatives implies that there be a "base case" -- frequently an analysis and extrapolation of the current official Air Force program -- against which the planner's alternatives can be compared. Incremental requirements are determined through analysis of both the alternatives being juxtaposed and the "base case." Explicit recognition is given to: the more important complex interactions of all elements of the force structure and the proposals for new systems or activities; the availability and inheritance of resources freed by force elements being phased out of the force as new elements are introduced; and the timing of the introduction of new force elements. Measures of incremental resource requirements are heavily influenced by the real or postulated characteristics of the base case as of a point in time. The criticality of time and resource inheritance in determining both annual and total (life-cycle) incremental resources negates, for most purposes, the usefulness of "wing slices" or "building block" costs.

The element of time is also crucial to the distinction of the Research and Development, Investment, and Operating phases of a system life cycle. Identification of resource requirements in these categories is often helpful (by separating non-recurring from recurring requirements) in both estimating and analyzing the impact of proposals. While there is general agreement about the meaning of Research and Development, the distinction between Investment and Operating costs present far more troublesome problems. In the economic sense with which we are concerned in long-range planning studies, the following Force and Financial Program definitions are roughly applicable:

Investment: Capital (one-time) costs required beyond the development phase to introduce a new capability into operational use.

Operating: The annual costs required to operate and maintain a given capability for an element (of the force structure) throughout its projected life or operational use.

The Force and Financial Program, however, goes on to further define these categories by budget appropriation. Both the Operation and Maintenance and Military Personnel appropriations are totally defined as operating. There are circumstances, however, when Investment costs would be incurred in these appropriations. Much of the cost of converting an F-100 pilot to the F-4, typically called initial training cost, is represented by instructor and student pay, aircraft fuel, travel, supplies and base maintenance, all of which the Force and Financial Program classifies as Operating. This cost is truly an investment in new capability which should be categorized as such in a study of the F-4. Our conception of Investment and Operating costs is not dependent on budgetary definition, but rather on the timing and economic implications of a proposal. This does not prevent the identification of Investment and Operating costs within each of the appropriation subdivisions as these costs are estimated to occur.

The selection of end products for any given analysis also determines whether a given cost is Operating or Investment. Training provided by the Air Training Command may be an Investment when related to weapons end products; the same cost might be Operating, if the end products of the analyses were the functions and policies of the Air Training Command itself. In the latter instance, improvements in Air Training Command capabilities would be categorized as Investment.

Measures of incremental resource requirements will be generated in the model through the consistent application of estimating relationships. These are statements of how one variable or set of variables affects the requirement for another variable -- cost as a function of manpower, crews as a function of aircraft per squadron and flying hours, etc. Estimating relationships may be classified into two types: (1) those representing known or "actual" values for present systems, often based on accounting or management reports, etc. -- annual civilian pay per CONUS civilian, or fuel costs per flying hour for the C-130; and (2) those which are generalized from current and past experiences for use in broader settings or for extrapolation to new systems -- e.g., determining depot maintenance requirements as a function of aircraft speed, thrust, weight, etc.

Nearly all estimating relationships contain some statistical variance. Fuel costs per flying hour, for example, are merely averages of experience with a wide variety of weather conditions and flight profiles. Generalized relationships are often particularly subject to variance from the "real world," failing to reproduce precisely the sample data from which they are drawn. This variance does not obviate the usefulness of estimating relationships for planning purposes; it only suggests caution in the interpretation of estimates as absolute values.

It was stated that estimating relationships are to be applied in a consistent fashion. Consistency implies that there be a certain regularity between changes in the force structure (or other explanatory variables) and the corresponding estimates. Consistency further implies that there be few, if any, arbitrary changes to estimated values which would diminish their relevancy to the estimating base. If the estimating relationships are valid, arbitrary changes in estimates to attain preconceived or otherwise fixed results are unacceptable. If the application of an estimating relationship yields erroneous results, the relationship itself should be modified or replaced. Only in this manner can the comparability of estimates among alternatives be assured.

