ORGANIZING LARGE PROJECTS: HOW MANAGERS DECIDE

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ABSTRACT: Now tools will help managers design organization structures for large engineering and construction projects. An improved understanding of how managers decide in structuring project organizations is necessary to develop these tools and to assist managers in the systematic design of organizations tailored to meet project goals under unique situations. This paper reports a portion of results from research conducted to determine current practices in project organization design. The conclusion that adaptation dominates this process leads to several implications for industry professionals and researchers wishing to improve project performance. Recognizing the role of adaptation in current practices of organizational structuring will allow managers to avoid inertia and systematically design organizations. Researchers can assist by expanding variables in organization theory to better capture project situation and structure and by developing new tools to assist in systematic organization design.

INTRODUCTION

Managers can increase the potential for high levels of project performance by effectively structuring project organizations. Since many recent projects have an expanded scope and degree of complexity as compared to their predecessors, they present an even greater management challenge. Managers in construction need improved tools to assist with this crucial decision-making activity.

This paper seeks to assist managers designing organizations for large projects by reporting the results of research on current practices for structuring construction organizations, and by suggesting future research to further aid managers in organization design. A future paper will report related findings from this research regarding situation, organization structure and relationships between these two variables on large engineering and construction projects.

The paper first provides examples of project organizations to illustrate the importance of organization structure for project results. The research method and the sample are described next. The following section reviews the relevant organization and decision-making theory and develops models from each for use in this investigation. The results section contains the findings regarding how construction managers decide in organizational structuring, presents implications and practical applications for industry professionals, and suggests actions by both managers and researchers to improve organization design and project performance.

BUILDING STRUCTURE ANALOGY

Systematic design of organizational structures is analogous to the design of building structures. For each, designers evaluate performance

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requirements (termed design criteria, e.g., loads and permissible deflections, for buildings) and situational factors (or technical characteristics of building structural components) to determine the optimal structure. For project organizations, cost, schedule, quality, and safety goals generally define the performance requirements; external influence and operations technology make up the situation. For building structures, the design criteria define the loads; strength properties of the materials determine the technical characteristics. Structural engineers use a systematic method, based on both theory and experimentation, to relate the design criteria and the technical characteristics in designing structures to meet performance requirements.

An equivalent procedure for the design of organization structures does not yet exist. If it did, such a methodology would allow managers to systematically evaluate a project situation and to tailor the organization to achieve the desired performance under these conditions. The design of appropriate organizations could not, of course, assure adequate performance. Managers do that. Structures suited to the unique situation of the project could, however, assist managers of varying abilities to achieve acceptable performance by managing the differences in intervening variables found on each project.

Project Organizational Structuring: Requirements and Experience

Project organizations are different from manufacturing organizations and from each other. Goals, external influences, and work operations all depart from other types of organizations and vary on individual projects.

Structuring Requirements.—Unlike some ongoing enterprises, projects demand a series of decisions regarding organization structure. Mobilization forces a need for initial structuring; changes in project phase stimulate reorganization. Other influences, such as progression through the project life cycle (4), performance difficulties, changes in project goals, or a dynamic project situation, may require further reorganization. In addition, the multiple subunits involved in a project organization, such as the project engineering and design group, the procurement staff, and the site construction team, each change differently in response to these influences.

Structuring Experience.—The results of large engineering and construction projects, including several different types, indicate the important influence of project organization on performance. On transportation projects, use of both the design-build and the construction management delivery systems creates substantial differences in organization structuring. Project results also vary widely.

For example, managers of the Bay Area Rapid Transit (BART) project assigned full responsibility for engineering and construction to a system consultant. This simplified the organization and improved communication as compared with other approaches (14). The project experienced comparatively few delays at the design/construction interface. In contrast, the Washington Metropolitan Area Transit Authority (WMATA) project used a more fragmented structure and experienced difficulties in

assigning responsibility and in making timely decisions. Although many other factors determined the results of these two projects, this comparison suggests that organization structure is one influence. Continuing organizational problems on subsequent transportation projects lead researchers to conclude: "The problem is that far too little is known about how to build and operate effective organizations for the management of these large projects, and at present the transit authorities are groping in the dark for solutions which are much more complex than is generally realized" (14).

