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Programming Practices in the Building Process

Opportunities for Improvement

Committee on Improving Preliminary Planning/Programming in the Building Delivery Cycle
Federal Construction Council
Building Research Board
Commission on Engineering and Technical Systems
National Research Council

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1

INTRODUCTION

The use of programming--an on-going process that determines the functional and technical performance requirements of a facility--is increasingly being seen as an effective means to improve the quality and efficiency of buildings. Current programming and related planning activities vary from organization to organization, but the purpose of the process is consistent: to help building users explore options for meeting their facility requirements. Improved programming has the potential to enhance and clarify these options in a timely manner and to provide the criteria by which the facility will be designed and the completed facility evaluated. Although programming may appear to be a discrete phase in the building process, it is, in fact, a continuous process that relates to all activities from planning, budgeting, design, construction, and use of buildings.

Programming services may not always result in new construction or changes to the physical building, but in organizational or managerial changes that achieve the same objectives. More and more organizations are willing to pay for long-term quality improvements in health, safety, security, and functional performance of buildings, and in the satisfaction of building users. As a consequence, specialized programming firms have been formed in the last 10 years to work with in-house space managers and facility managers of client organizations in an effort to specify facility requirements for the present and those anticipated for the future.

There is an increasing awareness in the private and public sectors of the potential benefits of programming when applied to almost any type of building or environment. Programming encourages better communication among the owners, designers, managers and eventual users of the facility. Good communication is particularly necessary for large organizations and government agencies with highly complex and substantial construction programs, frequently consisting of repetitive building types, such as offices, factories, schools, or housing. Programming also provides a better information base for design decision making which can result in better quality buildings.

Programming efforts can range from new construction to adaptive re-use, from interior spaces to outdoor environments, and from small buildings to facility master plans. Public Works Canada and the U.S.

General Services Administration, for example, have undertaken efforts to make programming an integral part of their building procurement.

Government agencies, as large and long-term owners and users of facilities, can benefit from taking advantage of emerging new approaches and opportunities in programming. With this in mind, the Federal Construction Council, consisting of those agencies that design, construct and manage federal facilities, asked the Building Research Board of the National Research Council to form a committee that would recommend potential improvements in programming practices. The committee developed three project objectives. They are:

1. To review existing programming practices and identify strengths and limitations,

2. To discern new opportunities for improving methods and approaches to programming, and

3. To develop recommendations with applicability to both the public and private sectors concerning policy, programming methods and technology, and professional practice.

This committee's work builds upon the findings of two other Building Research Board committees. In 1985 the Committee on Building Diagnostics completed its report that described the emerging field of building diagnostics and linked new evaluative techniques to improvements in programming.(1) Four members of the Committee on Building Diagnostics agreed to serve on the present committee.(2)

A second and ongoing committee is the Committee on Advanced Technology for Building Design and Engineering. Since 1982 this committee has been examining the potential for computer-based technologies to improve the process by which buildings are designed, constructed, and managed. The committee concluded, after a series of workshops, that a computerized integrated project data base to support all phases of the building process would be a beneficial and likely development.(3) Such an integrated project data base, a prototype of which is now being developed under that committee's purview, would enhance programming practices by providing a means by which the criteria and requirements developed in the traditional project specific programming phase could be carried through the entire building process electronically as opposed to manually, as is the case today.

Both of these committees identified opportunities to improve the programming process and each emphasized the growing importance of programming practices in the face of changing building requirements.

The committee's work and this report build upon these opportunities and other new approaches associated with programming. To do this, the report first offers descriptions of programming within the overall planning context and project specific programming. It then examines characteristics of current practices including strengths and limitations. Trends that will influence programming are described and new approaches and opportunities in terms of techniques and technologies are presented. The report concludes with recommendations for specific action to improve programming practices in the future.

The report appendixes present material developed by committee members and federal agency liaison representatives. Appendixes 1 and 2 (in text and tables) cover existing programming practices in selected federal agencies: the Veterans Administration, the Naval Facilities Engineering Command, the Public Health Service, the Department of the Army, the Department of Energy and the State Department. Appendix 3 presents some case examples of attempts to introduce innovations in the building industry, and Appendix 4 discusses the effects of value engineering on programming. Biographical sketches of committee members are contained in Appendix 5.

2

PROGRAMMING IN THE PLANNING CONTEXT

BACKGROUND

While designers always performed a certain amount of programming--not necessarily documented in explicit program documents--programming as a specialized activity in the building process emerged during the 1960s.

Programming was introduced into the literature by Horowitz,(4) Agostini,(5) Wheeler,(6) and Pena(7) who discussed new programming processes within design firms and construction organizations. Later books by White(8) and Sanoff(9) addressed methods of architectural programming. Collections of case studies on facility programming were offered by Palmer(10) and Preiser.(11, 12) The U.S. General Services Administration published a two-part technical handbook for design programming, which elaborated on the process of programming in the governmental context.(13)

Pilot efforts in linking building evaluations (diagnostics and post-occupancy evaluation studies) to feedforward into programming and design guideline literature were undertaken in the 1970s by the U.S. Army Construction Engineering Research Laboratory. There was an attempt to integrate the results of diagnostic studies into a computer-based data base.

Existing programming practices have evolved in recent years from a traditional listing of spaces completed prior to design initiation to a more comprehensive exploration of values, needs and requirements underlying the intent of the facility and examined at various stages in the building process.

Programming is normally a responsibility of the building owner. The American Institute of Architects (AIA) standard contract states that "The Architect shall review the program supplied by the owner." An architect or engineer receiving a contract for the design stage may include programming not only as an initial step of that project, but also at key points throughout the project as well.

The same people or organizations may or may not carry out each application of programming during the building process. A government agency may engage programming during budget appropriations planning. An architectural firm may apply programming prior to schematic design. Before a building is occupied, a facilities management group may use programming in connection with the layout of specific interior arrangements. For this reason, programming holds many meanings and involves different methods, each suited for a particular application. This report deals with programming in two areas: 1) programming within the overall planning context, and 2) project specific programming.

PROGRAMMING WITHIN THE OVERALL PLANNING CONTEXT

This area of programming refers to the larger context within which programming operates--those planning functions that affect programming or are affected by it. Planning is defined here as the ongoing process of defining primarily long-term, future missions and objectives and translating them into resource requirements (money, manpower, capital facilities, equipment, supplies, etc.).

In the broadest sense, programming for analysis occurs at four levels: 1) strategic planning, 2) master planning, 3) project specific programming, and 4) resource management. At each level, the process entails both analysis of a problem and synthesis of a solution. Thus, programming is interwoven in all levels of planning to some degree. Table 1 describes the nature of each level of planning activity and the resulting products.

TABLE 1 Levels of Planning

Levels	Description	Products
I Strategic Planning	Missions, goals, strategies -Location, relocation -Markets -Products -10 to 15 year horizon	Qualitative and quantitative needs analysis
II Master Planning	Overall set of needs to satisfy the strategic plan -Cost analysis included -3 to 5 year time frame	Two parts: a) operational master plan & b) facilities master plan
III Project Specific	Scope and requirements for specific project including costs and alternatives -Project term time frame	Programming documents
IV Resource Management	-Design evaluation -Preconstruction evaluation -Fit up -Facilities management including operations and maintenance -Feedback -On-going cycle	Evaluation documents throughout the process

At the strategic planning level, the analysis addresses: What are the priorities? How is the environment changing? The synthesis provides a vision of where the organization is going. Activity at this level seeks a consensus on organizational missions, goals and strategies. The outlook is usually for a long-term time frame with a 10-15 year horizon.

The master planning level is a comprehensive "road map" for a three- to five-year time frame. It encompasses both operational as well as physical aspects. The analysis addresses: What is going to change, grow, shrink, remain stable, or be in transition? Where is improvement possible? What will it require? This level has two subcategories: a) operational master planning, and b) facilities master planning. Operational master planning refers to the organization's responses to strategic plans. Facilities master planning describes the physical requirements to house the organizational needs.

The project specific level of planning involves the delivery of a new building, the installation of equipment, the renovation of an existing building and so forth. The analysis must establish the specific requirements to be met in offering a solution. The synthesis must translate these requirements into a cohesive end result--a description of a particular project with the intent to build that project.

The resource management level includes the day-to-day facility management and operation. The analysis involves how well the facility is working and how to make it work better. The synthesis is the implementation of corrective measures.

A traditional view of these four levels depicts a sequential relationship among them (Figure 1). In other words, closure on the strategic plan initiates master planning, which when completed is the basis for delivering a project that provides a facility for on-going management and use. The great deal of uncertainty and change that private companies and government agencies face today creates inadequacies in this traditional sequential process. A more dynamic process is necessary and emerging.

Such a dynamic process involves the bringing about of fundamental and strategic changes (Figure 2). Greater importance is placed on creative strategic planning. In turn, the organization must address how new directions will alter existing conditions. It is also likely that such "top-down" changes are met with resistance. Often physical planning provides a basis for making the strategic choices visible. Moreover, it serves as a measure of the fit between the strategic vision set by the executive leadership and the interpreted implications of how existing situations will change.

Often the dynamic process encounters two circumstances. First, the strategic plan is constantly changing and may no longer correspond with the master plan, or, second, the master plan simply does not go far enough in adopting new directions. Both circumstances are likely to cause a planning process that cannot achieve adequate closure. This delays the start of project. The result places a greater burden

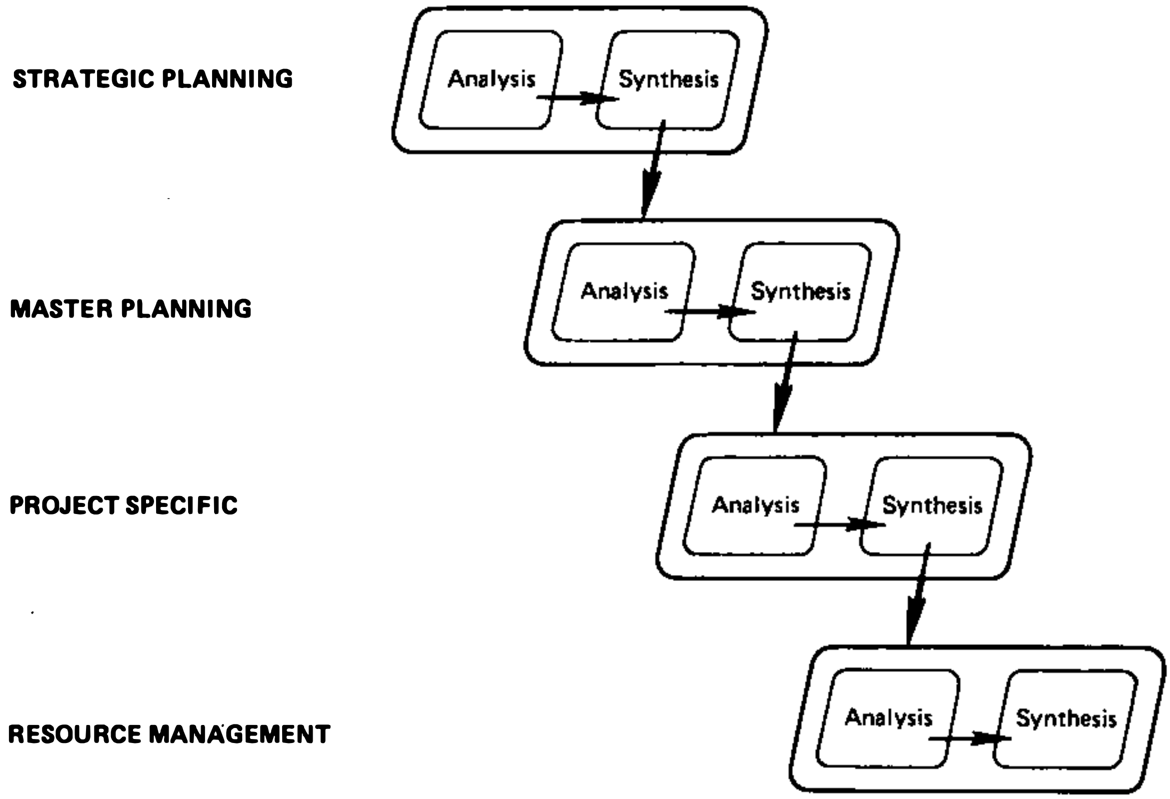

FIGURE 1 Sequential process.

on facility management to act on a "crisis" basis for the provision of facilities. Accommodation is reached given the best available plan.

While this dynamic planning process is less than ideal, it occurs in practice. The challenge, therefore, is the advancement of programming practices that can accommodate high degrees of uncertainty, rapid turn-around, and crisis response. Moreover, it implies that planning is becoming a continuous activity involving people throughout a company or agency. Finally, distinctions between "business" planning and "building" planning are becoming more difficult to make. All of these factors are placing new demands on the process, content and techniques involved in programming.