FRAMEWORK OF THE MODEL

To complement the major concepts suggested for the model, a framework has been devised as a guide for further research and implementation. The framework consists of end-product program elements and budget-oriented cost elements. It is intended first as an aid to research by defining current Air Force activities, and ultimately as the foundation of the model's output format. Basically, the framework is a general, more aggregative version of the Force and Financial Program (F&FP) structure. A number of changes in F&FP definitions are needed, however, to avoid some of its inconsistencies and peculiarities. Modeling requires homogeneous definitions and a rounding of non-essential differences to permit generalization. Despite some differences in definition, the model framework provides a large measure of compatibility with the Air Force planning-programming-budgeting process.

Cost Elements

The major consideration in establishing cost elements for the model is their relationship to the data base and their usefulness for communication of estimates. A continuing flow of data is necessary to keep the estimating relationships which support the cost elements dynamic and meaningful. Similarly, the elements must be clearly defined and understood to be useful in communicating results. These considerations appear to be best met by utilizing the conventional Air Force budget/appropriation structure as the primary basis for the cost elements.

The budget, with its detailed accounting support, is the most complete and consistent source of financial information. It is relatively stable, and changes from one year to the next usually can be easily traced. The budget structure, furthermore, is generally understood by both the Air Force and Department of Defense planners and is used in the F&FP. The disadvantages of the budget structure for representing and conveying resource implications in economic terms are outweighed by the practical data and communicative advantages.

Cost elements in the model will generally be direct reflections of the budget structure at the appropriation and program level. At the detail level -- materiel programs, projects, and object classes -- considerable aggregation will be necessary to correspond to the level of estimating capability. Final determinations of the specific cost elements to be used and their structure can only be made during the course of research. The development of estimating relationships and the specification of cost elements is a mutual and evolutionary process. Each element, however, will be defined by reference to the budget subdivisions included.

Program Elements

The end-product complements to the model framework cost elements are program elements patterned after those of the F&FP. Our program elements, viewed broadly, are combinations of tactical and support activities, each defined by equipments, organizations, functions performed and geographic locations. As in the F&FP, these program elements are grouped into seven programs* representing the major tactical forces and support functions of the military service.

Three categories of program elements have been identified for all but the Research and Development Program (program element criteria for Program VI have not yet been established). The three categories are Mission, Command Support, and Installations. Each category has a different connotation for our research and each relates to a potentially different planning end product.

The Mission category includes all of the program elements usually identified, by virtue of their major equipment function, as the primary activities of the Air Force. This includes the weapons, airlift aircraft and a few composite activities, such as COIN, which have identifiable tactical functions. The tactical Mission elements are those most frequently of concern to the planner. We have broadened the Mission definition, however, to include the line functions of the major support commands in Program VII. In the main, the Mission program elements will correspond to those in the F&FP for research purposes. The Command Support category includes all of the elements representing command-wide or Air Force-wide administration, command and control, or other support activities relating to the aggregate mission of the particular Program or of the Air Force. Major air command headquarters, bands, special tactical and advanced training

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*I: Strategic Retaliatory; II: Continental Air and Missile Defense; III: General Purpose; IV: Airlift-Sealift; V: Reserve and Guard; VI: Research and Development; and VII: General Support.

activities, and administrative activities are included within Command program elements. In a departure from the P&FP, we propose that electronic ground systems be categorized as a Command activity and that initially several of the individual 'L' system program elements be combined to permit better definition.

The installations category includes the housekeeping and base support functions for each Program. The program element categorization scheme is illustrated in Table 1.

Each program element is defined by its major resources: specific kinds of organizations and personnel, their mission and unit authorized equipment, and for the base support elements, bases and facilities. There are instances, as in the B-52/KC-135 complex, where an organization is included in more than one program element. In these cases, the organization(s) must be statistically divided (perhaps on the basis of direct man-hours, etc.) among each applicable element. Considerable stress is being placed on the use of organizations as building blocks for program elements. Organizations are, in our opinion, the common denominators of much Air Force activity, and are useful indicators, if at times imperfect ones, of functions being performed (Table 2).