The Trans-Alaska Pipeline System (TAPS) further illustrated the importance of organization in determining project results. Because of multiple ownership and extensive external influence, the project began with a tall and broad organization. Decentralization was limited, and the inability to make rapid decisions restrained engineering and construction progress (13). When construction reached 15% completion, the owner decentralized the organization into geographic segments. A special investigator (6) reviewed the project and identified deficiencies in organization structure as a factor in project cost overruns. Even though the project experienced substantial cost overruns, this radical change in structure allowed decision-making to better support work progress and helped in achieving scheduled goals.

Organizations for nuclear power plants also vary widely (21). Earlier projects used functional structures consistent with experience on coal fired plants. As scope and complexity grew, managers of nuclear construction applied both the matrix (organizations involving dual reporting) and the project (or task force) organization structure (20). Surveys of nuclear construction experience identified organization as an area of great importance and weak performance (19) and as a barrier to shortening construction schedules (11).

Research Method

Model building, empirical data collection, and analysis of decision-making using models, formed the research design for this investigation of organizational structuring on large projects.

Model Building.—Five models of possible decision-making processes in organization design guided this investigation. As described in the following, these rational-contingency, adaptation, behavioral choice, political, and "garbage can" models distilled organization or decision-making theory and suggested implications to structure both the data collection and analysis.

Data Collection.—The investigation employed in-depth interviews of decision-makers, review of documents, and observation of site operations as the major means of data collection. The interviews, which totaled 45 for the eight projects studied, included the manager heading each organization and at least two key managers reporting to him. Each interview included five major segments: (1) The project situation at the time of the decision studied; (2) the resulting organization structure; (3) the decision-making process; (4) possible influences on decision-making process implied by the models; and (5) the manager's personal theories regarding organizational structuring.

The data collection also involved reviewing several types of project documents to further define the project situation, the organization structure, and the decision-making process. These documents included organization charts, administrative procedures, progress reports, and special reports on organization and project results. For a portion of the sample, data collection also involved direct observation of construction operations and coordination meetings.

Analysis of Decision-Making.—The data analysis included the following steps: (1) Preparing a data summary for each project in a case study format; (2) defining the organizational situation and structure by analyzing the data using situational variables and structural variables; (3) comparing the empirical data with implications from the models of decision-making to determine primary and secondary model application; and (4) developing conclusion regarding conformance of the empirical data to the models and potential for more systematic organization design.

Description of Sample

Eight engineering and construction projects made up the sample for this investigation. These four process plants and four power plants are each considered "megaprojects" within the industrial segment of the construction industry.

Decisions Studied.—This investigation considered two types of decisions. For four of the projects, the data concerned initial structuring of the organization. For the other projects, the investigation considered a major reorganization. Decisions made by individual managers formed the level of analysis for each project.

Organizational Description.—For the process plants, the unit of analysis was the owner's project management organization, each consisting of a team of 30 to 80 managers, engineers, and other specialists. They were assigned from the project management division of a large corporation. This team managed all phases of project execution. Fig. 1 depicts this firm's standard organization for large projects.

The project team typically managed the work of a single engineering, procurement, and construction contractor. Under the terms of the normal cost plus fixed fee agreement, the contractor completed the detailed design, procured the necessary equipment and materials, and constructed the facility.

For the power projects, the construction management organization formed the unit of analysis. An architect/engineer and constructor firm assigned the 250 to 450 personnel in this site organization (Fig. 2). These projects employed both the design-construct and the construction management delivery systems. Despite these differences in delivery systems, the responsibilities assigned to the construction management organizations were very similar. This resulted from the uniform use of "cost-reimbursable" contracts, which allowed direction of contractor activities by the construction manager.