PROJECT SPECIFIC PROGRAMMING

Given this understanding of programming within the overall planning process, it is possible to focus on project specific programming. The process is very general and has, of course, almost as many variations as there are practitioners.

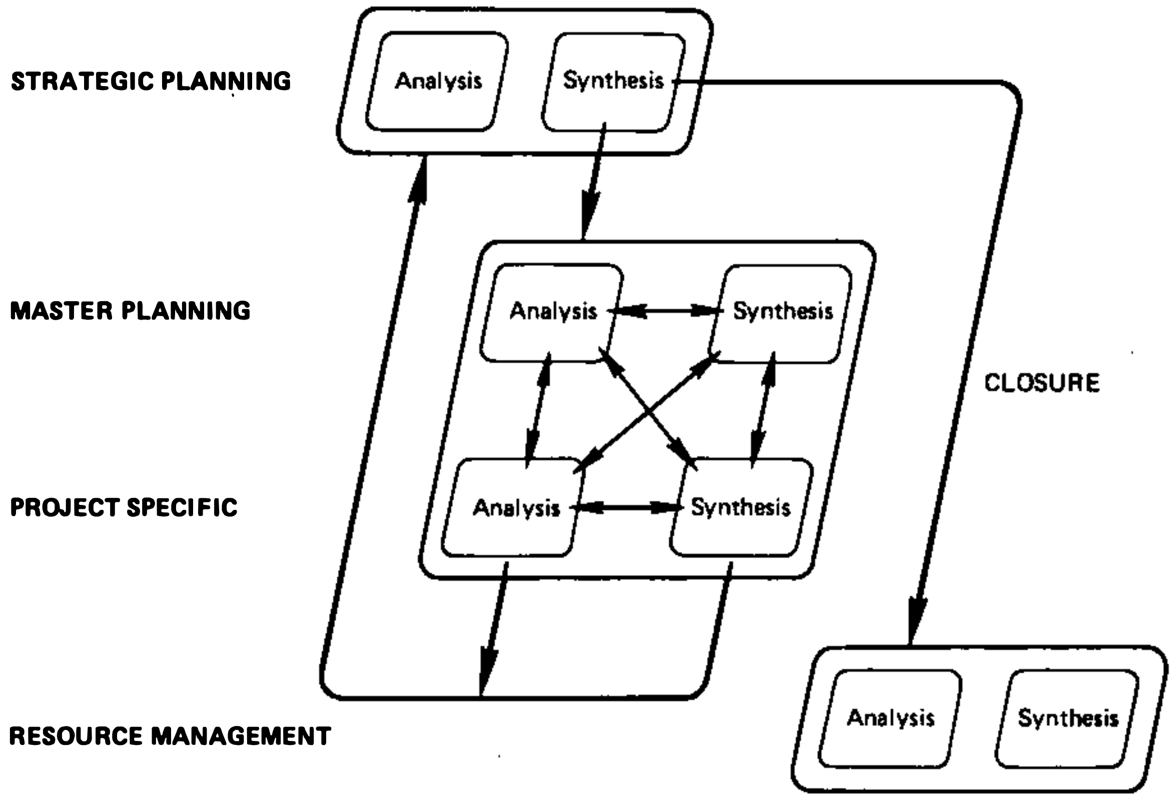

FIGURE 2 Dynamic process.

Project specific programming, in a broad sense, is the process of identification and analysis of a facility-related problem prior to the synthesis of the design of a solution. Descriptions of project specific programming vary greatly from organization to organization within the public and private sectors.* Each organization tailors the process to its own particular building process, project management method, and design philosophy. In the federal construction process the term preliminary planning is commonly used to refer to all of the activities that occur prior to design and construction. During preliminary planning, an agency defines the needs for a project and develops a general description of it.

The intent of project specific programming is to reach agreement and approval of both quantitative and qualitative requirements that will serve as the basis for design. The procedures for reaching acceptance (or consensus) entail the participation by the building

*Programming terms are sometimes used interchangeably depending on the organization and the programming or planning service being undertaken. For simplicity's sake, the committee uses the term programming to encompass all activities that prepare for design decisions to be made in an informed way.

owners and eventual users with design professionals, and the resolution of conflicting requirements or requests. To accomplish this, project specific programming must be a highly communicative process. A valid program balances three aspects: 1) functional scope, 2) total cost, and 3) perceived quality expectations. Trade-offs are often necessary to achieve this balance. Furthermore, project specific programming often encompasses both the determination of present needs, and the anticipation of future needs.

Project specific programming is presumed to occur when: 1) the organizational mission, goals, and strategies have been defined, 2) the operational master plan has been made, and 3) the need for a specific facility has been identified and resources have been allotted for its planning and programming.

The steps and procedures that comprise project specific programming--like programming philosophies themselves--vary from organization to organization. Such variations of programming practices are caused largely by differences in fundamental understandings of what programming should achieve. For example, the committee heard programming described as:

- The establishment of performance specifications for a new facility,
- The documentation of design decisions and their rationale after they are made,
- A process to elicit environmental preferences from building users, and
- A tool for producing a meeting of the minds between the building owner and designer regarding the desirable attributes of the new facility.

These and other understandings of what programming should achieve inevitably influence the specific procedures, content and documentation which, together, translate the program into an action plan and a tangible product.

Most philosophical positions regarding the value and role of programming contain a common theme: the importance of preparing for design decisions, so that these decisions may be made in an informed way. Programming permits building users to make decisions about how they will operate in the facility and about the desired attributes of the facility.

Programming practices can be divided into three major phases: 1) initiation phase, 2) conducting phase, and 3) application phase.

Initiation Phase

The initiation phase involves preparation for the programming effort and may include activities such as confirming the feasibility and advisability of the project, orienting the building owner to the programming process, orienting the programmer to the project, reaching agreement about ground rules, responsibilities and decision making, collecting and verifying programming work already done, determining who are information providers, and planning for data collection from building users. Activities in the initiation phase inform the programming process and render it more productive and effective.

Steps in this phase include:(14)

1. The organizational goals and objectives of the building owner need to be obtained and documented, whether they are formal, informal, or personal. Frequently, difficulties exist in obtaining stated goals and objectives, and inferences will have to be made from existing operations. Further, pertinent constraints such as codes and regulations need to be analyzed.

2. Organizational objectives are translated into functional needs of the organization. Usually, department names and breakdowns of organizations reflect the major functions they are designed to serve.

3. Functions of organizations are further broken down into activities or programs that need to be spatially accommodated. Activities refer to specific work processes that take place in specific activity settings or work stations.

Conducting Phase

The conducting phase follows the above preparation and is the heart of the effort. It normally involves activities such as the collection, organization, analysis and documentation of information, verification of collected data, search for information relationships and conflicts, testing of critical relationships such as project scope versus quality and budget, extraction of design implications, and review of the total informational picture for an understanding of the overall project.

Steps in this phase include:

4. Performance requirements and environmental criteria for each activity setting are formulated.

5. Adjacency requirements and a schedule are devised in order to establish priorities and trade-offs concerning space utilization.

6. Designation of spaces occurs after all activity settings with appropriate space estimates have been compiled, thus providing the first gross area estimate.

7. Options for different program resolutions for the functional needs are presented, usually tied to time phases and cost considerations. These may involve no-cost solutions (e.g., exchange of existing furnishings or donated labor and goods), medium-cost solutions requiring some capital expenditure (e.g., painting or remodeling) and high-cost solutions requiring major investment (e.g., structural changes and additions to existing structures or entirely new buildings).

Application Phase

The primary objective of the application phase is to insure that a program is implemented in such a way that its original intent is fully realized. A way to achieve this objective is effective reporting and communicating of the program thrust and elements. A further important aspect is the need to review carefully the ramifications of a program throughout the building process in order to assess shortcomings and benefits of programming.

The application phase often overlaps with the conducting phase and may include editing and rewriting, discovery of information gaps, manuscript review, development of graphics, production of camera-ready copy, comprehensive final review, transition to schematics, printing and distribution of reports and making presentations.

The application phase includes these steps:

8. Reporting programming results,
9. Reviewing programming results, and
10. Planning actions based on results.

Program Reports

Program reports typically contain common elements including a project overview, project context, detailed project requirements, project budget and schedule, summaries, and conclusions.

The project overview includes an overall description of the project, definitions and methods, and organization of the report.

The project context typically consists of a survey of the building type, project history, owner philosophy and goals, overview of the owner's operation, building occupant profile, reference to applicable codes and regulations, and a site analysis.

Detailed project requirements include data about the divisions, departments and specific areas to be included in the facility. Typical space information contains space name, space size, number of each, critical dimensions, furniture and equipment, space use schedule, adjacency requirements to other spaces, and technical and environmental requirements such as lighting, mechanical, acoustics, security and image.

The project budget and schedule document the cost and time constraints.

Summaries contain similar kinds of information from the detailed space requirements (occupancy, activities, technical systems) organized for easy reference.

Conclusions include key project issues, overall project mission, recommendations and alternatives. The summaries and conclusions serve to organize the program information for design and other kinds of decisions, and they frequently stimulate new iterations of the programming effort.

3

CHARACTERISTICS OF CURRENT PRACTICE

The committee reviewed programming practices within both the public and private sectors and concluded that there are basically few differences between public and private practices. One of the committee's original tasks was to examine existing practices and then to compare and contrast the public and private sector approaches. With the assistance of the federal liaison representatives, the committee reviewed programming practices in the Army, Navy, Veterans Administration, Food and Drug Administration, Department of Energy, Department of State, and General Services Administration. Committee members provided expertise about private sector programming practices. Appendixes 1 and 2 give examples of selected programming practices.

There are certain characteristics of programming that can be generalized as indicated in the questions below.

Who carries out Programming? Programming is undertaken by at least three types of entities: 1) individuals and groups within the building owner's organization, typically associated with facilities management and space planning, 2) individuals or departments within architecture, design and planning firms, and 3) individuals and groups operating as independent specialized programming consultants. In some projects programming is carried out without the involvement of the eventual users of the facility such as in speculative housing and retail space. In other projects programming occurs with the involvement of prospective users, particularly in institutional facilities such as hospitals, senior centers, and schools. Programming may also be undertaken through simulation and gaming in cases where no precedent exists for an innovative building type.

What types of programming are carried out? The answer depends upon the time frame within which programming occurs. Programming can be short-term, with immediate paybacks for the purpose of rehabilitation or the optimization of facilities. It can also be long-term, relating to strategic planning or master planning of organizations and their facilities.

Who pays for programming? The building owner's organization usually pays with specially earmarked "advance planning" or programming funds, especially in the public sector. Special funds are also provided by interest groups or private organizations such as those in the health facilities field to generate programming guidance for new or innovative facility types.

What is being programmed? Programming may extend from the level of an entire facility (such as a military installation) to a complex of buildings (such as a hospital) to a single building and all the way to the level of individual rooms or spaces (such as an office). Each of these levels of scale requires a different degree of specificity of detail and information to be programmed. At times programming extends beyond physical facilities and concerns items such as financial programs, organizational growth and management, and staffing efficiency.

How are the results of programming documented and communicated? Programming results are often documented and communicated through written reports as described in Chapter 2. Programming also uses graphic communication techniques (graphs, tables, charts, flow diagrams, bubble diagrams, and so forth), as well as simulation techniques, such as computer graphics and video tape recordings.

The formats and methods of documenting programmatic material also tend to differ between the public and private sectors. The public sector uses predominantly written and numerical formats. The private sector uses (in addition to written and numerical) more verbal and graphic formats. Graphic formats offer certain advantages including helping decision making, addressing conflict resolution, providing clarity of meaning, and fostering creative thinking. Some forms of documenting and reporting are best suited for problem solving in the design phase while other forms are more appropriate for managerial activities.

What is the cost of programming? Programming costs can be roughly identified by three arbitrarily defined levels of effort. These are based on the process model developed for post-occupancy evaluation.(15) They are:

1. Indicative/ballpark-type of programming to arrive at rough, first estimates of space needed and associated costs,
2. A detailed programming effort that encompasses the entire facility and surrounding parameters including the site, overall spatial organization, and relationships of building parts to the level of rooms and their respective programming requirements, and
3. Programming that requires research to be carried out, for example, in establishing the programming requirements for entirely new types of facilities and their associated technologies such as the programming and design of space stations or settlements.

DEGREES OF PROGRAMMING SOPHISTICATION

Four degrees of programming sophistication are discernible by the following factors: 1) analytical techniques applied, 2) the scope of management services and the programming team, 3) the nature of the problem, 4) the nature of the research, 5) owner organization structure and decision making, and 6) user involvement.

First Degree of Programming Sophistication

This application of programming consists largely of the traditional architectural services in which the programmer merely organizes the data received from the owner, adds site analysis, and tests the simple economic feasibility of the project. The data are sufficient to formulate a statement of the design problem.