Using the Framework

In the research process, the cost element/program element framework is a device for defining and delineating the activities of the Air Force. The framework is oriented to the language and structure of the Air Force as an aid to estimation, documentation, and communication. The key idea in using the framework is to associate with each program element (organizations, actually) all of the costs which it incurs directly; and further, to identify the significant actions, operations, decisions, policies and other phenomena which generate or affect these costs. By concentrating first on costs as they are actually incurred, we can take better advantage of existing financial and non-financial data. Many Air Force data are not directly related to weapons, but rather to organizations or the management of training,

Table 1

CATEGORY/PROGRAM ELEMENT SCHEME

PROGRAM I - STRATEGIC RETALIATORY

Mission

B-52
AMSA
MM
M-X
etc.

Command

Headquarters Support - SAC
SAC Command and Control - SAC
Advanced Training - SAC
etc.

Installations

Base Support - SAC

PROGRAM VII - GENERAL SUPPORT

Mission - Training

Recruit Training
Technical Training
Flight Training
etc.

Mission - Logistic Support

Materiel Maintenance
Transportation and Supply
Procurement and Production
etc.

Command

Headquarters and Command Support - ATC
Headquarters and Command Support - AFLC
etc.

Installations

Base Support - ATC
Base Support - AFLC

Table 2

ILLUSTRATION OF PROGRAM ELEMENT DEFINITIONS

Heavy Strategic Bomber (B-52/AMSA/B-X etc)*

Organizations

Hvy Bombardment Wing
Strat. Aerospace Wing
Medical Group

Hvy Bombardment Sqd
Armament & Electronics Mtce Sqd
Munitions Mtce Sqd
Organizational Mtc Sqd
Field Mtce Sqd
Airborne Missile Mtce Sqd

Equipment

Mission Aircraft U.E.
Unit Support Aircraft
Airborne Missiles
Vehicle Authorizations
Support Equipment (E-AID) Auths.

Base Support - SAC

Organizations

Support Group
Air Base Sqd
Combat Defense Sqd
Food Service Sqd
Civil Engineering Sqd
Supply Sqd
Support Sqd
Transportation Sqd
Consol. Acft Mtce Sqd
etc

Equipment

T-33/T-39/C-47 etc Support Aircraft
Vehicle Authorizations
Support Equipment (E-AID) Auths.

Bases

Beale AFB
Offutt AFB
Malmstrom AFB
Pease AFB
etc

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*Definitions of future system program elements will be developed from the organizations and equipments of current system -- B-52, B-58, etc -- program elements.

maintenance, supply or other activities represented by the program elements. With full knowledge of the characteristics of each program element, meaningful association of costs with planning end products -- typically, identifying variable support costs to weapon systems -- can be more readily accomplished. A "bottom up" approach to identification of costs should also provide a good basis for the non-weapons planning analyses suggested earlier.

The framework program elements for the current Air Force are also the basis for describing advanced weapons or other new proposals. Thus the B-52 program element not only defines the current SAC heavy bomber, it will also be the guide for the AMSA or B-X element in a future force structure. The basic output formats of the model will be generalizations of the program elements of the research framework, plus new proposals.

The research framework should be easily adaptable to output formats for weapon systems, F&FP program elements, or other end product identifications in planning studies. For weapon-system-oriented analyses, all weapons-related (variable) costs of support activities program elements would be identified with the appropriate weapon system program element. For example, base support costs generated by the F-111 would be added to, and displayed with, the direct costs of the F-111 program element. After allocating all the weapons-related costs, the base support program elements (and other support activity elements) would be displayed with the remaining fixed costs. If the base support activities were t objective of the analysis, identification of support costs to weapo... would not be necessary; however, it would be desirable to add in any training, command administration, logistical support or other costs generated or affected by the base support program elements.

The manner in which research is directed -- and the development of estimating relationships -- provides the basis for meaningful identification of cost to numerous kinds of end products. It is likely that for certain studies the end products will be subsets or other modifications of the weapon and support program elements. For example, base maintenance organizations, derived from all other applicable program elements, could be aggregated as an end product. The estimating model, once the basic relationships have been established, is primarily an input-output "accounting" device for the end products.