Technical Description.—The first half of the sample included four hydrocarbon processing plants. Despite differences in output, the basic design and operations technology for these projects varied little. These projects consisted primarily of process systems, as contrasted with the

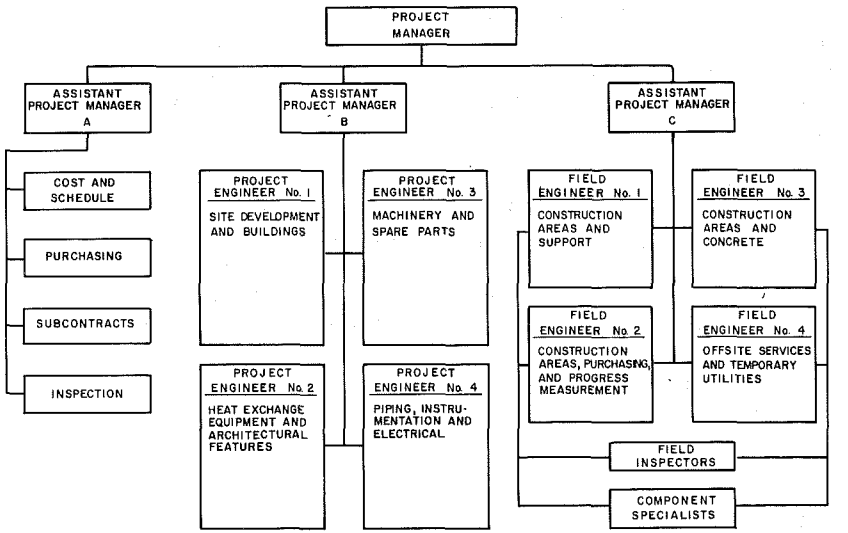


FIG. 1.—Typical Project Organization—Process Plant Projects

dominance of structural and architectural features in commercial construction projects.

Nuclear power plants made up the second half of the sample. Their technology included extensive civil, structural, mechanical and electrical work actvities. The combination of site development, building construction and process system installation made these projects cut across the

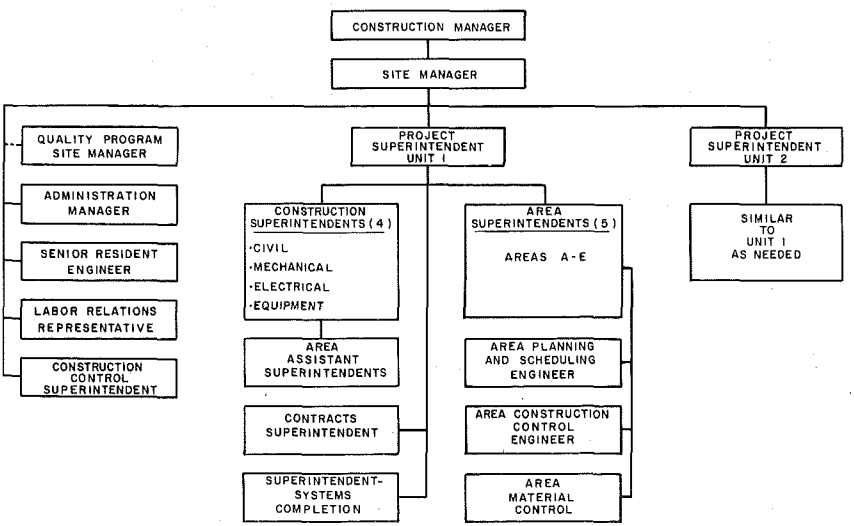


FIG. 2.—Typical Site Organization—Power Plant Projects

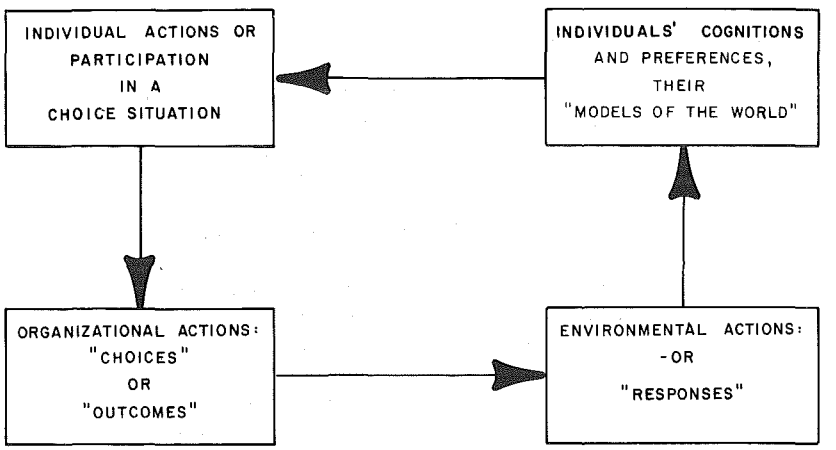
three major segments of the construction industry (heavy, building and industrial).