The programming process addresses two levels of detail corresponding with the phases of the design process: schematic design and design development. First degree programming leads to the design of a simple, perhaps single, building--usually a familiar building type.

A programmer inexperienced with the owner's building type needs to obtain a general understanding of requirements through library research, or a survey or tour of similar projects. This background will improve communication with the owner, and help the programmer understand the nature of the design problem.

The owner is the central decision maker and is also the user. The owner is an active, working member of the team.

Second Degree of Programming Sophistication

The two-phase process may become a three-phase process on projects that require a master planning phase as well as schematic design and design development phases. The idea of providing the appropriate information for each phase still applies.

The programmer begins to provide consulting services to lead the owner through the decision-making process. The programmer takes the leadership to develop the program, provides most of the information through extensive interviewing, statistical analysis and long-range projections.

The expanded scope of this degree of programming may introduce the computer as an analytical tool. Some early computer applications include: 1) generating space requirements, 2) manipulating the space inventory, 3) analyzing functional affinities, and 4) conducting sophisticated economic analysis.

Second degree programming deals with a complex building group. The programmer must have specialized knowledge in the building type with extensive experience as a background for space parameters. Past experience will be useful in testing functional and organizational relationships and concepts, and in understanding the implications of the organizational structure.

The programming team becomes more interdisciplinary. Specialists are needed to deal with problems in analysis and with complex functional organizational requirements. The implication of program alternatives for capital costs and longer term financial feasibility are examined.

The owner is still the final authority in decision making. Characteristically, the owner in this level is a multi-headed group in which the owner is not necessarily the building user. The user group may be comprised of several groups with conflicting interests in which case it is helpful and sometimes necessary to negotiate (through working groups or other means) resolutions.

Third Degree of Programming Sophistication

Third degree programming is still directed at a specific building project; however, there are generally many more issues to be resolved before developing the program. The analysis includes a survey of existing operational and functional plans as well as management activities concerned with the efficient operations of the organization.

The management of the programming team becomes a major aspect at this level--the organization of work, the logistics of trips, the preparation of presentation material, and the timing of critical decisions to permit work to progress without recycling.

This degree of sophistication deals with large, complex projects such as an entire industrial community, a military community or a university campus. The projects involve a full spectrum of building types within a comprehensive master plan. This level of programming will probably remain the exclusive domain of the large, highly specialized practice of multi-company joint venture organizations.

The program development requires experience from a variety of consultants and large volumes of documentation to justify and support decisions and recommendations made by the architect and consultants. Often the programmer has responsibility to develop the program with little or no involvement of the owner organization.

A number of economic analyses related directly to programming alternatives are undertaken at this level of sophistication. This includes investigating the consequences of program decisions on capital costs, life-cycle costs, and measures of productivity.

There is likely to be a very complex administrative organization which processes approvals between the owner and the programmer. In some cases, however, high-level decisions are made unilaterally by corporate executives or governmental administrators. While the building user group may or may not be involved in the approval process, the programmer must create a model of the user organization and a profile of the characteristics of the user group.

Fourth Degree of Program Sophistication

This application involves urban problems and, therefore, the major considerations of function, form, economy and time are expanded to include political considerations. Involvement by the programmer is at the bureaucratic level where planning problems are co-mingled with political issues and power struggles.

Fourth degree programming deals with a whole series of loosely connected problems in urban development. These problems are not always facilities oriented such as in the case of publicly financed projects in which the planning and design of the facilities themselves are secondary to the larger issues of land location, financing, and public acceptance. Research must be extensive for the recommendations to withstand public scrutiny.

This level of programming is an area for firms of all sizes involving all types of publicly funded building projects and for programmers with a strong sense of public service and a high tolerance for the bureaucratic process.

Decision making may put all logic aside for public image and expediency. The structure of this complex owner would indicate more conflicting values, longer funding schedules and public presentations involving advocacy groups and other bureaucratic organizations.

STRENGTHS AND LIMITATIONS OF CURRENT PRACTICE

Public vs. Private Sectors

While distinctions between public and private sector programming practices tend to be minimal, there are distinct strengths and limitations of each that were identified by the committee and should be considered in light of the trends and opportunities described in the following chapters.

In the public sector programming is enhanced by the economies achieved through greater standardization and repetition of facilities. In addition, the initiating and approval agencies tend to be centralized resulting in programming practices that benefit from a greater tendency to recognize new trends, opportunities and problems.

A public sector limitation is the prolonged time lapse--two years or more--in the funding process that increases a program's obsolescence. Communication breakdowns tend to occur frequently because of the geographical separation of the initiating and approval agencies, and the using agencies in the field. This can be compounded by administrative fragmentation.

The private sector strengths lie with its greater ability to try novel solutions. Whereas the financial resources in the public sector are allocated to achieve a mission, the private sector tends to place emphasis on return on investment as the basis for resource allocation.

Limitations of the private sector approach to programming chiefly concern the limited sharing of data and knowledge with other companies.

Programming as a Discrete Activity

Many of the problems or limitations of current programming practices stem from the fact that programming is often viewed as a discrete front-end or preliminary stage in the building process, in which requirements are set out in isolation from subsequent knowledge and tradeoffs of funding, design, construction and use. Programs are too often viewed as definitive documents rather than as on-going processes of discussion, negotiation and decision making (that are, however, brought to closure at the proper time). The same program documents often serve a multitude of quite distinct purposes, from funding justification through design requirements and evaluation criteria.

Long-Term Intent

Programming at the master planning level involves understanding and developing very general, long-term criteria to establish location, size, and general characteristics of a facility before producing preliminary budgets and analyzing alternate options. Project specific programming that follows further develops requirements for a fuller set of design criteria. A detailed interior program is generated later in the process, the purpose of which is to produce a basis for detailed space planning and interior design. Paradoxically, certain micro-scale issues must be addressed in the earliest master plan program in anticipation of the types of workplaces and space standards to be housed over time.

A general lack of understanding concerning the linkages between this series of programming efforts is an underlying weakness in the current process. Many programming practitioners develop the detailed program initially, generating much unnecessary, even confusing, data and possibly by-passing an investigation of long-term intent.

The Programmer and Obtaining Data

One of the inherent weaknesses in many programming efforts is the insufficient training of the programmer and the propensity to accept data as finite and unchanging.

The first step in programming is to obtain and document organizational goals. This presumes some interaction between the programmer--whether in-house or consultative--and the key decision makers, and an attempt on the part of the programmer to obtain management's organizational goals. This step can be seen as an example of data gathering practice in general.

Obtaining these data should, on the face of it, be quite simple if the organizational plan was finite and static in response to a finite and static set of corporate goals and missions. However, this is almost never the case. In fact, in any modern, dynamic organization markets change, goals change, technology changes, and none of these is controlled by corporate management. Quite often, when new facilities are being considered, it indicates possible changes in organizational goals.

The result is that organizational goals must be understood by the programmer--not simply obtained. The programmer is dealing with knowledge and insight, not just data. This raises the question: who obtains this information and how? In practice, the answer ranges from a response to a written questionnaire to a "factual" question posed by a programmer, or a probing analysis of senior management goals and intentions by a senior analyst knowledgeable about organizations and buildings. The key is for the programmer to understand not only the particular organizational plan but its underlying strategic rationale so that the criteria eventually developed reflect the potential for change and future responsiveness.

Standards

An important step in the data acquisition phase of programming is to translate goals into concepts. This must be a joint effort on the part of the programmer and the owner. This step raises the issue of creating standards for the project specific program. In theory, the specific project program should draw from an existing set of established standards of space and equipment allocations for various functions.

In practice, it is rare that programming standards exist. If standards do exist, it eases the task of programming and decision making. However, in a world of rapidly changing technologies and work habits, it is doubtful that standards will be applicable to a new and perhaps somewhat different set of functions. If there are no standards for a particular project, they must be developed and, given the urgency of many projects, this means a hurried and limited analysis of environmental options. Ideally, a data base should exist, be accessible to all large multi-facility users, and be updated as information for new projects becomes available. This could become the basis for a feedback and evaluation system.

Projecting Future Needs and Changes

After data are organized, the "ideal" requirements are compared to existing constraints. This is not a simple tally of space needed versus space available; it is a complex task of evaluating the quality and cost of existing real estate in its present condition and as it might be transformed. It is a task of projecting the organization's future needs into proposed buildings, exploring costs and comparing those costs and descriptions against the advantages of other alternatives. Should the organization build anew, renovate, move, or demolish? This phase may require appraisers, architects, engineers and real estate professionals acting to help analyze programming options.

A major area of programming concern arises here. It is the issue of projecting future needs and future change. The professional programmatic response to this challenge ranges from disregard to obtaining a statement from the client regarding finite, "verified" growth patterns. The problem, of course, is that no one can foresee the future accurately. Forecasts are frequently inaccurate. The programmers' response to this should be to understand the potential for growth and change, and to perceive this growth as a range of variable probabilities that becomes an intrinsic part of creating criteria for a responsive facility. The programmer must then help the building owner and other professionals identify alternative approaches and assist in their evaluation.

Ability to Affect Decisions

One benefit of programming is assistance in decision making. This is true throughout the planning and design process but is particularly evident in the approval process. The programmer has the responsibility of understanding the issues and making them clear to an owner to help elicit intelligent decisions. A propensity sometimes exists to simply gather information, tabulate it, and produce it in a consolidated format (this is sometimes referred to as stenographic programming).

A programmer and building owner should have an objective point of view about the appropriate course of action after having studied all the variables and analyzed options. The programmer's point of view should be free from political pressure that can arise in a design firm, for example, where the programming element is sometimes subordinate to the design activity. Where programming is done in-house, there may be a lack of perspective of the world outside the parent organization. Where programming is undertaken by a third party, concerns are raised about program translation and the lack of understanding of design constraints.

Communicating the Program

A common way of passing the programmer's information, insights and criteria to participants in the next phase in the building process is through a written report. Project specific programs are perceived as finite documents with "accurate" data to be written down and handed to a designer for execution.

There are many weaknesses inherent in this notion. Words are subject to interpretation; designers usually prefer graphic symbols. Unaccompanied written reports generally lose their effectiveness quickly. Design teams change through the design process. Even if the initial team understood the program intent perfectly, it is unlikely that later teams would as the program is passed off in subsequent phases.

4

TRENDS

In the future, the following trends promise to introduce new possibilities for programming that will, in turn, influence the processes and techniques of traditional programming.

STRATEGIC PLANNING

Programming techniques are increasingly being applied to a widening variety of planning activities. In the private sector, traditional strategic business planning was predominantly a quantitative exercise--planning for growth. Today, people are planning for change, and techniques that handle qualitative as well as quantitative data are necessary. The transfer of programming techniques that foster consensus reaching, ideation, and graphic communication from strictly architectural applications to business applications can be anticipated.

Federal agencies, irrespective of their mission, can benefit greatly from the application of programming techniques in developing long-range strategies for resource utilization whether the resources are people, money, facilities, equipment or supplies. Properly conceptualized resource utilization plans can reveal weaknesses in organization, infrastructure elements, the misuse or misallocation of resources, and can also identify critical or emergent needs in any of the resource bases mentioned. In the case of facilities, given the difficulty experienced by most agencies in getting funds appropriated for capital improvement projects, it is imperative that existing resources be put to the best use.

FACILITIES MANAGEMENT

Facilities management is an emerging discipline as companies increasingly view buildings and real estate arrangements as strategic assets, and not just a "necessary expense of doing business." As companies and agencies strive for the most productive operation, they must address improvements in the costs of owning, operating and leasing buildings, furniture and equipment. Facilities managers will drive improvements in programming practices and techniques. They will take advantage of building evaluation and diagnostic methods to manage better existing installations, and to pass on lessons learned in the programming, design and management of new buildings and interiors.

Application of programming techniques to the business of managing facilities can also be of great benefit to federal agencies. Management of existing facilities is directly related to long-range resource planning. Current uses of space and facilities can have a significant impact on future decisions regarding that space. Space utilization rates for various categories of occupancy (e.g., office, laboratory, storage, general purpose, or special purpose) need to be closely observed so that timely re-allocation can be made to assure the best use of space. By properly using the space currently in their inventory, federal agencies may be able to reduce the need for future capital outlays for added space.

CHANGING NATURE OF THE PROBLEM

While the content of programming is application specific, the programming process applies to the analysis of many types of problems. An architectural problem encompasses function, form, economy and time. In contrast, for the application to a business problem the content might encompass categories such as environment, task, structure, people, and technology (a classification scheme developed by Harold Leavitt).(16)

In the future, programming methods (qualitative strengths) will merge with systems engineering methods (quantitative strengths). This combination of methodologies will cover the broader domain of capital investment problems, applicable to both public and private sector concerns. Programming will address emerging issues such as worker productivity, factory modernization, and intelligent building systems. Moreover, the traditional first-cost based methods will broaden to include economics of procuring and providing accommodations as opposed to structures. This shift will parallel a trend in the design of buildings from capital expenditures for structures to expenditures for equipment.

