ADAPTING THE BUILDING SYSTEM INTEGRATION METHOD TO PORTRAY ARCHITECTURAL ORGANIZATIONS

A Thesis

by

AMITAVA SINHA RAY

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2003

Major Subject: Architecture

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Approved as to style and content by:

Mark J. Clayton (Chair of Committee)	Rodney C. Hill (Member)
Arnold Vedlitz (Member)	Phillip J. Tabb (Head of Department)

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ABSTRACT

Adapting the Building System Integration Method to Portray Architectural Organizations. (December 2003)

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This thesis primarily deals with the adaptation of a theory from one context and its application in another context. In this case the "building systems integration theory" which has been introduced in the context of buildings, in the book Building Systems Integration Handbook (Rush, 1986), is adapted to the context of architectural organizations. The hypothesis of this research is that "building system integration principles can be applied to architectural business organizations." Building system integration theory defines four fundamental systems within buildings and five levels of integration ranging from unified to remote. It further defines an abstract two dimensional diagrammatic language that is referred to as a "ball diagram" for portraying the system integration within a building. Using the building system as an analogue to organizational structure, I have redefined the five levels of integration in the vocabulary of an organization and formulated seven systems in an organization on the basis of my literature review. I surveyed five prominent architectural firms in Texas (three Matrix organizations, and two Studio organizations) and discussed their project handling methods with their principals in charge, with the intention of investigating the degree of contact between personnel, their meeting patterns, and the reporting structure. This has

helped me to identify the levels of integration between systems in each organization and eventually represent the working process of these firms using the diagrammatic language introduced in BSIH. The resulting diagrams, which primarily represent the production/ delivery segment of the organizations, reveal organizational structures during the project cycle as well as certain characteristics of a Matrix or Studio. Due to the limited scope of the survey done initially, some shortcomings were noticed in the diagramming method including the absence of any representation of the client and the user in the diagrams. Despite certain shortcomings owing to the scale of the investigation, it is felt that the diagramming method portrayed here is a novel yet effective idea to represent organizations and the levels of integration between systems in an organization that contributes to the production of a cohesive organizational design theory.

DEDICATION

“Karmanya wadhikaraste

maa phaleshu kada chana

maa karma phal hetur

bhuma te sangrost karmani”

“Do your duties sincerely and leave the

results to God.”

——Bhagawat Gita——

This work is dedicated to my parents.

ACKNOWLEDGEMENTS

The completion of this thesis towards my master's degree would not have been possible without the encouragement, support and guidance of many.

I would like to express my heartfelt gratitude to my advisory committee chair and Executive Associate Dean of the College of Architecture, Dr. Mark Clayton, for all the wisdom he shared with me and for having guided me in every step of this research. Dr. Rodney Hill, professor in the College of Architecture, was a constant source of guidance and encouragement. His experience with social and behavioral factors in architecture, creativity and future studies lent support to some of the ideas presented in this thesis. I am equally honored to have the Executive Associate Dean of the Bush School, Dr. Arnold Vedlitz on my committee. His crucial suggestions and the vast resources of organizational vocabulary that he had to offer, were extremely helpful.

Dr. Clayton and Dr. Valerian Miranda helped me coordinate with the principals of the five architectural firms I surveyed. I am thankful to both of them for their support. I also wish to thank Dr. Elton Abbott, for his initial comments in support of my ideas for this thesis. Most importantly, I am indebted to the principals of the five architectural firms I surveyed, for sparing their valuable time and sharing their information with me.

I would like to thank my family and friends for all their trust, support and love that they have bestowed upon me. A special note of thanks to Archana, for her unbounded encouragement and affection.

I express my deepest gratitude to God for having made this whole experience yet another endorsement of faith, goodwill and hard work.

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1. INTRODUCTION

1.1 Background

Creativity in the design of any artifact involves not only issues of functionality and aesthetics but the conscientious integration of systems and subsystems to achieve maximum performance levels. All artifacts, be they the spectacles in nature, building architecture, business organizations, computers, etc., have a complex interaction of components, structure and relationships. For the optimum level of performance, all contributing systems in an artifact must have appropriate levels of integration. The building systems integration theory (Rush, 1986) introduced in the Building Systems Integration Handbook (BSIH), is a unique theory that defines five levels of integration between four building systems to permit analysis and discussion of relations among subsystems. The book further represents any building section in terms of its system integration by diagramming the systems using a "ball diagram".

Systems in a building are integrated naturally during the process of design and execution (Rush, 1986). The BSIH provides the designers with a vocabulary for discussing the creativity involved in the less obvious aspects of building design. With this knowledge, a designer can make a conscientious effort to recognize appropriate integration during the design stage, thus being able to achieve a building that has depth in every detail and is efficient. This integration theory seems a very logical way to

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This thesis follows the style and format of *Journal of Architectural & Planning Research.*

understand and help in the refinement of the design of many other artifacts. The diagramming method in BSIH may also be an effective method for representing and understanding these designed artifacts, including business organizations in an abstract way that also represent the integration of systems in them.

1.2 Research Problem

The complexity of today's business world translates into complexity of the organizational design of any company (Galbriath, 2002). Most large organizations, including architectural firms, have a complex system of operation due to typically challenging market demands and competition. Business organizations have evolved from a vertical framework toward a horizontal pattern that eliminate layers of management and gives project teams more responsibility (Linn and Pearson, 1997; Galbraith, 2002). Many architectural organizations thrive on the team model, where the design, construction and administrative units work collaboratively to coordinate efforts and achieve customer satisfaction.