Reasons for Sample Selection.—This research design attempted to collect several types of data and to develop conclusions with high internal and external validity (2). The three means of data collection considered both qualitative and quantitative information as suggested by the ethnographic (15,23–25) and direct research approaches (12). The sample size allowed both in-depth analysis of the individual projects and generalization of results over the industrial construction segment. The models of decision-making provided a series of "mini-hypotheses" for comparison with the empirical data. This avoided the overly narrow focus of single hypothesis testing.

Models from Organization and Decision-Making Theory

The investigation used five models of decision-making distilled from existing theories. This followed the organization research methodology of using model-based investigation to deduce explanations from facts (5), or to increase understanding of events using existing theories (1). This section reviews the decision-making models used in the research and their implications.

Adaptation Model.—Under this model, managers use a learning process, based on trial and error, in designing organizations. Ambiguity in cause and effect relationships may cause errors in this learning based on experience (9). Disruption of single links in the complete cycle of choice, such as between individual actions and organizational actions, (Fig. 3) cause varied learning errors. This model implies that experience dominates organizational structuring and that managers adapt past



SOURCE: MARCH & OLSEN (1975: 159)

FIG. 3.—Complete Cycle of Choice

structures to current situations. This adaptation emphasizes past successes and avoids past problems.

Behavioral Choice Model.—In this model, managers attempt rational analysis and decision-making but find that limitations in available information and in ability to process information constrain this process. These constraints result in subsequent changes based on performance feedback. Adversity stimulates search; reaction follows (7).

Behavioral choice theory leads to four implications for decision-making in organizational structuring. First, behavioral factors limit rationality in the structuring process. Second, managers search for alternative organization structures in times of adversity. Third, managers intentionally leave portions of the structure ambiguous. Finally, structuring requires satisfying, or accepting satisfactory, rather than optimal solutions (10).

"Garbage Can" Model.—This model of decision-making applies in conditions of unclear goals and technology. Independent streams of problems, participants, and choices which happen to meet in time determine outcomes in organizations conforming to this model (3). As a result, decisions are not rationally linked with the problems requiring choices. These conditions result in decision-making by "resolution" (solution by periods of analysis), by "flight" (movement by a choice to more attractive problems), or by "oversight" (problem attachment to other choices).

The "garbage can" model leads to three implications for decision-making in organizational structuring. First, ambiguous goals and technology create random and confused decision-making. Relationships between problems, solutions and choices are difficult to determine. Second, the time relationships between problems and solutions determine outcome. Third, solutions drive problems; because of prior success, participant advocacy, or external influence, managers adopt solutions which are not relevant to existing problems.

Political Model.—Organization structure, under the political model, is what the powerful actors want it to be. These actors acquire power by doing best what the organization needs most, by the dependence of others, by providing critical resources and knowledge, by coping with uncertainty, or by being irreplaceable (16,17). This results in structuring to meet the goals of powerful individuals or subunits, rather than those of the entire organization.

The political model leads to three implications regarding organization structuring. First, power relationships determine the structure. Second, the structuring process involves negotiations between powerful actors. Finally, power changes, caused by changes in critical contingencies or by unique individual capabilities, produce structural changes.

Rational-Contingency Model.—This model proposes that managers use rational decision-making to design organizations optimally suited to meet the project's goals, subject to its unique constraints (18). Decision processes involve adequate information and complete analysis. Contingency variables such as external influence, operations technology, and individual capability of key managers define the situation. Organization design includes six steps: (1) Establishing project goals; (2) defining the situation; (3) formulating alternatives; (4) anticipating performance using

each alternative; (5) evaluating the alternatives by comparing anticipated performance with the goals; and (6) selecting a structure which optimally meets all goals.