INCREASING SPECIALIZATION

Technology is increasing the sophistication of both what goes on in buildings as well as what makes up buildings. Techniques will vary with the level of detail that the process must address, such as strategic, schematic or detailed specification.

The traditional training of many architects is no longer sufficient to address the full range of issues that must be addressed during the programming phase. There is an increasing need for conceptual engineering expertise (especially mechanical and electrical) and other specialists (vibration control, lighting, air cleanliness, environmental emissions, and life safety). It is likely that there will evolve multi-disciplinary programming teams with the programmer as an integrating specialist in information and communication management.

Programming methods and techniques will develop within specialties for addressing particular types of buildings, such as hospitals, laboratories and so forth. This will make it more difficult to standardize programming procedures. Even so, this trend will not preclude general methodologies that are necessary for addressing unique and novel problems. These general methodologies represent the fundamental principles of programming, and will serve as the foundation for the specialized applications.

GROWING COMPLEXITY OF OWNER ORGANIZATIONS

Future applications of programming will take place in the global economy. Corporations and agencies are constructing and managing buildings throughout the world. Foreign-based companies are constructing and operating buildings in the United States. Programming must address multinational and multifunctional organizations. As these organizations become more complex, the demand for effective communication increases, especially when the organization's decision makers are diverse and geographically separated.

BROADENING SPECTRUM OF USER INVOLVEMENT

Programming will require advanced techniques for managing the participation of large numbers of people in the process. This is taking place because: 1) building users are demanding more involvement, 2) companies and agencies are seeking acceptance of fundamental changes in work practices and resource allocations, and 3) as planning focuses more on change, it is important to recognize that innovative ideas exist at all levels of an organization.

CHANGING NATURE OF WORK AND THE WORK FORCE

Many economic and socio-economic factors are emerging that will affect the nature of work and the work force. These should be considered in the programming process for a building if it is to meet expectations when occupied and have the flexibility to respond to changing needs.

State-of-the-art equipment, such as computers and robots, affect spatial and systems requirements and are extending the building use beyond the conventional work day. Capital costs may indicate both this extended use and multipurpose use of space.

Changing family structure and life styles indicate accommodation to needs that may be reflected in both hours and locations of work. Computers make possible the use of home work space supplemental to that of the office. Life style expectations require work accommodations conducive to a satisfied work force, including ease of transportation and access, environmental amenities, and support facilities such as child care and exercise opportunities.

Programmers and planners must be alert to the changing nature of the work force and provide capability for the facility to respond as required in the most efficient manner.

"FAST TRACK" AND PROGRAMMING

Increasingly, developers of many major commercial and institutional properties have relied on a system of simultaneous or overlapping design and build rather than on the more conventional bid process based on completed drawings and specifications. This overlapping system has been termed "fast track" because it operates several activities on parallel (rather than sequential) tracks, and because it has the capacity to save on overall design and construction time. Time savings, however, are not its only potential benefit. Properly managed, a fast-track system allows several phases of design (schematic, preliminary design, design development and construction drawings), each having major segments (architectural, structural, mechanical, electrical), to be developed separately but concurrently. These phases are coordinated with one another and checked against current market prices and availabilities without having to be completely finished. A fast-track system inevitably results in incremental design and cost changes to one or more systems, each of which must be related back to programmatic intent. This system can facilitate an ongoing relationship between design and program rather than delivery of a program at the start with little or no ongoing coordination or continuity throughout the project.

NEW BUILDING TYPES AND PROGRAMMING

Downtown commercial developments have traditionally been single use facilities such as office buildings, hotels or retail centers. The programming and market analyses have been done by separate developers and separate planning and design teams. Over the past several years, there has been a trend towards downtown areas that are more than a compendium of individual buildings and more toward a mixed-use fabric requiring integrated housing, parking, retail, office and hotel spaces and including street amenities and public spaces. San Francisco's recently amended downtown zoning plan is a move in this direction.

The result of this trend towards new building types and programming is that programming professionals must find ways to broaden their capabilities and address the entire potential of a full block or multi-block downtown development, rather than the relatively narrow, single-use, and single-building design challenge. This widening of perspective applies also to the developers of such properties and their other consultants and designers. It is likely that the next decade will see many professional consortia established to address this trend and its design and financial implications.

In addition to mixed-use developments, the growth of other new types of buildings, such as day care centers, various types of housing for the elderly, halfway houses, new types of retail environments, and intelligent buildings are in need of programmers' attention.

5

NEW OPPORTUNITIES AND APPROACHES

Given the existing state of practice and the anticipated trends, the committee identified new approaches and opportunities for programming that will facilitate faster, more economical and better programming practices. The following sections describe some approaches and opportunities for improving programming practices.

PROGRAMMING AND THE INTEGRATED DATA BASE

Approach The Building Research Board's Committee on Advanced Technology for Building Design and Engineering has advocated the development of a computer-based project integrated data base for capturing, storing, maintaining, and retrieving information (intentional, judgmental, and descriptive) developed for and resulting from the building process as it spans the life of a project. This project integrated data base is depicted in Figure 3.

Conceptually, the development of a project integrated data base is to be accomplished by providing to all design disciplines (i.e., multiple users with multiple views) a single accessible data base of specific project information, as well as associative information from other projects and external data bases.

Opportunity The project integrated data base has the potential to make data generated in the planning and programming phase (be it numerical, narrative, graphic, procedural) not just discrete events, usually concluded by a report, but a continuum of knowledge available equally throughout all phases of the building process. In addition, such information would be accessible as a resource for future projects.

The implications for the programming process are far reaching. First, most of the discontinuity of discrete programming practices could be replaced by a continuum of an integrative, evolutionary programming process, enhanced by captured past programming experiences and augmented by building diagnostics and other evaluative feedback. Furthermore, the availability through an integrated data base of this programming knowledge throughout the building process will provide a new set of criteria for analysis, synthesis and evolution of the physical elements to be constructed.

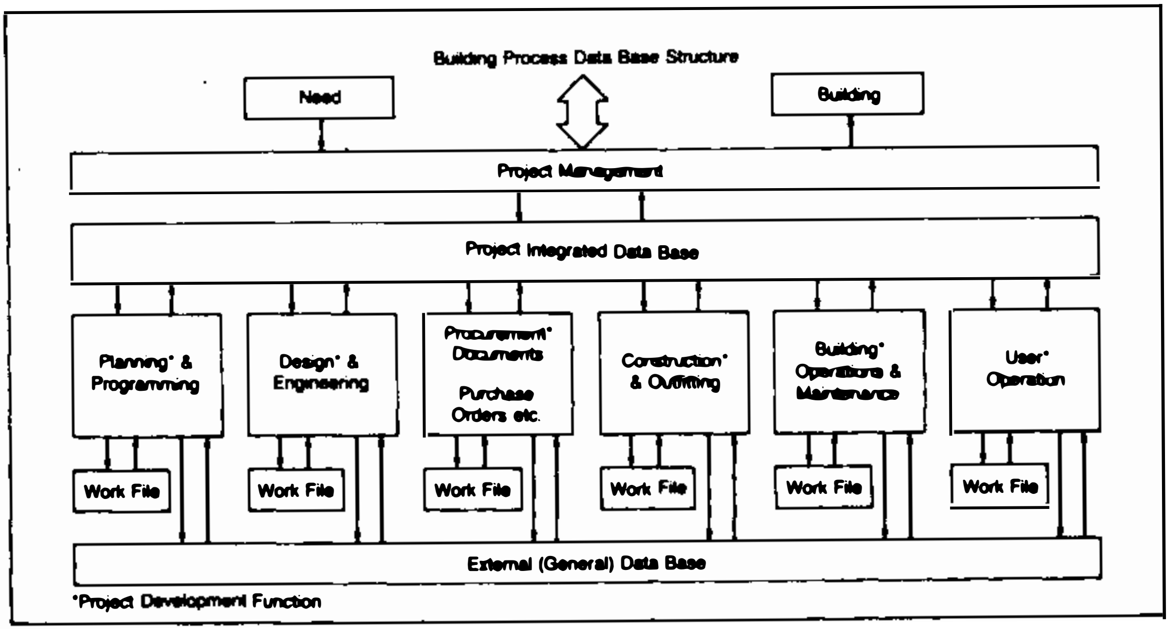

FIGURE 3 Project integrated data base.

COMPUTER SOFTWARE

Approach Computer graphics software is available with population and space forecasting features. These allow the simulation of alternative growth scenarios and make it possible to manipulate and display space demand and space inventory data bases interchangeably in both numerical and graphic formats. Another benefit of computer-aided systems is improved area take-off analysis to obtain parameters (such as area per person) and building efficiency (the relationship between net area and gross building area).

Opportunity Software for personal computers is making financial analysis easier and more practical to use. This encourages more sophisticated analysis earlier in the programming process. It also encourages the consideration of a wide range of options such as lease versus build analysis during the programming phase. Software also is being expanded to include the testing of building forms prior to the design of the building, as well as interior spaces, furniture layouts, as well as lighting distribution and patterns.

COST ESTIMATING SYSTEMS

Approach New computer applications will assist the price performance analysis of emerging building technologies such as the installation of local area networks. These systems will also enhance traditional cost estimating, which should encourage the application of parametric estimating approaches in addition to quantity take-off unit price approaches. This, in turn, will improve the predictability of cost estimates during early preliminary planning stages.

Opportunity New computer services will make data bases on cost and building parameters available and accessible through networks and on-line services. This should encourage the analysis of cost as an integral aspect of programming. It will also provide data on building user groups and building types, providing the potential for more in-depth background research.

BUILDING DIAGNOSTICS

Approach There are close conceptual links between the processes of programming and those of building diagnostics. Both have in common the need for an experienced and knowledgeable person to orchestrate the process. While each of them has instruments and devices which can be used to facilitate the process, it is the involvement of knowledgeable experts that is vital to their conduct.

Programming brings together the knowledge and judgment of experts to develop performance levels, space conditions, and user needs into a comprehensive statement that can be used to design, specify, construct, operate, and maintain a facility. It also can serve as the basis of diagnostic evaluation.

Diagnostics brings together the knowledge of an expert on the measurement of human responses with environmental measurement, testing and evaluation techniques to make a prognosis about the future performance characteristics of a space, a building or its components and systems.

Opportunity When the development of building diagnostics as a technique for building evaluation has more fully matured, and when the use of computer-aided design tools has progressed further, it should become possible to use diagnostic techniques to support programming. The building that is being defined during the programming stage is a "virtual building"--one that exists in the mind of the programmer, or in a computer simulation. It will eventually be possible to perform diagnostic procedures on this virtual building. The prognosis that is made by applying building diagnostics to a virtual building will provide guidance to the experienced programmer in deciding whether or not alternative design criteria should be used. For example, it should be possible to evaluate the performance characteristics of a workspace (with diagnostics applied to the virtual building) being programmed, and from the prognosis of worker satisfaction to determine the impact of revised lighting conditions.

When the building is completed, it should be possible to use diagnostic instruments--remote building sensors, for example--to provide new data on building use and operation. Such data will improve analysis of building performance.

USER INVOLVEMENT IN BUILDING EVALUATION

Approach In a period where building use is rapidly changing and the people who occupy buildings are more sensitive to their physical surroundings, the involvement of building users in planning and managing buildings is essential. The involvement of users should be ongoing, beginning at the inception of the building (during the project specific programming stage) and continuing after it is built and occupied (post occupancy evaluation). Continuous involvement of users after a building is completed is central to evaluation and provides the building managers with information about the degree to which the building is performing according to design specifications. The involvement of the user in the diagnostic process can also be viewed as central to programming for a new building. Many building diagnostics or evaluations today are initiated with the sole purpose of providing input to those who will plan or program another building, similar in purpose, staffing and size to the one that is being evaluated. This user involvement is a key element linking diagnostics and programming.

Although there are several approaches to involving users in the programming of buildings, surveys using self-administered questionnaires have the potential of generating information in large quantities and at reasonable costs. Information covering the thoughts and activities of a large number of users can be obtained quickly and economically.

Several methodological developments in survey research make this possible. First, there is a greater understanding of the use and application of sampling theory in the selection and questioning of building users. Responses from samples of people can provide reliable estimates of the total population. Second, technical developments in the coding and processing of questionnaires have greatly reduced the time between the gathering of data and the point when the programmer can have survey the findings. Finally, the collection of data about the physical environment associated with each user and the analysis of these data in conjunction with responses provide programmers with information about how users are likely to respond to different kinds of environmental conditions.