Because of the complexity of the decisions made, the successful division of responsibility within a large business organization may be responsible for the growth and success of an organization. There definitely remains a need for better tools to assist in understanding the less obvious aspects of designing an organization just as in the case of a building. The language and concepts in the BSIH theory may help those who design business organizations to choose appropriate degrees of integration among the units.

1.3 Hypothesis

The hypothesis of this research is that “building system integration principles can be applied to architectural business organizations.” The concepts of BSIH theory for buildings are an analog to concepts of organizations. In particular, the notion of distinct and invariable systems and the differentiation of five degrees of integration, as expressed in ball diagrams, can be usefully applied to describe an organization.

1.4 Outline of the Thesis

Section 2 presents the literature review of architectural practice, design theory, business management, business modeling, and the BSIH theory. This section builds a base for the formulation of the hypothesis and its necessity. Section 3 introduces a method to translate the BSIH theory from the building environment to the business environment. Section 4 explains the case study method along with a detailed study of five architectural firms and the application of BSIH theory to diagram the stages in their project delivery process. Section 5 presents the complete diagrams of the projects segment in each firm and discusses the applicability of the BSIH theory to organizations. It includes implications for future research and summarizes conclusions regarding the hypothesis.

2 POINT OF DEPARTURE

The need for a new research arises from the lack of a solution to a particular problem. To establish appropriate degrees of integration in an organization, there is a need to understand how an architectural organization functions and the existing methods to study and diagram them.

2.1 Architectural Practice

In order to study the organizational structure and the functional systems within a firm, it is important to understand how a mid to large size architectural firm may operate in terms of its services and its discretion towards structuring its manpower. Architectural firms can be classified into the professional service firm bracket just like law, consulting, investment, banking, accountancy, engineering and others (Maister, 1987). Professional services usually involve a high degree of interaction with the clients, as well as the architect's professional commitment in all areas (de Vido, 1984). Two important features of the professional services firm thus are the types of professional service activity and the project team structure that it requires to deliver the firm's services. I will also try to explain how the project team structure can work cohesively and successfully during a project cycle.

2.1.1 Technologies in Practice

Maister (1987) characterizes professional service projects into three types: "Brains," "Grey Hair," and "Procedure." The key elements of the Brains type professional services are creativity, innovation and the pioneering of new approaches, concepts or techniques. Grey Hair projects usually require a lesser degree of innovation and creativity than the

Brains project. The general nature of the problem is familiar, and the activities necessary to complete the project may be similar to those performed on other projects. The third type, Procedure projects, involve a well-recognized and familiar type of problem. The steps necessary to accomplish a task is programmatic though some customization may be required initially.

Theorists proposed generic categories in architectural firms by applying Maister's work specifically to architecture firms:

- **Strong-Idea (Brains) Firms**- These firms are organized to deliver expert services in specific areas or provide innovative solutions to unique projects,
- **Strong-Service (Grey Hair) Firms-** These firms are organized to deliver experience and reliability, especially on complex assignments, and
- **Strong-Delivery (Procedure) Firms-** These firms are organized to provide highly efficient service on similar or routine-type assignments, often to clients who seek more of a product than a service (Coxe et al., 1986).

Although new ideas typically originate in strong-idea firms, they are then widely applied by strong-service firms as the ideas become understood and accepted in the market. Further, when the ideas become routinized and are in demand client after client, some or all of the work will move to strong-delivery firms, where repetitive projects are efficiently turned out.

2.1.2 Project Team Structures

Brains projects usually involve highly skilled and highly paid professionals, and every project is a "one-off." Hence the teams will tend to have extremely trained and

experienced people, with little chance of junior level jobs. The Grey Hair and Procedure projects on the other hand increasingly involve familiar tasks and can be delegated from senior to junior personnel. Procedure projects have the characteristics of an assembly line whereas Grey Hair projects also characteristically have middle level staff at the analysis and diagnosis stages (Maister, 1987).

Large architecture firms lie predominately in the strong-service or strong-delivery types and provide expertise in certain market areas that can be applied in repetitive projects. Also, the trends in their staffing show signs of strong-delivery and strong-service firms that hire and train paraprofessionals to do maximum amount of the work via standardized procedures, and have either studio teams with principals in charge or projects headed by project managers and delivered by departments (Coxe et al., 1986).

Linn and Pearson (1997) believe that most successful architecture firms are adopting horizontal organization models, eliminating layers of management and giving project teams more responsibility. Similarly, Elmuti (1996) asserts that that team-based management system is identified as a useful strategy not only for the manufacturing industry but also the service industry. Leaner management structures tend to empower team members to look at the big picture. Marketing, client relations, research, design, and project delivery are viewed together, not separately. Responsibilities for these activities cut across different sections of the organization. Some firms like the Hillier Group and Gensler make project profitability the responsibility of each project team, by developing a system of studios which function like ‘mini businesses’ (Linn and Pearson, 1997). One of the core requirements for the success of this strategy is empowerment,

which is the concept of enabling the subordinates in an organization to have the authority and capacity to make decisions and act for the organization (Elmuti, 1996). Empowerment is the successful integration of authority, resources, information and accountability (Fisher, 2001).