The model leads to four implications. First, managers use rational decision-making processes. Second, situational changes force structural changes, and conversely, structures remain unchanged in static situations. Third, situation determines structure, with the environment setting the periphery and the technology structuring the core (18). Finally, individual capability modifies the structure.

How Managers Decide

This research attempted to identify the current practices in organization design and the major influences on the outcome of organizational structuring. This section describes findings concerning the decision processes that managers actually use to structure project organizations.

Primary Decision Process.—Managers primarily applied their experience and adapted past organizations to make the structuring decisions on six of the eight projects (Table 1). They used trial and error in a learning process to develop the structures judged most effective in meeting project goals.

What prompted the prevalence of adaptation over other possible methods of structuring? First, demands for immediate decisions and time

TABLE 1.—Summary of Model Application

Project (1)	Decision studied (2)	Primary model(s)[g] (3)	Secondary model(s)[g] (4)
A	Initial structuring	Adaptation	Rational-contingency[a,b,c]
B	Initial structuring	Adaptation	Rational-contingency[a,b]
C	Initial structuring	Adaptation[e] Political[f]	Garbage can Rational-contingency[b,d]
D	Reorganization	Adaptation	Political Rational-contingincy[b]
E	Reorganization	Adaptation	Political Rational-contingency[a,b,c]
F	Reorganization	Behavioral choice	Rational-contingency[a,b,d]
G	Initial structuring	Adaptation	Political Rational contingency
H	Reorganization	Behavioral choice	Political Rational-contingency[a,b,d]

[a]Model applies for project goals.
[b]Model applies for design or operations technology.
[c]Model applies for individual capability.
[d]Model applies for analysis of project situation.
[e]Model applies in determining the superstructure.
[f]Model applies in determining the decision-making system.
[g]Model applies to overall structuring process unless otherwise indicated.

constraints precluded the analysis necessary for other decision-making processes. Second, shortages of information and limited individual ability to handle the information available suggested use of familiar organizational forms. Third, frequent and severe changes in both project goals and project situation created a dynamic condition preventing other decision processes. As a result, many managers stated: "I used my experience."

Managers adapted past experience to achieve two main objectives. They first attempted to avoid problems with past organizations, and second, sought to repeat past successes.

Examples of the first approach included:

1. Work division into "manageable pieces" to avoid prior problems of overloading the managers responsible for individual subunits.
2. Attempts to fully define coincident authority and responsibility and thereby to avoid the confusion of organizational evolution experienced on prior projects.
3. Use of either the geographic area or the work discipline basis for unit grouping to avoid prior problems in coordinating the work using one of these types of organization.
4. Refusal to use coordinator positions based on past difficulties resulting from the limited authority given to individuals assigned these responsibilities.

Examples of efforts to repeat past successes included:

1. Using familiar unit grouping, such as functional structures for engineering activities or area organizations for construction management.
2. Establishing checks and balances for various activities to assist in meeting several types of goals.
3. Requiring specific types of experience for designated positions.
4. Assigning authority and responsibility for various types of decisions at specific levels in the organization.

Other Decision Processes.—Although the investigation indicated frequent use of adaptation in organizational structuring, other decision-making processes provided either primary or secondary explanation of structuring on specific projects. These included systematic analysis, political processes, and random choice.

Systematic analysis in organizational structuring (conforming to the rational-contingency model) involved statement of objectives, definition of the project situation, and development of alternative structures. Managers attempted this process for reorganization decisions on two of the projects in the sample (those designated Behavioral Choice in Table 1). Changes in objectives and situation, limitations on information availability, difficulties in using the information available, and lack of a well developed procedure for analysis each restrained the systematic organization design. When managers considered alternatives in either initial structuring or in project reorganization, they did so only in general terms.

Organizational structuring involved political processes when the power distribution varied from the bureaucratic basis of position in the hier-

archy. Examples included increased power of subunits based on external influence, on specialized knowledge, or on the ability to handle crucial organizational contingencies. Structural changes such as variations in reporting levels, differing degrees of decision-making involvement, and altered resource allocation each indicated power influences in organization design.

Random choice determined certain elements of organization. The timing and qualification of available personnel influenced the design of positions. The sample also showed time relationships influencing structure; managers conveniently grouped unrelated reorganizations; they acted to resolve several unrelated problems simultaneously.