Opportunity Programming implies looking ahead--feedforward. Evaluation is feedback to modify a design or to improve a subsequent program. Unquestionably, as the constructive use of feedback continues to increase in importance in business and government, programming practices will increasingly emphasize evaluation. It is important to recognize that evaluation occurs throughout the building process, not simply at the end. In fact, the results of evaluation are most useful when they serve as input to the planning and programming phase. In this sense, evaluation occurs at the beginning of the process.

Many of the problems or limitations of current programming practices stem from the fact that programming has been viewed as a discrete front-end or preliminary step in the building process in which requirements are set out in isolation from subsequent knowledge and tradeoffs of funding, design and construction. Improvement in evaluation techniques should enhance the programming process.

COMMUNICATING RESULTS

Approach In situations where there are communication barriers, caused, for example, by language differences, there may be different perceptions and understandings between the professional sector (architects, planners, designers) and the public at large. There are simulation methods and techniques that can present and communicate proposed alternatives and results. This ensures that intelligent judgments can be passed by those who are going to be the users of the proposed project.

Opportunity Methods of simulation using video and modelling techniques, and computer graphics are advantageous in situations where communication between the user and the programmer is difficult, such as in cross-cultural situations in which language forms a barrier. Simulation techniques further permit the programmer to assess the probable impact of proposed facilities on those who are affected by them; for example, modelscope pictures (also moving pictures) can simulate the effects of space and movement through space.

6

RECOMMENDATIONS

The committee makes ten recommendations for consideration by agencies of the federal government responsible for construction programs or that perform research related to buildings, and by interested private sector concerns. These recommendations recognize the lack of institutional support in this field and the need to generate research, disseminate information, and advance the state of the art. As such the recommendations are aimed at process issues (recommendations 1, 2, 3 and 4), techniques and methods (recommendations 5, 6 and 7) and improving the use of programming (recommendations 8, 9 and 10).

PROCESS RECOMMENDATIONS

Recommendation 1 **Broadening the perspective of programming practices.** Federal agencies responsible for the design, construction, and operation of facilities should introduce and adopt programming as an on-going process, the practice of which continues through each stage of the building process. Administrators should review existing programming practices within their agencies in light of the opportunities and recommendations described in this report and should evaluate how time, money, and skilled personnel are allocated to programming activities.

Discussion The committee compared and examined existing programming practices within the private and federal sectors. Liaison representatives provided descriptions of their respective agency practices (see Appendix One).(17) After reviewing these reports, the committee concluded that some form of programming is undertaken in each of the agencies examined. However, the level of effort and the results differ significantly across federal agencies.

In many agencies it is difficult to pinpoint where programming, as defined in this report, begins and where it ends. Terminology differs among agencies and within agencies themselves. Programming is carried out with differing levels of efficiency and success. Programming is viewed, in general, as a discrete, front-end or preliminary stage in the building process in which requirements are set out in isolation from subsequent trade-offs of funding, design, and construction. Programs are seen as definitive documents rather than as on-going processes of discussion, negotiation and decision making. Programming documents serve many purposes--from funding justifications to design requirements. Because of this front-end view, programs tend to deal with certain limited types of information to inform design decisions.

The committee believes that the building process can be improved, and better buildings will result, if federal agencies, as large and continuous owners and users of facilities, take the lead in recognizing the benefits of continuous programming to their respective building activities.

Programming techniques can also improve the quality of strategic planning and master planning activities, as evidenced in emerging practices in the corporate and private spheres (see Chapter 4).

Furthermore, improvements in building quality will result from an ongoing cycle of evaluation through feedforward of the lessons learned into the updating of design criteria for new projects. It is possible that such updating would be enhanced through a computer-based integrated project data base that is readily accessible (see Chapter 5).

Recommendation 2 Evolving programming practices in response to changing context. Government agencies, in cooperation with the private sector, should continue to develop more sophisticated and dynamic programming practices in order to meet successfully the challenges of programming under conditions of increasing uncertainty, crisis response, and rapid change experienced in the building process.

Discussion Programming does not exist in the context of a sequential or linear process. The process is dynamic and iterative with activities--strategic planning, master planning, project specific programming, and resource management--occuring simultaneously (see Chapter 2). While this dynamic process is less than ideal--it often results in crisis management--it is common practice and appears to be increasing in frequency. The committee has identified techniques that may be considered within this evolving context of programming such as: 1) new simulation and communications techniques and technologies, 2) diagnostic techniques to evaluate the program of a virtual building (i.e., before the building is built), 3) programming efforts using a computer-based integrated project data base and other computer software opportunities, and 4) analysis of beneficial effects of programming and post-occupancy evaluation through the entire building process. These and other opportunities are more fully described in Chapter 5.

Recommendation 3 Impact of programming on life-cycle savings. The committee recommends that long-term research be established for a comparative analysis of life-cycle savings for facilities that are built using programming practices and those that are built without extensive programming. The project would analyze costs over the life cycle and the degree of change in environmental quality from a life-cycle perspective.

Discussion It is postulated that the extensive use of programming at the early phases of the building process, and its carry-through across other phases, will improve the quality of the building and result in life-cycle cost savings. The committee recommends that a longitudinal study--similar to those undertaken in the medical fields--be undertaken that examines the quality and costs of programmed facilities from cradle to grave (conception to demolition) including the adaptability for reuse. Detailed computer-based recordkeeping about building performance over time, advanced measurement and diagnostic techniques, and behavioral research methods exist and could be used in this study. The results of this program will yield information about the long-term benefits of programming and provide the accountability for actions taken during the life of the building.

Recommendation 4 **Examine expanded roles of programming.** Given the increasing number of roles programs are playing in the building process, the committee recommends that research be undertaken to analyze and better understand these roles, possibly through a series of case studies.

Discussion As more roles are assigned to the traditional program, it is necessary to understand better the implications of this trend and to learn how best to combine and/or separate these roles which include: programming for funding approval, competitive bidding, quality control, facility management, and educating the building users. The committee concluded that a detailed comparative analysis and comparison of the various roles that programs play in the building process should be conducted. This effort could be undertaken by having government building projects monitored from start to finish to determine the types and magnitude of programming practices used throughout the project's life.

TECHNIQUES AND METHODS

Recommendation 5 **Utilizing new technologies in programming.** A number of technological innovations, which may have beneficial effects on the practice of programming, should be explored and exploited.

Discussion Chapter 5 discusses recent developments in computer modeling, simulation, retrieval, display and communication technologies which may provide opportunities for enhanced programming and interaction among the participants in the building process. For example, video techniques combined with computer graphics are becoming effective tools in presentations to client organizations, as well as in other preconstruction applications, by simulating walkthroughs through proposed spaces. Similarly, moving images of state-of-the-art facility evaluations could be stored on videotape and become retrievable from central clearing houses through remote access via satellite transmission. These are but a few examples of technologies (most of which have been developed for purposes other than programming) that might be put to use by programmers in the future.

Recommendation 6 Linking building evaluation data to programming. Universities and federal agencies responsible for building programs should collaborate on how the results and findings from post-occupancy evaluations and building diagnostics can be incorporated into a data base available to the agencies, universities, and programmers in general. Efforts should be made to establish a repository of data and findings from post-occupancy evaluations and building diagnoses that can be accessed and used as input for various programming activities.

Discussion Programming, as a continuous activity throughout the building process, should benefit from data gathered in post-occupancy evaluation studies, building diagnostic evaluations, and other performance-related activities. Pilot applications are needed to understand this feedback loop. The work of the BRB Committee on Advanced Technology for Building Design and Engineering is investigating the development of a project integrated data base that could use the computer's capabilities to help achieve this feedback loop. This and other efforts should be supported by those agencies that can gain from the experience.

Recommendation 7 Applying improved information-gathering techniques. Federal agencies should take the lead and initiate activities such as workshops, seminars, or training programs to introduce new information-gathering techniques for eliciting facts and ideas from building users. These activities should emphasize information-gathering techniques explicitly related to programming.

Discussion The committee found that new information-gathering techniques are not well understood or known within many federal agencies responsible for building programs. These techniques--many drawn from the research community and from the private sector--are available to elicit information from building users including building users, owners, facility managers, maintenance personnel, and so forth. Techniques range from standard interviewing procedures and sample surveys to more sophisticated telecommunications systems. The proposed activities should focus on collecting data from prospective users at the virtual building stage--before the building is built--as well as gathering data from users of existing buildings.

IMPROVING THE USE OF PROGRAMMING

Recommendation 8 Improvement of linkages between government and educational programs. The committee recommends that linkages be better utilized between universities that are engaged in programming and programming research, and federal agencies responsible for building programs. These improved linkages could involve internships, information exchanges, and personnel exchanges. This could be accompanied by the formation of federal interagency working groups of programmers or those associated with the programming process.

Discussion The committee believes that programmers in the federal agencies, by and large, do not have a clear understanding of the latest practices and techniques in programming. Likewise, students are not as aware as they should be about the requirements and problems faced by government personnel involved in this field. Linkages between government and universities could serve to enlighten and educate both groups. Possibilities include federal agencies setting up internships whereby students could be exposed to governmental practices for varying periods of time. Similarly, agencies could create opportunities for interested faculty to work with agencies in connection with sabbaticals and/or leaves of absence. Another linkage that could be encouraged is the exchange of documents between agencies and universities involved in programming activities. Finally, increased communication could occur by inviting governmental programmers to universities for lectures or short-term teaching assignments.

Interagency federal working groups of programmers could serve as a steering group to develop such linkages. A good model exists with the current Federal Construction Council Interagency Computer User Group program which sponsors periodic meetings, symposia, and conferences.

Recommendation 9 Understanding the education and training of programmers. Given the increasing importance of programming and the growing body of building-related research to which programmers must respond, efforts should be made to understand better what programming training opportunities exist and what courses they entail. A research plan should be devised which considers the purpose, value, methods and anticipated outcome or product of a compendium of current education and training efforts in programming and related activities (such as evaluation). The findings should be shared by all participants and disseminated to all those who program and to those who educate programmers. Of particular importance is the accumulation of information about programming methods, content, criteria and communication methods.

Discussion Two research tasks are suggested in order that those who program and those who educate and train programmers can benefit from a more comprehensive understanding of current theory, similarities to related fields, and relationship to other disciplines. These efforts constitute a first step toward improving the state of programming education and training and could be undertaken by university research groups. They are:

1. Conduct a detailed survey of governmental agencies, schools, corporations and private consultants to collect, compare, organize and present current theory and practice regarding programming methods,

content, criteria and communication methods. (Initial inquiries on this topic were conducted by the committee, but a detailed survey was beyond the committee's scope of responsibilities.)

2. Analyze various disciplines to identify ideas, processes and technologies that may be useful to programming. The study might include disciplines such as management, journalism, law, medicine, physics, chemistry, and business, as well as disciplines concerned with decision-making processes in general.

<u>Recommendation 10</u> **Investigate codification of programming standards of practice.** The committee recommends that a neutral body (such as the National Research Council) undertake an investigation of the need for some standards of programming practices.

<u>Discussion:</u> As an evolving field of specialization, programming involves a number of unresolved issues pertaining to definition of terms and language, legal and ethical considerations, fees and reimbursements, responsibilities of programmers, definition of products to be expected, and professional certification. In light of the increasing frequency and size of court claims, the committee believes that the issue of standards of practice should be investigated.

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APPENDIX 1

PROGRAMMING WITHIN SELECTED FEDERAL AGENCIES

VETERANS ADMINISTRATION

Marvin Spatz

The Veterans Administration's (VA) process for preliminary planning/programming and other aspects of its construction projects is the subject of a recently completed consultant's study, and some changes in the process (and organization) have been recommended by the consultant. However, at this time, no decision has yet been made regarding adoption or implementation of the recommendations.

Several VA organizational elements are involved in the preliminary planning/programming of VA's major ($2,000,000 or more estimated cost) construction projects. They are:

- Department of Medicine and Surgery (DM&S), Central Office, headed by the Chief Medical Director,
- DM&S regions and regional directors, and the medical districts comprising each region,
- VA medical centers (VAMC),
- Associate deputy administrator for logistics,
- Office of Construction (O/C), and
- Controller's Office.

The missions, goals, and strategies for each VAMC are established by DM&S through a Medical District Initiated Program Planning (MEDIPP) procedure. Each VAMC develops a five-year plan, updated annually, that identifies individual proposed construction projects. Annually, DM&S is required to submit to Congress a Five Year Medical Facility Construction Needs Assessment (FYMFCNA), together with a list of the ten VAMC's most in need of construction. Selection of projects from the individual VAMC five year plans, or from other sources, for inclusion in the FYMFCNA and in the list of ten is done by DM&S. The FYMFCNA lists projects and their "guesstimated" costs for the Advanced Planning Fund (APF). The APF provides funding for preliminary development of projects before they have been included and funded in a specific fiscal year construction program.