Besides empowerment, what matters most to the firm is how it executes and delivers its projects for the client. Aspects of the process are: team organization; project schedule and deliverables; staff roles and responsibilities; and individual accountability for decisions (Piven, 1989). Mr. Piven, a principal consultant of the Coxe Group specializing in the management of professional design firms, interprets six common project organization structures in architectural firms primarily depending upon the role of individuals in design and managerial issues:

- The principal-led team- A project team is lead by a principal in charge who is a top executive in the firm.
- The architect-led team- A project team is lead by a project architect, supported by a principal in charge in the firm.
- The designer-led team- A project team is lead by a project designer and supported by a principal in charge in the firm.
- The manager-led team- A project team is lead by a person with special skills and abilities in management (project manager) who is supported by a principal in charge.
- The co-designer and manager team- A project team is lead by a project manager and a project designer, who are supported by a principal in charge in the firm.

- Manager-led departments- A project manager leads a group of departments (such as design, interiors, etc.) headed by individual department heads. The project manager is supported by a principal in charge in the firm.

The paper further reveals the dilemmas that arise in each of these different organizational structures due to the existence of two roles of the architect: as a designer and as a manager (Broadbent, 1973). Personnel are often torn between their degrees of commitment to design and technological aspects of design on one hand and managerial issues on the other. For example, in a designer-led team, the designers may find themselves unwilling or incapable of dealing with expanding managerial and technical project needs. Similarly in manager-led teams, managers might be unable to address the levels of design desired by the firm or the clients. Hence depending upon their needs and requirements, each firm selects its own organizational structure. Piven (1989) mentions that strong-service firms will be most effective using departments.

2.2 Architectural Business Modeling

The human organization can be represented by a series of organizational charts. An organizational chart defines the specific positions of personnel in the organization, and the flow of authority through a hierarchy. It usually does not dynamically represent the levels of interaction prevalent between personnel during the stages of a project cycle.

Dr. Robert E. Johnson's course pack for Strategies in Architectural Management (Johnson, 2002) presents a few predominant organizational charts that attempt to portray the structure of architectural firms. He classifies the organizations into four major types:

- Departmental Organizations: These organizations function as a group of separate departments that undertake responsibilities at different stages of a project cycle. The departments correspond to phases in a typical sequence: predesign, design, construction documentation, and construction administration. Each of these departments is headed by a department head. The overall control of these departments rests on the shoulders of one or more principals.
- Generalist Organizations: These organizations function usually with one set of professional staff, which takes care of the design, drafting, specifications, construction administration, model making, and rendering. This heterogeneous staff is under the direct control of one or more principals in the firm.
- Studio Organizations: These organizations function with one or more managing principals leading separate and redundant studios. There may be one or more project teams under each studio that is headed by a project manager. The project teams are self sufficient units with designers, technical staff, drafters, specification writers, estimators, model makers, renderers as well as construction administration personnel. Each studio is capable of providing complete and comprehensive services.
- Matrix Organizations: These organizations have separate project principals each overseeing a set of projects. These principals coordinate with various departments, namely design, construction documentation, and construction administration. A project manager is responsible for the functioning of each of the departments at each different phase of the project cycle.

Just as the increasing complexity of buildings over the years has generated the challenge to coordinate between an increasing numbers of professional services (Gutman, 1988), it has also increased the need to be able to satisfactorily represent the production facilities (Rathwell, 2000). The hint lies in the following statement, in which Mintzberg (1979) aptly captures the essence of an organization:

> Every organized human activity – from making of pots to the placing of a man on the moon – gives rise to two fundamental and opposing requirements: the *division of labor* into various tasks to be performed, and the *coordination* of these tasks to accomplish the activity.

If we can diagrammatically represent an organization to not just portray the hierarchical structure but reflect the division of labor and coordination of tasks to accomplish the firm's objectives, we would be able to address the issues of the above mentioned representational shortcomings. In the following sub-section, we will see how responsibilities are divided and tasks coordinated in architectural organizations.

2.3 Architectural Project Delivery

An architectural design project cycle is defined by a series of major phases, where some of the phases merge into one another. However, often each of the new phases requires a fresh set of skills and knowledge that can only be provided by different personnel. The chronology of the structure of design projects can be basically subdivided into two major phases: (i) primary design phase and (ii) phases related to production-consumption cycle (Asimow, 1962).

Pena et al. (1987) outlines the total project delivery systems as a complete series of operations leading to the occupancy of a completed building, as portrayed in Figure 1. It consists of (1) programming (P), (2) schematic design (SD), (3) design development (DD), (4) construction documents (CD), (5) bidding, and (6) construction. The first three steps comprise the total design process.

Figure 1: Total Project Delivery System (Pena et al., 1987).

A 3D/I essay (3D/I website, 2002) on project delivery strategy divides design and construction into three distinct phases: project definition, design and construction (Figure 2), which they believe may overlap, subdivide or regroup, but cannot be eliminated.

Figure 2: Three phases of design and construction at 3D/I (3D/I, 2002).

Several techniques of project delivery are prevalent in the industry, including the traditional process of construction following design development, or a fast track process, where the construction begins even before the design is finished. Design-build is another approach where the same firm provides both design and construction. Each of these

methods present different cases of coordination approaches between consulting professionals and personnel within the firm.