The model will have a capability for estimating money costs as either total obligational authority required or expenditures. Although the F&FP, and most current planning exercises, deal in total obligational authority, the economic impact of proposed forces is often better described with expenditure estimates -- i.e., the actual drain on Treasury cash.

Computational Structure of the Model

In addition to the cost-element/program-element framework, a number of ideas have evolved concerning the internal structure of the model. Computationally, the model will translate the planner's force structure specifications -- number of squadrons by major equipments, activity rates, etc. - into the terms necessitated by our estimating methods. The structure used in making estimates is usually one geared to total equipment to be procured, by type, bases and facilities, functions to be performed, and other categories which frequently must be recast from the planners inputs. A major function of the model is to make the necessary translations between inputs and operating requirements, and then distribute estimates to the proper program element.

To facilitate this translation, the new model is conceived as a series of semi-independent sub-models controlled by a single integration model. The sub-models will reflect the categories in which estimates are actually prepared: procurement of equipment, manpower, training, etc. With the inclusion of the sub-models, the total framework of the model might be viewed as a three-dimensional matrix, as depicted in Fig. 1. The exact number of sub-models and the form of the integrating model will be determined in the course of the research. Working with individual sub-models should make the task of building a complete force structure model more manageable.

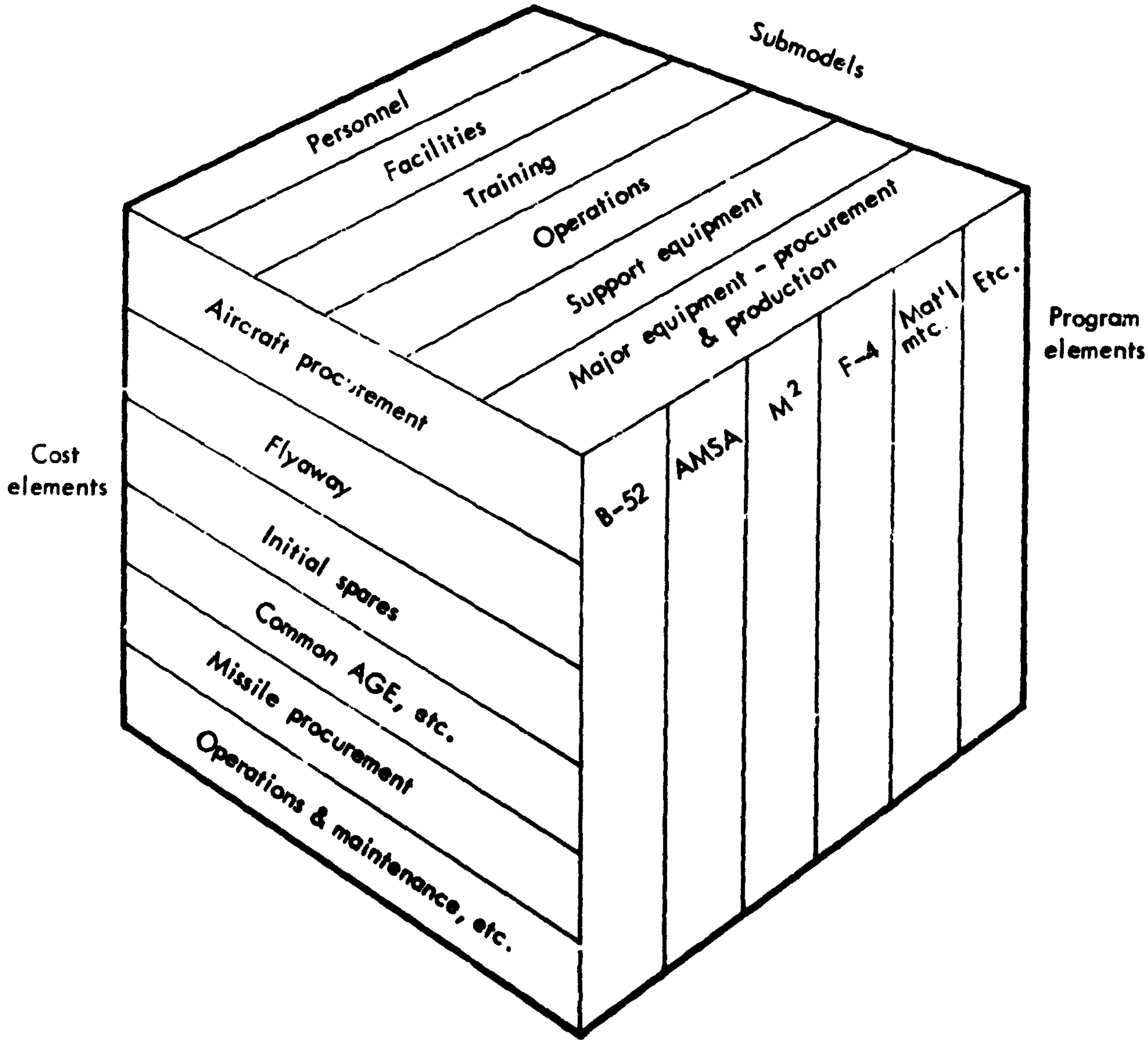

Fig. 1—General framework of the proposed force structure cost analysis model

Semi-independent sub-models offer several advantages for force structure analysis. The reasonableness of a production schedule implied by a force structure projection, the requirement for attrition reserves, or the optimal assignment of equipments between competing program elements could perhaps all be dealt through the use of a procurement and production sub-model. Using subsidiary information produced in each sub-model -- a generalized material annex perhaps, in the procurement and production example -- the planner should be able to do a better job of formulating a proposed force structure. Each major step in the planning process could be analyzed sequentially, thereby avoiding the "impossibilities" that sometimes characterize current force planning. The fundamental idea is that of continuous feedback and operation between planner, cost analyst and model. A related goal is to provide detailed information on intermediate calculations, whenever desired, for closer analysis or documentation.