The APF process most frequently is the triggering device for the preliminary planning/programming effort. It is carried out by representatives of DM&S who prepare a data package that describes the functions intended to be accommodated and their projected work loads and staffing. O/C's Health Care Facilities Service (HCFS) develops a space program based upon application of the agency's space planning criteria to the projected work loads and staffing.

In cases of additions and alterations to existing facilities, HCFS also compares all existing spaces with those which would be provided in accordance with current workload and staffing data to determine deviations (+ or -) from criteria. Thus, the APF, which derives from a list of specific projects, also provides the mechanism not only to determine the viability and scope of a project, but also to take a broader look at the total facility with a view to longer range facility development needs and strategies.

Conceptuals and preliminaries are reviewed within O/C and by the controller's office. The nature of the project, its estimated cost, and its sensitivity determine what level of administrative review and approval is required.

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NAVAL FACILITIES ENGINEERING COMMAND

Robert Myers

Introduction

The planning of facilities for the Department of the Navy is a part of the Navy's process for planning, budgeting, designing, and constructing facilities at Naval bases/installations. This process is mandated at the direction of the Office of the Chief of Naval Operations. The development and maintenance of the policies, procedures, techniques, and quality control of this process has been delegated to the Naval Facilities Engineering Command Headquarters (NAVFACENGCOMHQ), and its six Engineering Field Divisions (EFDs) (Philadelphia, District of Columbia, Norfolk, Charleston, San Francisco, and Honolulu). NAVFACENGCOMHQ and its EFDs provide professional planning, design, and construction services to the various Commands of the Navy.

This section, on existing practices, addresses only the planning aspects of the Navy's overall process of planning, budget, design, and construction.

Background

Planning for Naval installations is performed at various levels. Facilities master plans are developed at the following levels:

- Regional level--all installations in a specific defined geographical area, e.g., the Norfolk, Virginia area,
- Complex level--more than one installation in a specific defined geographical area, e.g., the Naval installations in the Sewells Point area of Norfolk, Virginia,
- System level--specific types of installations, e.g., all Naval ordnance stations, and
- Installation level--one activity, such as the Naval station, Norfolk, Virginia.

The regional, complex and system facilities master plans are prepared on an "as needed" basis. However, the installation facilities master plan is prepared on a six-year cycle. Certain dynamic sections of the master plan are updated more frequently, some on a yearly basis (e.g., the listing of facility requirements, the facility inventory, or proposed construction projects).

Normally, the preparation of a facilities master plan for Naval installations is a joint effort of the installation planner, the EFD planner(s), and an architectural/engineering (A&E) firm. All planning is under the guidance of the EFD. The completed product (facilities master plan) is submitted to NAVFACENGCOMHQ for review before being sent to the Office of the Chief of Naval Operations for approval.

What Is a Facilities Master Plan?

A facilities master plan for the Navy consists of several sections:

- Background (history of the installation, climatology, geology, environmental concerns, historical structures, etc.),
- Mission,
- Assigned tasks, functions, workload,
- Assigned ships, aircraft, personnel (military and civilian),
- Computed facility requirements necessary to perform the mission,
- Existing conditions (land, buildings, structures),
- Existing constraints (natural, man-made, political, budget, etc.),
- Statement of existing conditions as compared with facility requirements (identification of the deficiencies or surpluses),
- Analysis of data,
- Synthesis and development of concepts for full and effective use of existing facilities, disposal of unneeded facilities, and acquisition of new facilities (such as conversion to other uses, building renovations, leasing, new construction, demolition, etc.), and
- Recommendations.

The master plan projects a five to eight year time frame for buildings and structures, and a 10 to 25 year time frame for use of the land. It is important to understand that a master plan for a Naval installation is similar to a master plan for a city, since it covers systems of roads, utilities (power, water, sewer), signage, traffic flow, relationships to the surrounding community, building and structures, facilities relating to airfields, waterfront, offices, housing, industrial shops, warehousing, etc. The master plan addresses the macro level of detail, but develops concepts that result in recommendations at the micro level.

The Process of Planning

The individual techniques of facilities planning vary within the different public sector agencies, within the various firms of the private sector, and between the private and public sectors. However, the steps of the process have a commonality to them that puts the basic logic of the process on common terms between the public and private sectors. Some of these steps may be combined, or perhaps performed intuitively; however, they all are performed.

At the macro level of master plan development, five steps are evident. The description of the Navy's process for planning follows these steps. This process of facilities planning within the Navy begins after establishing the missions, tasks, functions, and workload at Naval Activities and extends to the point where the final construction drawing and specifications are prepared. The five steps are:

Step 1 - Assumptions

1.1 Mission goals and strategies are already defined.
1.2 Organizational master plan is already defined.
1.3 Financial resources already allocated (or authorized).

Step 2 - Data Acquisition

2.1 Obtain and Document Organizational Goals This level of information has already been established by the Chief of Naval Operations and the senior command in the chain-of-command of the installation for which the planning is being performed. The data is readily available to the planners and is provided by the Naval installation and/or the installation's chain-of-command. The organizational goals are presented in a statement of the mission, tasks, functions, and workload assigned and through any other issued policy and guidance. The planner also obtains from a centralized data base official projections of number of ships (by type), aircraft (also by type), and personnel (officers, enlisted, and civilian) assigned to the installation.

2.2 Translate Organizational Goals into Functions The information from step 2.1 is used to identify the various types of functions to be performed at the installation. For example, if the mission, task, function, and workload statement indicate that the installation is a Naval air station with maintenance, training, and housing responsibi- lities, the planner knows that there is a need for runways, taxiways, aircraft hangars, training buildings, office space, barracks, mess halls, etc.

2.3 Convert Functions into Optional Macro-Facility Requirements The information determined in step 2.2 is converted into facility require- ments. This is done through the use of established planning factors (found in NAVFAC Publication P-80, Planning Criteria for Navy and Marine Corps Shore Activities). If established planning factors are not available, then a separate analysis performed by the activity, activity/EFD, or activity/EFD/A&E is performed. Once the list of facility requirements has been determined, the information is entered into a central computer data base, and is referred to as the installation's "Basic Facility Requirements." The data base is accessed at the EFDs and NAVFAC (soon to be available through computer terminals at the installation and its chain-of-command).

2.4 Identify Existing Conditions and Constraints plus Feedback from Other Jobs The determination of existing conditions is a joint installation/EFD effort. All land, buildings, and structures are inventoried and a determination made as to their condition, current use and user, size, and potential future use. This information is entered into the centralized computer data base. All existing constraints (natural, man-made, community, budget, etc.) are also identified and documented.

Step 3 - Analysis and Synthesis

3.1 Organize the Data The data gathered during steps 1 and 2 are organized for further analysis and synthesis.

3.2 Determine the Deviation of Existing vs. Requirement (Need) This is performed through use of the computer and through the planner's input. The information will show, at a macro scale, the runways, taxiways, hangars, etc., and whether there is a deficiency or surplus. This is broken down into more specific data concerning land, buildings, and structures that are affected.

3.3 Identify Alternatives The information determined in step 3.2 is analyzed and synthesized, including using the constraints from step 2.4. This forms a basis for determining whether there is additional land required (or land can be disposed of), what buildings are candidates for conversions to other uses, or have space to accept new uses or users, which buildings are candidates for renovations or demolitions, and what is required in the way of acquisitions (lease or new construction).

3.4 Evaluate Alternatives This step consists of reviewing the various alternatives based on the installation's input, chain-of-command policy, and guidance, budget, time, or phasing impacts, etc.

3.5 Recommendations The recommendations are then quantified and recorded into the centralized computer data base and in narrative form. This completes the master plan.

Step 4 - Review/Approval

The master plan is published in draft hard copy and sent through the chain-of-command and NAVFACENGCOMHQ to the Office of the Chief of Naval Operations for review and approval. Once approved, it represents the five to eight year plan for the installation's use, disposal and acquisition of facilities, both from a macro and micro level. The approved hard copy is then distributed to all interested commands.

Step 5 - Documentation - Specific Design Program

Based on the approved recommendations of the master plan, the installation develops a project submittal for any identified new construction acquisitions. This takes the form of a preliminary project submittal using Department of Defense Form DD 1391. This preliminary DD 1391 is submitted through the chain-of-command and the EFD to NAVFACENGCOMHQ for review and approval. When approved, it is entered into a centralized computer data base referred to as the "Military Construction Requirements List". This data base represents an approved quantity of projects that are used to form the basis for the Five Year Defense Plan for military construction within the Navy. A preliminary DD 1391 contains a narrative of project description, project justification, statements concerning environmental impacts, historical impacts, OSHA, handicapped design, etc. It also contains a site plan and justification from the approved master plan, a cost estimate, and if appropriate, an economic analysis.

At the micro level the steps in project specific programming are as follows:

Step 1 - Data Acquisition and Step 2 - Analysis and Synthesis

These steps are performed through the development of a DD 1391 and facilities study. They form the basis for the user of the facility to make known, at a micro scale, the internal relationships of space, occupants, and special needs (alarms, security, communications, hazardous/OSHA related items, etc.). This is often accomplished under an A&E contract and represents the planning at the project specific level. The DD 1391 and facility study are prepared when the project's sponsoring command decides to support funding of the project. The DD 1391 and facility study are also the documents used to define the criteria and project scope to award a contract for design by an A&E firm.

Step 3 - Review and Approval or Revise

The DD 1391 and facility study form the basis for preparation of budget documents to be submitted to the Navy Comptroller, Chief of Naval Operations, and Office of the Secretary of Defense. The 35 percent design by the A&E and the project details and specifics developed during design often result in further revision or defining the project solution and dollars required. This information is used to modify the final project DD 1391 (budget document) which is sent to Congress for final authorization for construction.

Step 4 - Documentation - Design and User Criteria

This documentation is developed as the design proceeds to 100 percent and the contract drawings and specifications are sent out for bid.

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PROJECT PROGRAMMING/PLANNING IN THE PUBLIC HEALTH SERVICE

William H. Hoffman
Food and Drug Administration

Introduction

Agencies of the Public Health Service include the National Institutes of Health, the Centers for Disease Control, the Food and Drug Administration, and the Alcohol, Drug Abuse, and Mental Health Administration. The Public Health Service as a whole is one of the constituent elements of the Department of Health and Human Services (DHHS).

Facility Needs

Facility needs of the agencies making up the Public Health Service can be the result of a number of factors, not the least of which are growth and change, but, as in the case of the Food and Drug Administration (FDA), the need for capital improvement projects can arise because of the obsolescence of existing facilities or because of inherent facility defects resulting from poor design or inadequate maintenance that has resulted in a badly deteriorated facility. As is the case with most other Public Health Service agencies, FDA has prepared long-range facility plans that are updated periodically and provide a road map to tell the agency where it is now and where it should be heading with respect to the replacement or improvement of facilities.

In the Public Health Service all budget requests for capital improvements, whether for a new building or renovation of an existing facility, must be accompanied by a Program of Requirements (POR) if the project is a new construction project estimated to cost more than $2,000,000 or a renovation project that is estimated to cost more than $1,000,000. A POR is a complex document containing a great deal of information having several purposes. Included among the elements of a POR are the following:

1. Introduction
2. Agency Organization and Operation
3. Space and Occupancy Summary
4. Space Schedule
5. Staffing Summary
6. Architectural Requirements
7. Structural Requirements

8. Electrical Requirements
9. Mechanical Requirements
10. Safety and Security Requirements
11. Miscellaneous Factors
12. Executive Summary

In addition to providing a narrative description of the project, the POR provides a description of the agency program elements to be accommodated and a justification for the project. The space schedule indicates how much net assignable area is to be provided for each organizational entity. The space schedule or directive is usually very detailed and, in combination with the staffing summary, shows all program occupied space and personnel. The space and occupancy summary provides agency management, the Public Health Service, the Department of Health and Human Services, the Office of Management and Budget, and the Congress a good idea of the size of the facility.

Items six through eleven provide what is known as general design criteria. This part of POR lays out for the designer the general desires of the agency regarding siting of the building, some guidelines regarding floor loading, use of demountable partitions, and some general guidelines on the design of mechanical and electrical systems.

In addition to the information developed under general design criteria, a POR may also include specific design criteria. This section of the POR provides information for a given type of space, including electrical requirements, lighting, plumbing, surface finishes, HVAC requirements, etc. This information is usually augmented during design by direct interaction between the design team and the users.

A cost estimate for the project may also be provided and shown in current dollars and then escalated to the midpoint of construction. A projected schedule for design and construction is also included in most POR documents.

Uses of the POR

In addition to providing agency management with information about a given project, the POR provides a detailed description of what is needed, why it is needed, how much it will cost, and how long it should take to design and build. The POR also provides a sufficient level of detail so that it can be used as a basis for fee negotiation between the agency and professional architect/engineers. During the course of developing a POR, the people representing the organizational elements to be housed in the new or renovated space are forced to confront and develop answers for many questions they would otherwise not be concerned with until much later in the building process. By having to deal with some rather complex issues early on, the users gain useful insights into the design process and the limits that must be placed upon their desires so that the space to be provided is affordable.