2.3.1 Challenges During Project Delivery

There has been a remarkable increase in the number of individuals and work groups who are needed to produce buildings that has resulted from the increasing complexity of buildings and the requirement of knowledge of a vast range of special areas outside the realms of architecture (Gutman, 1988). This creates the need to coordinate with a wide range of professionals, such as contractors, estimators, mechanical and structural consultants, during the course of the project.

Apart from the issue of coordinating with various professionals, the architectural firms need to make a wise decision regarding their own role. In a foreword to *Innovative Management Techniques for Architectural Design and Construction,* Bradford Perkins comments that firms that are not only creative in design, but also creative in managing the design and construction process to overcome the challenges of delivering quality architecture within the constraints of budget and schedule.

Linn and Pearson (1997) see a growing number of architectural firms making management an essential part of their mission. In the process, architects with skills in marketing, business development, and project delivery are being welcomed into such architectural firms where design is no longer the whole story. Referring to leadership of an architectural firm, the article adds that a clear vision at the very beginning can provide the direction to architectural firms for “the creative orchestration of markets, strategy, process, and organization that is the hallmark of accomplished firm leaders.”

Consequently it is not surprising to note that excelling in marketing, project delivery, human resources, and financial performance are as important as design itself for most large and well established architectural firms.

Cameron (1989), a partner in design-firm marketing and strategic-planning consultants in San Francisco reiterates that marketing is not only about selling design and technical capabilities to the clients but also the firm's service potential, and supports the importance of marketing in the architect's profession.

The continuous relationship between marketing activities and project delivery through the life of a project is illustrated by Burden (1986). Figure 3 represents his ideas in a simplified form, where Figure 3a shows the traditional idea of marketing and project delivery efforts being separate. Figure 3b, shows the modified scenario, where project delivery begins within the marketing area when the client objectives are defined and analyzed, and the marketing effort continues until the end stages of a project cycle.

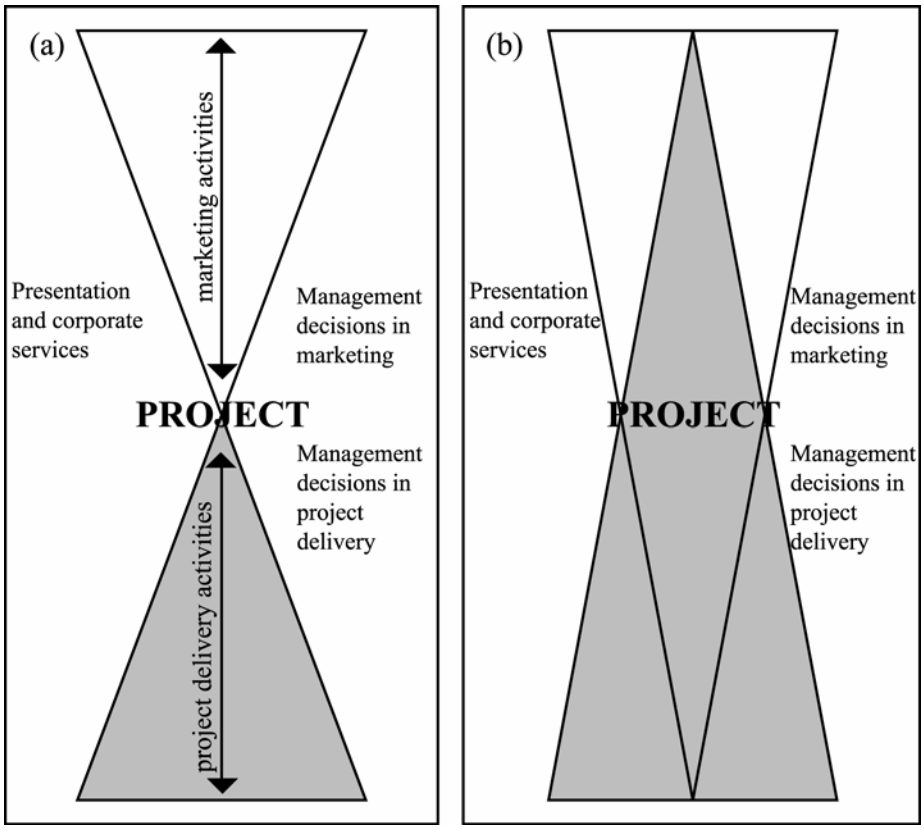


Figure 3: A diagrammatic interpretation of the two cases of marketing versus the design-production-construction process (or project delivery) as explained by Burden (1986).

The reasons for coordinating the marketing and project delivery processes, as stated by Burden (1986) are:

- Both clients and architects believe that architecture has a business as well as an aesthetic side.
- Clients believe that the process results in a product.
- The client needs to have a smooth transition from the marketing department to the design crew.

- Analyzing the client's objectives in the early marketing stages will allow the architect to control and direct the marketing message as well as build the client's confidence regarding the firm's effort to deliver what he expects.
- In an effort to have repeat business marketing efforts should not end with the commission but should continue until the end of the project. A coordinated approach will help to stabilize the firm's mission and control the kind and volume of work.
- The effectiveness of the marketing effort may be diluted or aborted if it is not coordinated with project delivery.