Relationship to Decision-Making Theory.—This research indicated that decision-making practices in organizational structuring conformed most closely with behavioral decision theory (7). The prevalance of adaptation processes introduced the potential for bias and error in organization design (22). Limited information availability, and limited time and cognitive capacity to process the information available, conformed to predictions of behavioral theories of decision-making (7,8). Under these theories, environmentally induced change produces unanticipated consequences because of behavioral influences within the organization. Learning errors occur. Therefore, the results of organizational adaptation can differ significantly from the predictions of rational analysis theories.

Implications for Industry Professionals

Managers seeking to organize large engineering and construction projects effectively face a formidable challenge. Failure to specify the desired states of structural variables can lead to inefficient and confusing organizational evolution. The resulting structures may not best meet the goals of the organization under the project's situation. This research indicates that managers can improve both the efficiency of the structuring process and the performance of the resulting organization by:

1. Recognizing the role of adaptation in the current practice of organizational structuring and the potential bias created by this decision-making process (22).
2. Rejecting the inertia of reliance on familiar structures and systematically designing innovative forms to recognize the project situation and to best meet project goals under this situation.

If project managers recognize the importance of experience in organizational structuring, they can assist other managers in gaining appropriate experience. This recognition will also encourage transfer of experience with various types of organization structures and to various size projects. For smaller organizations, recognition of differences in project situation in assigning scarce resources is especially critical.

Development and manager application of enhanced tools for systematic organization design could result in better organization fit for the project situation and in better performance to achieve project goals. This research strongly indicated both a need for improved tools to design

organizations and a willingness on the part of industry professionals to apply these tools.

Conclusions and Practical Applications

This investigation sought to develop a better understanding of current practices in organizational structuring and to provide a focus on needed improvements. The results included both implications for project organization and performance and suggestions for organizational researchers.

How Managers Decide.—This research indicated that managers adapt and apply experience as a primary means of organizational structuring. They use a learning process which may be subject to bias and other error. In designing organization structures, many managers attempt rational analysis but encounter several constraints. Political and even random choice processes also influence organizational structuring.

Implications for Project Organization and Performance.—Managers should expect larger, more complex projects presenting greater challenges for both organization and management in the future. The importance of these projects in meeting national priorities will result in their greater visibility and in increased external demands for adequate performance. The results of this research indicated an opportunity for improved performance through more systematic organization design.

Organization design using systematic methods, once they are developed, could improve project performance by: (1) Greater definition of both project situation and organization structure; (2) increased potential for innovation in structuring; (3) decreased error by lessening bias in the structuring process; and (4) increased fit of the structure to the project goals and situation. This would allow not just "working smarter" but also "organizing smarter."

This attempt to apply a systematic method for organization design would recognize the departure of current practices from rational models. General management principles and "rules of thumb" makeup currently available tools. If researchers assist managers with more appropriate tools, the tailoring of organization structure to meet unique project goals under differing project situation should improve project performance. Current practices indicate substantial opportunities.

Suggestions for Future Research.—This investigation identified many opportunities and needs for future research to enhance our understanding of, and to improve, organization design. Increased development of several theoretical issues would assist managers to more effectively organize large engineering and construction projects. These issues include:

1. Expansion of existing variables to define project situations and project organization structures, including operations technology, design technology, and assignment of specific work tasks.
2. Increased understanding of how ambiguity regarding project goals or project situation influences decision-making in organization structuring.
3. Greater understanding of the mechanism for the influence of contingency variables, such as environment or technology, on structure.
4. Expansion of methodologies for investigating decision-making and structure in project organizations to include approaches giving more

consideration to the qualitative data describing the context of decision-making for both organizing and managing.

The largest opportunity for organization researchers is to develop a systematic method for organization design. Approaching the analogy of building structure design, in which design criteria and structural capability are related with proven and systematic methods, will be extremely difficult. However, the potential returns include decreased costs and schedules. Developing new tools for use by industry professionals in the analysis of project situation, the identification of structural alternatives, the anticipation of project performance under these alternatives, and the selection of optimal structures, make up this research agenda. The potential returns on this research investment make it an attractive challenge.

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