Design Phase

During the design phase, a triangular relationship among the designer, the agency's project manager, and the agency's program staff (user) is developed to permit direct interface between the designer and users with the agency project manager acting as a controller to keep the project on schedule, within original project scope, and within budget.

Often, the agency project manager will follow a project from inception through design and construction to beneficial occupancy.

Observations

The process described here works reasonably well, except that its success or failure is totally dependent upon getting Congressional appropriations. It frequently happens that several years of work that have gone into the preparation of a POR will come to naught because of funding limitations.

APPENDIX 2

TABLE OF PRELIMINARY PLANNING/PROGRAMMING ACTIVITIES IN SELECTED FEDERAL AGENCIES

In 1982 a standing committee of the Federal Construction Council issued a report, "Preliminary Planning for Construction Projects."* The report contained a table describing preliminary planning and programming activities of selected federal agencies. One of the first tasks undertaken by present Committee on Improving Preliminary Planning/Programming in the Building Delivery Cycle was to ask federal liaison representatives to update this table. Presented here are three updated tables and, in the case of the Department of Energy, one new chart.

*This report can be found in the Federal Construction Council's Transactions of the Federal Construction Council for 1980 - 1981, National Academy Press, Washington, D.C., 1982.

DEPARTMENT OF THE NAVY

Phases of the Planning Effort	Responsible Organization	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design	How Funded
Planning Phase:							
Requirements Development	Local Command	Entered in Automated Data Base	Establishes Facility Needs	Lists required facilities based on mission and workload			Operations and Maintenance
				Uses Navy Criteria found in NAVFAC P-80 or special analysis			O&M
Existing Conditions and Assets Analysis	NAVFAC Engineering Field Division (EFD)	Entered into Automated Data Base and Existing Conditions Map	Identifies and analyzes existing conditions and facilities	Lists facilities inventory including square feet, current use, user and condition			O&M
Plan Development	NAVFAC EFD/ Local Command Assists	Facilities Requirement Plan and Master Plan	Puts in document form, plans for Chain of Command review and use	Establishes existing land use plan and plan to acquire new, use existing, and dispose of surplus facilities and land	Plans Approved by Chief of Naval Operations	100% of project	O&M individual planning
Project Justification	Local Command	Preliminary DD Form 1391	Project description and justification for Chain of Command review and validation				O&M

DEPARTMENT OF THE NAVY (continued)

Phases of the Planning Effort	Responsible Organization	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design	How Funded
Budget Phase:							
Detailed Project Justification	Local Command	DD Form 1391 and Facility Study	Project Description Cost & Scope Refinement for Budget Review	Project description, costs justification and all federally required statements on environment, handicapped access, etc.		100% of individual project planning	O&M
Budget Submission	Chief of Naval Operations	DD Form 1391	Justification of project to the Congress			100% of individual project planning	O&M
Design Phase:							
Project Scoping	NAVFAC EFD	Design Scope Definition	Outlining basic technical and functional facility requirements	Set direction for designer		0-15 Project Design	Planning and Design Funds
Project Engineering Documentation	NAVFAC EFD/ A&E	35% drawing (Construction)	Refinement of cost and scope before submit to Congress	Final Budget Submission and Development of technical design		35 Project Design	Planning and Design Funds
Final Drawings & Specifications	NAVFAC EFD/ A&E	100% Construction Drawings & Specs	Construction bid documents	Complete Construction Drawings & Specifications		100 Project Design	Planning and Design Funds

DEPARTMENT OF THE NAVY (continued)

Phases of the Planning Effort	Responsible Organization	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design	How Funded
Construction Phase:							
Project Construction Military		NAVFAC EFD	"As-builts"	Record copy including field	Final Construction		Construction
Post Review:							
Post Occupancy Evaluation (POE)	NAVFACENGCOMHQ	POE Report on Post Occupancy	To determine suitability of previous design; lessons to be learned; (revisions to facility planning, design criteria guidelines, and acquisition system as a whole)	Lessons learned; recommendations for correction of deficiencies noted in the current project and for future applications.		Post Construction Phase	O&M

DEPARTMENT OF THE ARMY

Phases of the Planning Effort	Responsible Organization	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design*	How Funded
Phase I:	Installation Commander	Phase I Project Development Brochure	To obtain preliminary approval of the project	Outline of project requirements and source data, functional flow diagrams, delineation of facility performance, space requirements, security requirements, etc.	Project Development Brochure is used to prepare DD Form 1391	NI	Operating Funds
		DD Form 1391 (Project Data Sheet)	To obtain preliminary approval of the project	Budget cost estimate plus brief description of the project	Based on Project Development Brochure	NI	Operating Funds
Phase II:							
(Undertaken if project is approved)	Corps of Engineers Field Offices	Phase II Project Development Brochure	To establish criteria for the project for design office (either private AE or Corps of Engineering Office	Functional requirements from Phase I Brochure plus detailed criteria and technical cost guidance		NI	Military Construction Army Funds
		Revised DD Form 1391	To provide justification for the project	Budget request, brief description of the project, justifiation, economic analysis		NI	Operating Funds
Concept Design	Private AE or Corps Design Office	Design Concept	To provide a firm basis final design and for substantiating cost estimates	Drawings and engineering data		35	Military Construction Army Funds

* % of Design means percent of overall effort represented by the document referred to. NI means not indicated.

DEPARTMENT OF ENERGY

Phases of the Planning Effort	Responsible Org.	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design	How Funded
1. Site Selection (Major projects only)	Special site selection team	Site selection study, environmental impact assesment/ statement	Research and documentation for siting decisions	Lists of various potential sites, their attributes and recommendations	Teams usually include both field and headquarters DOE order 4300.13	0	Operating
2. Site Development	Installation/ DOE Field Office	Site Development Plan (SDP)	Short and long range plans for future development and utilization of the existing facilities	Contains: site general information; existing conditions summary; planning analysis; master plan (15-20 years); 5 year plan	Updated annually DOE order 4320.1A. NOTE: most DOE installations are operated by operating contractors	0	Operating
3. Conceptual Design	Installation and A&E	Conceptual Design Report (CDR)	Project scope, feasibility, cost and justification	Concept design, cost and schedule, compliance with SDP, EIA, or EIS	Same A&E may not always be used for final design, DOE order 6410.1	5-15 of total	Operating
4. Project Programming	DOE field offices and headquarters	Candidate project lists (prioritized); short form project data sheets; schedule 44 project data sheets	Project selection and programming; project validation	Project scope and budgetary information	DOE projects are usually funded on a multiyear basis; DOE order 5100, budget manual DOE order 64a1		Operating
5. Project Design Criteria	Installation DOE Field Office	Project Design Criteria Package	Provides the designer with a detailed set of requirements, allows better understanding of project and design requirements; shortens learning curve for the A&E	Project design criteria documents, copies of standards and guides material from the CDR	Normally prepared while awaiting funding and before start of preliminary (Title I) design	35	Operating

DEPARTMENT OF ENERGY (continued)

Phases of the Planning Effort	Responsible Organization	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design	How Funded
6. Project Management Planning	Instal-lation/DOE Field Office	Project management plan, pro-ject charter, project plan	Management of project schedule, cost and technical milestones; sets baselines	Defines management authorities, respon-sibilities and required actions and reports	Required for MSA's and major projects (over 15 million) DOE 5700 series		Operating initially, plant and capital equipment later
7. Pre-liminary Design	Instal-lation/DOE Field Office, A&E	Title I Design Summary	Allows review of scope, economy, design criteria, cost, safety, environmental impact, prior to completion of design	Evaluation of design alternatives, any refinement of design criteria, outline specifications, accurate cost estimates, drawings	Includes a preliminary safety analysis report if not accomplished with CDR	15-30	Plant and capital equipment
8. Defini-tive Design	DOE field office/ installa-tion and A&E	Title II design contract documents	To provide bid and construction documents	Final plans and specifications, detailed cost estimates, safety, health, and environ-mental analyses.	Includes identification of test plan and permit requirements	100	Plant and capital equipment
9. Construc-tion	DOE Field Office or Installation and Con-struction Contractor	As built drawings and admini-strative documenta-tion	Construction administration and design documentation	Design drawings and field changes	Final construction		Plant and capital equipment
10. Test & Evalua-tion, Commi-ssioning	DOE Field Office/In-stallation	Construction completion report, in-spection documents	Ensure compliance with plans and specs; feedback to policy and procedures and future similar projects	Evaluation, real property inventory input, lessons learned, project management history, inspection completions	Includes results of operational checkout		Operating

57

DEPARTMENT OF STATE

Phases of the Planning Effort	Responsible Organization	Documents Developed	Purpose of Documents	Scope or Content of the Documents	Notes	% of Design	How Funded
Early Planning	FBO team composed of an area Operations Officer and project architect	Draft Personnel and Functional Space Programs and Budget Testimony	To estimate size & cost and obtain Congressional approval to proceed	Space program based on user documentation; and estimate budget			Operating Funds
Site Visit/ Feasibility Study	AE, Project Architect	Trip Report	To assemble information	Site investigation, local zoning and building regulations, local building methods, available construction materials, and supply and storage capabilities for materials	Preliminary planning and final design are almost always performed by the same AE firm	5	Congressional appropriation
Preliminary Design	AE, project architect	Plans, Elevations, Sections	To show general intent	Preliminary design submitted	Aesthetics approval given by non-government panel; functional approval by Dept.	100	Congressional appropriation

APPENDIX 3

OPPORTUNITIES FOR IMPROVING PROGRAMMING/PLANNING PROCESS FOR DELIVERY AND USE OF BUILDINGS

THE NATIONAL BUREAU OF STANDARDS EXPERIENCE

Reece Achenbach

In 1969 the Department of Housing and Urban Development contracted with the National Bureau of Standards to provide a set of performance criteria for four types of residential structures ranging from single-family detached to multi-family, high-rise structures. This effort was a part of Operation Breakthrough in which a number of building designers and contractors were selected to build innovative buildings utilizing and complying with the performance criteria prepared by NBS. The performance criteria covered 12 different building elements and the attributes of structural serviceability and safety, fire safety, health, illumination, acoustics, indoor environment, durability, and spatial arrangement for each element, whenever applicable.

The performance documents set forth performance requirements in narrative form, criteria for acceptance, a test method for determining compliance and a rationale for the requirements presented for each of the aprroximately 100 requirements.

A selected team of experts from several federal agencies identified 21 contractors from more than 100 proposed participants in the program. Each contractor was to build a group of residential units (10 to 100) of the design described in the proposal to comply with the appropriate set of performance criteria.

A large team of National Bureau of Standards (NBS) building research specialists prepared the performance documents. A smaller team monitored the contractors' work at two or more steps during construction to compare as-built construction with the intent of performance criteria. Laboratory mock-ups of a number of innovative components were laboratory tested to determine compliance.

It was found that a large number of items were not in compliance with the performance criteria at each of these review periods. The contractors were advised of these deviations and urged to make modifications.

The difficulty for the contractors in meeting the performance criteria in so many details engendered strong negative attitudes toward the performance criteria on the part of the particular contractors and the building industry.

A team of laboratory specialists from NBS was sent out to make an overall determination of compliance of one contractor's buildings after completion. A long list of deviations was identified and recorded.

At this point the sponsor, the Department of Housing and Urban Development (HUD), decided to make no further field inspections and to hasten occupancy of all of the projects because of an approaching Presidential election. It was anticipated that the success or failure of the Operation Breakthrough effort as a whole might be an issue in the political campaign.

Although more than 70 innovations in building materials, components, and assembly procedures were developed during Operation Breakthrough, the program was considered a failure by the building industry because the federal government had required contractors to meet an excessively long and detailed list of performance criteria, many of which were new to the building industry. Some part of the industry opposition to the program resulted from the fact that the building industry had very little part in the drafting of the performance criteria.

A much more successful joint effort between the public and private sectors of the building industry comprised the development of Criteria for Energy Conservation in Buildings beginning in 1973. The National Conference of States on Building Codes and Standards requested NBS to prepare a document on Criteria for Energy Conservation in Buildings with the intention that it be developed as a national standard. A team of specialists from the NBS Center for Building Technology supplemented by a smaller number of representatives of private sector building organizations drafted a criteria document which was then submitted to an industry-wide review. A policy decision by NBS was made early in 1974 to transfer the NBS criteria document to the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE)for promulgation as a national standard. ASHRAE appointed several committees consisting of public and private sector experts and totaling more than 100 persons to review and revise the document as needed for approval by ASHRAE for promulgation. Some additions and changes were made by the committee after which the document was issued as an ASHRAE standard in the fall of 1975.