The role of a project manager right from the marketing stages to the construction stages of a project cycle is captured in this statement by Houston architect Steve Wintner:

> "A project manager is a businessman, a psychologist, an accountant, a technician; part designer, part nuts-and-bolts. A truly rare combination of skills" (Birnberg, 1993).

Arguably, a successful relationship between architects, contractors, and clients is orchestrated by a project manager.

Though the need for a successful coordination of processes or functions during an architectural project cycle is felt, there is a lack of literature providing a way to represent and study this coordination. Piven (1989) comes closest to this objective when he devised tables to monitor the percentage of time expended by role and by phase in a project cycle (Figure 4) as well as the various functions and duties each person performs

(Figure 5a) and the amount of responsibility expected from each role during the various stages of the project (Figure 5b). The responsibilities are characterized as primary, secondary, or participative.

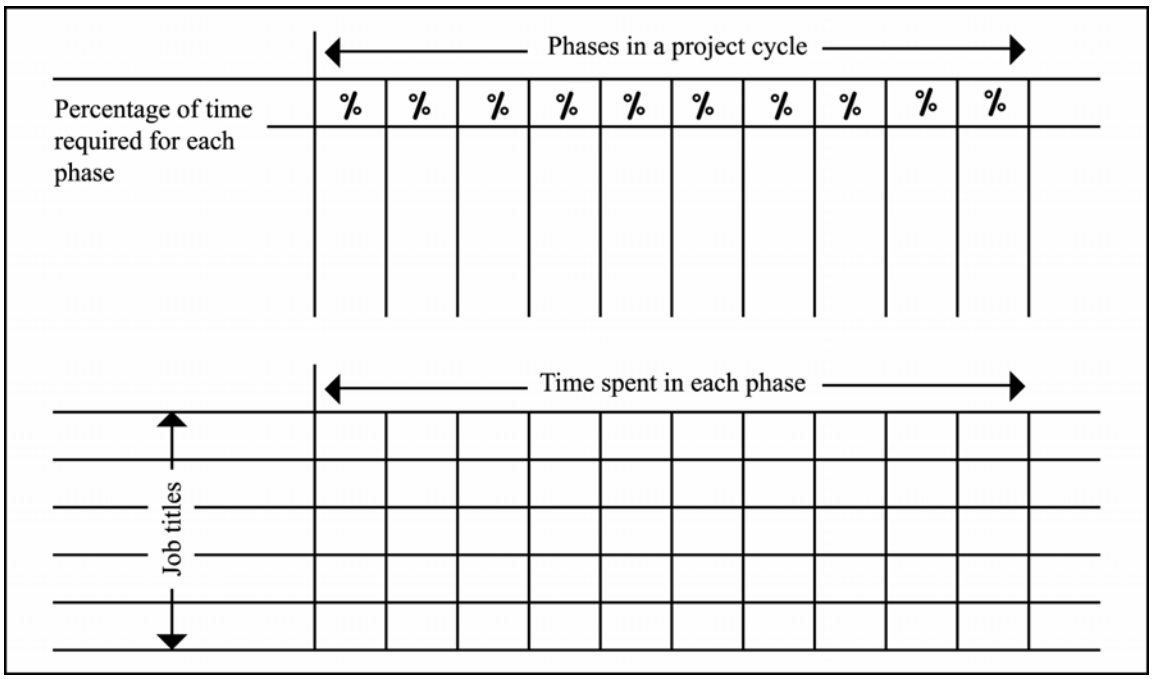


Figure 4: The idea for the project process diagram.

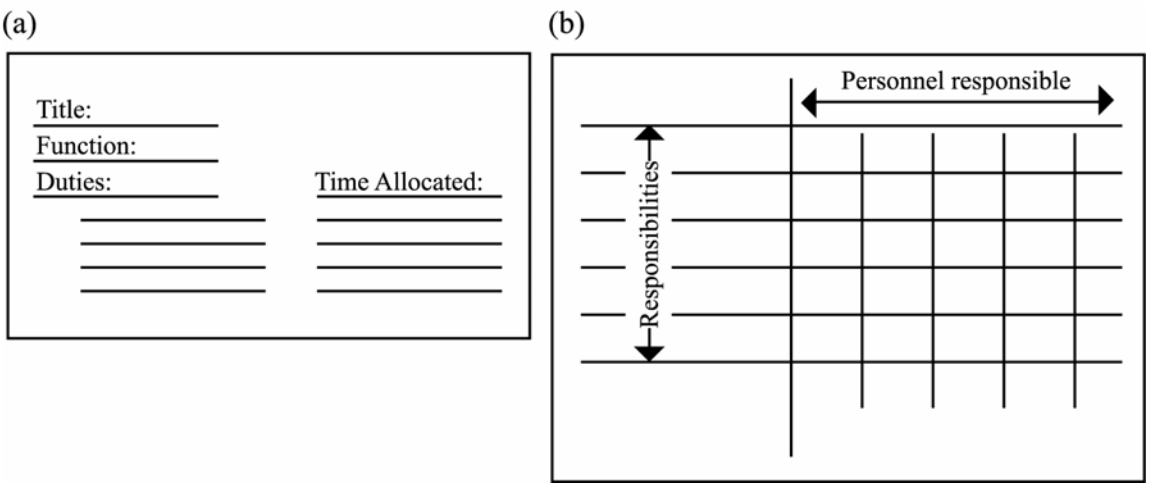


Figure 5: Tables to study the function, roles, and responsibilities of personnel during a project cycle.