To make the model as flexible as possible, it is intended to be able to operate on varying levels of input detail. Frequently a planner is able to specify only the broadest outlines of certain elements of his force; other elements (existing weapons, for example) may be stated in much greater detail. The model should have the capability of dealing concurrently with both the broad and the more specific.

The computational structure of the model should be flexible enough to readily accept changes in estimating techniques and relationships. The model should not be a static instrument if it is to embody the knowledge and understanding gained through continuing research, and its design should permit easy response to changes in Air Force organization, policy and operations, or new interests on the part of planners.

A LOOK TO THE FUTURE

The development of the new model, within the framework just described, will be an evolutionary process. Knowledge gained in one area will usually be applicable elsewhere, each step leading to another. Once a broad foundation of knowledge has been obtained, the pace of development will probably quicken in snowball fashion. Although it is difficult to schedule the kinds of development required, the model ought to approach operational form within twelve to eighteen months. Further development would continue indefinitely, at a lower rate of effort, to keep the model timely and increase its sophistication.

Two concurrent efforts are underway in the development of the model. On the one hand, the logic of the computational sub-models is being sketched out, drawn largely from current knowledge. Because of the mathematical and programming complexities involved, this is often a long lead-time process. Work can be profitably begun on the logic of the sub-models even without knowing all of the coefficients for the estimating relationships involved. On the other hand, basic research is being carried out within the cost-element/program-element framework and sub-model structure. This involves, for example, updating and improving existing estimating relationships, and development of new ones. Although neither working effort is truly independent of the other, they provide a convenient division of labor.

To make maximum use of the knowledge gained, sub-models that can be operated independently will be put into use as soon as they are completed. It is expected that some sub-models will be used, on an interim basis, in existing RAND cost models. While enhancing our estimating capabilities, early use of the sub-models will acquaint RAND and Air Force planners with what is coming. The ultimate success of the model is largely dependent upon the understanding and interest which planners have in its use.