Analysis and revision of the ASHRAE standard continued after 1975, and it was promulgated as a national standard (American National Standards Institute--ANSI) in 1980.

During the period between 1975 and 1980 a majority of the states adopted the ASHRAE standard, either as a complete document or with limited revisions as requirements for state buildings. Revision of the 1980 national standard has continued to augment the potential energy savings in buildings made possible by improved building technology.

In 1976 the federal government passed a law requiring that building energy performance standards be prepared for possible mandatory use on a national scale. The time period for preparation was three years. During this period the Department of Energy contracted with the American Institute of Architects to survey the state of the art in energy conservation in several classes of buildings that were designed for energy savings. These data were to be compared with the proposed levels of energy savings in the draft federal standards. During this process the building design and construction industries developed strong opposition to the proposed federal standards. The draft federal standards were withdrawn for general use in 1980 and made applicable only to federal construction. Here again, the industry opposed being directed by the federal government to meet government-drafted criteria for performance.

The ANSI standard, produced by joint public/private sector effort, has been regarded as a preferred alternative to federal standards and has continued to be widely used in the states. This program indicated that criteria or guidelines for the design and construction generated jointly by public/private sector representatives was much more likely to be accepted and used because they were more responsive to the interests of both the suppliers and users of buildings.

Other research, development, and demonstration projects have been carried out by NBS for private sector organizations or federal agencies with varying degrees of success. Some of these are briefly described as follows:

- The National Association of Homebuilders sponsored research at NBS on reduced size renting for 1, 1-1/2, and 2-story buildings using plastic pipe and fittings. It was found that smaller pipe sizes than had been required by existing codes satisfied the performance requirements for these types of residences. Modifications to the building codes were prepared and moved through the promulgation procedures. About 10 years elapsed between the initiation of the program and code acceptance.

- The General Services Administration approved the construction in about 1972 of a demonstration office building of medium height in Manchester, New Hampshire. The building envelope, the heating and air-conditioning systems, the lighting systems, and the fenestration were designed to demonstrate the possibility of attaining an annual energy usage level of 55,000 Btu per square foot of floor area per year. NBS designed the data collection system and collected data for several years. The initial energy use was about 60 percent above the goal mainly because of excessive by-pass of outdoor air around the wall insulation where the supports for the marble exterior cladding penetrated the insulation, and because heat pumps in zones near each other were simultaneously heating and cooling the occupied space. After a number of modifications the goal of 55,000 Btu per square foot per year was attained.

- HUD and DOE sponsored the demonstration of a total energy system for supplying heating, cooling, hot water and electricity to one of the Breakthrough developments in Jersey City consisting of four separated high-rise buildings and utilizing diesel-powered engine generators. This project successfully demonstrated the level of economic viability, reliability, energy conservation potential, and control system problems in this type of central utility system during several years of measured performance by NBS staff.

These examples reveal the potential for introducing innovations in building design, the need for carefully monitoring laboratory and field performance, the significant possibility of unsatisfactory results, and the strong need for collaboration between the public and private sectors in developing performance criteria or standards for buildings.

APPENDIX 4

VALUE ENGINEERING: WHAT EFFECTS ON PROGRAMMING?

Rachel James

Value engineering is an organized effort directed at analyzing the function of construction, equipment and supplies for the purpose of achieving the required functions at a reduced life cycle cost without loss of or compromising quality, aesthetics, or operation and maintenance capability. It's done through: (1) selecting high cost areas to study, (2) determining the basic function of the item, (3) "brainstorming" the problem and developing alternative ways of performing the required function, and (4) selecting the best possible alternatives to perform the required function at lowest life-cycle cost.

Life-cycle costing is the systematic evaluation of alternate designs and comparisons of their projected total construction, maintenance, and operation costs over the economic life of the building. The most economical building is one that is designed for the lowest life-cycle cost--not just the lowest initial cost.

The life cycle of a facility can be divided into four phases: (1) development, (2) design, (3) construction, and (4) operation and maintenance. For value engineering to be most effective, it is essential that it begin when the project is still "a gleam in the eye," in the developmental phase of preliminary planning/programming. It is this phase that provides the initial parameters for the design phase. During these two phases of a project the magnitude of the total operation and maintenance cost is determined.

Predominance of initial cost as a criteria for determining building design generally results in inadequate recognition of operation and maintenance costs. In the design-to-cost concept, which generally prevails throughout the federal sector, the goal should be to achieve the best balance between life-cycle cost, acceptable performance, and schedule. For every proposed facility, there are certain minimum performance standards that must be achieved and maximum cost ceilings. These limits act to fix the range of design solutions that are acceptable.

The final step in the development phase is to define the requirements and constraints that the facilities must meet. These requirements are developed from an analysis of the user's needs and are expressed quantitively. A set of alternates that satisfy the requirements are selected for analysis and screening. This process is iterative until the final requirements are developed and become an active factor in the site selection process for the facility. It is in the early developmental phases that applied creativity often has the greatest effect on project costs.

Upon selection of the site, an analysis of site development alternatives in which comparative site organizations are developed equitably for evaluation should be undertaken. One means of evaluation and comparison is a matrix utilizing facility characteristics defined in usual units of measure and costs, and functions to be satisfied with organizational occupants aligned to each function. Each site organization alternative concept has different quantitative requirements with respect to distribution of utilities, roads, and other characteristics that affect cost. Costs alone are not the sole factor for recommendations of the optimum site organization. Traffic patterns, long-range development opportunities, and aesthetics may have overriding life-cycle impacts.

The concept design stage of the building is where value engineering can generally be applied most effectively to maximize savings and reduce implementation costs. It is the phase that is most conducive to creativity, and a full team effort with mixed disciplines.

Value engineering should be an integral part of the design cycle and applied early in the design phase to each project with a savings potential, regardless of project cost. It should be initiated in the development phase--preliminary planning/programming--and used throughout the life cycle of the project.

APPENDIX 5

COMMITTEE MEMBERS' BIOGRAPHICAL INFORMATION

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Wolfgang F. E. Preiser is professor of architecture and co-director of the Institute for Environmental Education at the School of Architecture and Planning, University of New Mexico. He is also a partner and director of research with Architectural Research Consultants, Inc. in Albuquerque, N.M. Dr. Preiser holds a Ph.D. in Man-Environment Relations from Pennsylvania State University, as well as Master's Degrees in Architecture from Virginia Tech and the University of Karlsruhe in Germany. His Bachelor's Degree in Architecture is from the Technical University in Vienna, Austria. Dr. Preiser has extensive experience related to the fields of post-occupancy evaluation and programming with the U.S. Army Construction Engineering Research Laboratory and in private practice. He is the editor of Programming for Habitability (1975), Facility Programming (1978), and Programming the Built Environment (1985). The book Post-Occupancy Evaluation is expected to be published in 1986.

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Paul R. Achenbach is a consultant on energy conservation research and moisture problems in buildings. He was one of the authors of the National Program Plan on the Thermal Performance of Building Envelopes and Materials issued by the Department of Energy (DOE) and the editor of the second edition of that plan. He has been an advisor to DOE on programs for building materials research and to the Congressional House Science and Technology Committee in formulating a legislative energy conservation program for 1984. He was an active participant in the formation of the Building Thermal Envelope Coordinating Council at the National Institute for Building Sciences. He has been active in field assessment of moisture problems in housing in humid climates, and in the evaluation of current practices, guidelines and standards for moisture control in buildings.

He completed a 40-year career in 1979 as a research engineer in the Center for Building Technology at the National Bureau of Standards (NBS). In that capacity, he has had wide experience in field evaluation of whole buildings, both occupied and unoccupied, for compliance with performance requirements. He also performed in-situ tests of the performance of mechanical systems in buildings for compliance with specifications. He was the leader of a joint NBS-industry task group in 1974 that prepared the report on Performance Criteria for Energy Conservation in Buildings that became the basis of ASHRAE Standard 90. He was a member of the interagency group that selected the building designs to be used by the Department of Housing and Urban Development in Operation Breakthrough.

He received the Department of Commerce's Gold and Silver Medals and the Edward B. Rosa Award for outstanding achievement in the development of engineering standards, and the ASHRAE F. Paul Anderson Award for scientific achievements.

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Pleasantine Drake is a principal of Architectural Diagnostics, Ottawa, and specializes in building programming, diagnostics and evaluation as well as related areas of architectural and man-environment research. Her recent work has focused on office environments and on the role of functional diagnostics as a basis for the planning, programming and design of new and existing facilities. She was part of a team of consultants who worked with Architectural and Building Sciences Directorate, Public Works Canada in the development and application of building diagnostic and total building performance assessment procedures. As an associate professor at the University of Calgary, she developed and taught graduate curriculum in architectural/environmental programming and evaluation. Ms. Drake was also a member of the Building Research Board Committee on Building Diagnostics.

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Dan Int-Hout is currently the director of research of Krueger Manufacturing in Tucson, Arizona. Involved in the commercial construction industry for the past 14 years, he is an active member of ASHRAE, serving as chairman of the Thermal Comfort and Indoor Environmental Calculations committees. He has participated in the Industrial

Furniture Manufacturers Association, specializing in occupant comfort, air diffusion performance, acoustics, and lighting. Mr. Int-Hout was involved in the GSA Performance Standards (Peach Book), and he has been involved in a number of construction projects from the design stage through completion and performance verification stages, including a number of full-scale performance mock-ups.

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Arthur T. Kornblut is a principal in the Washington, D.C. law firm of Kornblut & Sokolove. Mr. Kornblut is a member of the bar in the District of Columbia and Ohio and holds an architect's license from the State of Ohio and an NCARB Certificate. He is a member of the American Bar Association and the American Institute of Architects. He also serves on the panel of arbitrators for the American Arbitration Asoociation.

Prior to entering the practice of law, Mr. Kornblut served as the administrator of the Department of Professional Practice with the American Institute of Architects in Washington.

Mr. Kornblut authors the Legal Perspectives column in Architectural Record and has written numerous articles and lectured extensively on the legal aspects of architecture, engineering and construction. He is on the board of directors of the Construction Sciences Research Foundation and the Virginia Society of Architects/AIA. Mr. Kornblut is the 1985-86 chairman of the American Bar Association Forum Committee on the Construction Industry.

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Robert W. Marans is a professor in the College of Architecture and Urban Planning at the University of Michigan, a research scientist at the University's Institute for Social Research and a licensed architect. He is also associate director of the University's Ph.D. program in Urban, Environmental, and Technological Planning. Dr. Marans' research focuses on peoples' responses to environmental settings ranging from offices and other workspaces to recreation areas and housing for older people. He is the recipient of a 1982 Applied Research Award for Progressive Architecture, a 1983 award for design research excellence from the National Endowment for the Arts, and has served as a member of the National Research Council's Committee on Building Diagnostics. His current research deals with techniques for building evaluation, lighting quality and energy in office buildings, and retirement communities.

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Douglas Nicholson, chairman of the board of Building Programs International, is also senior vice president of Cushman & Wakefield Inc. associated with the project development group acting as consultants or managers for development of major office and mixed-use complexes such as the Bank of America, Sears Tower, and Petro Canada in Calgary. Building Programs International is a consulting firm specializing in the development of long-range real estate and building programs for such major commercial firms as AMOCO, Citicorp, the World Bank, and Northwest Mutual Life, Inc.

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Steven Parshall is a vice president at CRS Sirrine, one of the largest A/E firms in the U.S. He is head of the research division where he has been responsible for investigation and publication of advanced ideas in the building industry at CRSS. This encompasses research and investigation into architectural prototypes, innovative modular and traditional building systems, new technology applications and specialized facility requirements. He has authored and co-authored numerous articles for publication, as well as speeches, studies and reports. Mr. Parshall is a specialist in the Problem Seeking method of programming, and assisted on the CRSS book, Problem Seeking: An Architectural Programming Primer. He has also co-authored, with William Pena, Facilities Evaluation: A Practical Approach to Post Occupancy Evaluation, among other CRSS research reports. Mr. Parshall has a dual masters degree in both Architecture and Business Administration. He is a registered architect in Texas.

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Edward T. White is professor of architecture and coordinator of the graduate Architectural Programming and Design Option in the School of Architecture, Florida A&M University. He is a registered architect in Arizona and Florida, and has fifteen years professional experience in programming and design for a wide range of building types, as well as ten years experience in curriculum planning, course design and teaching in architectural programming. Mr. White is author of six programming-related books which are used as texts in 130 schools in the United States and 21 foreign countries.

He is a member of the American Institute of Architects committee that completed the early conceptual planning, data collection and organizational strategy for the AIA publication: Architect's Guide to Facility Programming. He is author of a university-based study of programming practice in architecture firms and five other reports on programming and building evaluation.

Mr. White is presently serving as client-coordinator of a state-funded post-occupancy evaluation of the new School of Architecture building at Florida A&M and is planning a study of building procurement and programming practices in England and other European countries.