We can see that several kinds of management and team structures are prevalent in the architectural industry. Each of these methods has its own flaws, as well as its own challenges to achieve perfect coordination among the involved team members. This thesis strives to diagram this coordination between personnel and their roles in the project cycle through a system integration method that is adapted from the Building Systems Integration Handbook.

2.4 Building Systems Integration Handbook Theory

The Building Systems Integration Handbook was the result of a task force of the American Institute of Architects to formalize a rational process for architectural design. It reduces all building systems into four generic systems and derives all possible practical combinations of these systems based on a certain degree of integration. The book further describes a diagrammatic vocabulary to portray the systems integration in a building.

2.4.1 Functional Systems in Buildings

A system is defined as a coherent set of physical entities organized for a particular purpose. Four systems are adequate to describe a total building functionally:

- **Structure (S) –** By definition, the structure creates the equilibrium of a range of forces necessary to allow the building to stand. Structural forms include space frame, truss, post and beam, shell, and fabric structure.
- **Envelope (E) –** The prime function of the envelope is to protect the building from weathering and physical degradation by natural forces. Expressions of the envelope include roofing and siding.
- **Mechanical (M) –** Mechanical systems provide services to the building and its occupants. Mechanical systems include heating, ventilating and air conditioning (HVAC), electrical subsystems, plumbing subsystems, elevators and escalators, security equipment and fire safety sub-systems.
- **Interiors (I) –** Interiors transform the insides of a building into a habitable environment and allow some personalization. The interior system resolves the direct demands that people make on the building and provide comfort in supporting human activity. Interior sub-systems consist of ceilings, walls, finishes, furniture, and equipment.

2.4.2 Levels of Integration in Buildings

The book defines five levels of integration between systems based upon possible physical relationships between the four primary systems in a building. The five levels

establish a range of system interaction and serve as a conceptual model for understanding the way integration takes place. They are:

- **Remote** – Systems are physically separate yet are functionally coordinated with each other.
- **Touching** – Systems are in contact with each other without a permanent connection
- **Connected** – Systems are permanently attached (welded, bolted, glued) to each other.
- **Meshed** – Systems interpenetrate and occupy the same space.
- **Unified** – The systems are no longer distinct but share the physical form of each other.

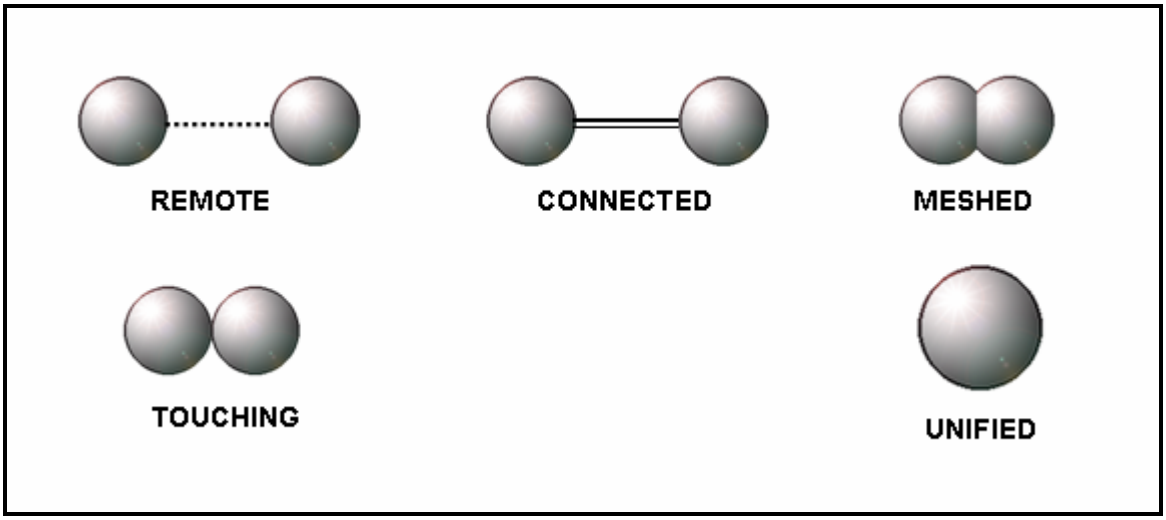


Figure 6: Five levels of integration (Rush, 1986).

The five levels of integration are expressed graphically through “ball diagrams” as in Figure 6. The ball-diagram method applied to a cross-section of the building illustrates the systems that are involved and the level of integration between them.

2.4.3 Diagramming Integration of Any Building Design

The purpose of an integration diagram is to establish and study the level of connection between systems or subsystems in a building. The diagram enables investigation of the levels of integration in order to conserve space, material, or time (Rush, 1986).

Figure 7 presents a generic idea of the building section diagrammed using the ball diagram method. The main feature of this method of diagramming is to portray the four structural subsystems: roof assembly, wall assembly, interior floor assembly, and the on-grade floor assembly separately, and then bring them together in a complete diagram.

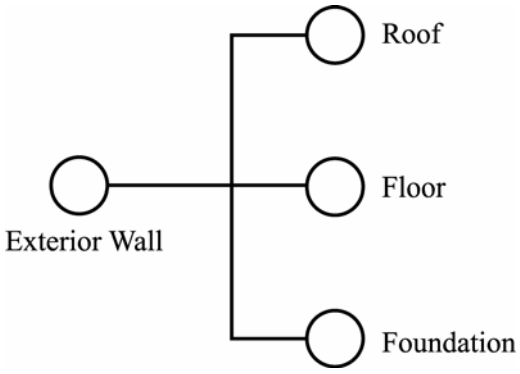


Figure 7: A generic idea of a building section through ball-diagrams.

These structural subsystems are diagrammed in terms of the levels of connection between the systems that individually classify as structure (S), envelope (E), mechanical

(M), and interior (I). All these components are diagrammed around the structure (S), which represents the basic connection between the roof structure to the wall structure, the wall structure to the interior floor structure, and the wall structure to the foundation.

The theory outlined above has been adapted from BSIH and applied to the environment of organizations to help us seek a method to represent the levels of coordination required during an architectural project cycle.

3. BUILDING SYSTEMS INTEGRATION HANDBOOK THEORY APPLIED TO ARCHITECTURAL ORGANIZATIONS

The adaptation of Rush's (1986) BSIH theory to organizations requires identification of fundamental systems and levels of integration.

3.1 Functional Systems in an Organization

Similarly to the systems in Building Systems Integration Handbook (BSIH), we can define the fundamental functional systems that exist in architectural organizations, especially the mid-to-large sized strong-service (Coxe, 1986) firms. These are:

- Administration and office management (A)
- Marketing (M)
- Design decision-making (D)
- Production/ Documentation (P_D)
- Analytical/ Evaluation (E)
- Project management (P_M)
- Construction administration (C)

I have devised the above terminology for the systems by borrowing from several sources about phases in design projects or departments in architectural organizations. Burden (1986) mentions eight major services along with four major management responsibilities during project delivery. The eight services are:

- Predesign services,
- Design competitions,
- Design development

- Construction documents,
- Bid packages-construction,
- Completion and occupancy,
- Publicity-publications-advertising, and
- Update general marketing plan.

The four responsibilities are:

- Programming design management,
- Project management,
- Construction management, and
- Facilities management.

Birnberg (1993), identifies five departments: marketing, design, production, specification, and construction. Similarly most of the references cited in Section 2 of this thesis identify the importance of one or more of marketing, design, construction, and project management, or the role of management in an organization.

3.1.1 Major Tasks Under Each System

Based upon a general understanding of the tasks and responsibilities associated with a typical architectural firm as well as supported by references, I have listed below the major tasks that can be considered under each of the seven systems.

The Administration and office management (A) system is responsible for the following tasks:

- formulating company policies and goals,
- controlling financial and budgetary policies,

- raising funds,
- maintaining inventories,
- managing accounts,
- executing payroll,
- assisting in hiring decisions,
- formulating and executing employee benefits,
- ensuring quality control.

The Marketing (M) system is accountable for the following tasks:

- designing marketing statement/ plan (Burden, 1986),
- identifying potential markets (Burden, 1986),
- studying demographic, economic and lifestyle trends to identify new markets (Linn and Pearson, 1997),
- establishing contacts,
- making proposals,
- projecting an image of the firm's specialties and capabilities (Linn and Pearson, 1997),
- reaching the identified markets through an effective communications plan (Burden, 1986),
- building a personal rapport with the client; this ensures future business (Cameron, 1989),
- extending regular and uninterrupted service and communication with the clients (Cameron, 1989),

- conducting client surveys to get feedback on the effectiveness of the firm's services during the duration of a project (Burden, 1986),
- keeping track of the clients' developments (Linn and Pearson, 1997),
- conducting a market analysis to compare current market trends and competition (Burden, 1986),
- participating in civic and community activities.

The Design decision-making (D) system is associated with the following tasks and responsibilities:

- enabling conceptual planning,
- producing the master/ site plan,
- preparing sketches and imagery of the architectural design,
- designing the interiors,
- designing the structure,
- preparing the services design imagery.

The Production/ Documentation (P_D) system is responsible for the following tasks:

- producing the conceptual/ schematic drawings,
- programming the facilities,
- preparing specifications,
- documenting the final architectural drawings,
- producing the interior drawings/ details,
- producing the structural drawings/ details,
- producing the services drawings/ details,

- documenting the working drawings,
- maintaining records.

The Analytical/ Evaluation (E) system is responsible for the following tasks:

- establishing project requirements,
- checking the specifications,
- performing code checking,
- defining environmental issues and performance,
- computing structural loads and performance,
- producing renderings (visual evaluation),
- evaluating design progress.

The Project Management (P_M) system is accountable for the following tasks:

- conducting client meetings/ contact,
- enabling quality assurance/ control,
- executing change order management,
- preparing project budget,
- reviewing consultants' expenses,
- conducting project team meetings,
- conducting consultant meetings,
- preparing project status reports,
- determining scope of the projects,
- conducting on-site observation,
- reviewing project close-out.

The Construction administration (C) system is generally associated with the following major tasks in an organization :

- supervising the production of construction documents,
- creating and checking the shop drawings,
- supervising the architectural, electrical and mechanical estimation,
- supervising the production of structural drawings and details,
- executing site development and supervising site work,
- supervising services design and execution,
- supporting supervision of construction activities.

3.2 Levels of Integration

3.2.1 Defining the Levels of Integration

We can redefine the BSIH levels of integration in terms of human relationships in organizations. These are defined in terms of the proximity of the systems to each other and the frequency of contact between the systems. The levels of integration thus are:

- **Remote** – Systems are physically separated from each other yet are still functionally coordinated. Communication between personnel in such a relationship is very rare or indirect. Personnel are usually in separate reporting hierarchies. For example, during the marketing stage, marketing personnel (M) may use brochures and presentation designed by the graphics team (E), although the graphics team is not associated directly with the project procurement efforts.
- **Touching** – Systems are in contact without a permanent connection. Personnel are in separate reporting hierarchies, yet are in occasional communication, such

as through shared committees and biweekly or monthly meetings. They could also be working closely during certain stages in a project. For example, during the programming stage in a design project, marketing personnel (M) may work very closely with the design personnel (D), to define the project in words or diagrams. They have distinctly different responsibilities, but come together to exchange vital information on the project.

- **Connected** – Systems are physically connected to each other. Personnel may be in the same or different reporting hierarchies, and may communicate through both formal meetings and informal encounters. They work closely during stages in a design project. For example, the project manager (P_M) and the chief architect (D) may belong to the same hierarchy and work closely during the design development stage. They have distinctly different responsibilities even during a certain stage in the project.
- **Meshed** – Personnel work very closely together, largely through informal encounters. Personnel may be interchangeable. For example, during the design development stage, the chief architect (D) may work very closely with the personnel in production (P_D) to convert ideas into drawings. These personnel are in the same reporting hierarchy in an organization, and work informally with their responsibilities often overlapping each other, as they go through several iterations between design and production.
- **Unified** – Systems are integrated to the point that they are no longer distinct from each other. Organizational functions are combined in a single job position. For

example, the project manager (P_M) and the chief architect (D) may be unified under the same title.

3.2.2 Understanding ‘Touching’, ‘Connected’, and ‘Meshed’ Relationships

Although there is an obvious difference between remote and unified, the three other degrees of integration express more subtle relationships that require greater elaboration. If for example, marketing and design personnel are under different hierarchies but work closely during certain stages of a project, it would be a touching relationship. Although they have distinctly different responsibilities, they come together in formal meetings to pool their efforts for the project. In case they still had their distinct responsibilities and had to work closely at stages through both formal and informal encounters, but reported to the same hierarchy, then the level of integration between them is connected. Now in case they are in the same reporting hierarchy, work closely together, and have overlapping responsibilities, then the level of integration is meshed. Their encounters are usually informal and so frequent as to be almost constant. Table 1 discusses the possible cases of similarities and distinction between the five levels of integration.

		Remote	Touching	Connected	Meshed	Unified
Interaction	Special appointment, rare contact, indirect collaboration	●				
	Regular, formal meetings		●	●		
	Informal, frequent discussions			●		
	Constant interaction				●	
Responsibility	Distinct responsibilities	●	●	●		
	Overlapping responsibilities				●	
	Multiple responsibilities					●
Hierarchy	Same hierarchy (same boss)			●	●	●
	Different hierarchy (different boss)	●	●	●		

Table 1: Possible similarities and distinction between the levels of integration.

3.3 Diagramming the Organization: Outline of a Method

An organization can be divided into two segments as in Figure 8 depending on the two major responsibilities that it might have:

- **Operations**- This is the administration and management segment. The operations segment is responsible for organizing the firm in terms of its policies and goals. It also works closely with other sections of a firm in making budgetary and financial decisions that affect the firm as a whole. This segment is also involved in the regular evaluation of different sections of the firm and making decisions on available resources including hiring and firing of personnel. One of the tasks

includes appointing or assigning principals and project managers for fresh projects.

- **Projects**: This is the production/ delivery segment. The projects segment is the other major responsibility of a firm, which is mainly in charge of the production and delivery of the firm's products. The associated responsibilities also include client management, marketing, design and research.

The functional system named Administration and office management (A) is the common factor between the operations and projects segments. This system is responsible for the operations and management of all aspects of the firm as well as controlling the shape of the projects handled by the firm. All projects handled by the firm are executed in a manner that is defined by the administration and is usually a defining characteristic of an organization. Any decision or action taken in the firm is guided by policies laid down by the firm management.

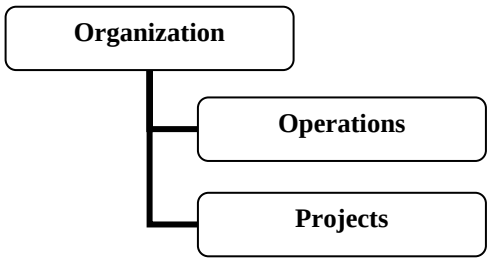


Figure 8: The segments in an organization.

Most project delivery methods start with a preliminary design; followed by schematic design, design development, contract documents, construction procurement or

sub contracting, and finally construction administration. Twomey (2002) classifies these stages into five major phases in the architectural and engineering services, such as schematic design phase, design development phase, construction document phase, bidding/ negotiation phase, and construction contract administration phase. In this research, I have classified the project delivery cycle into four major phases:

- **Procurement** - The procurement phase is mainly responsible for generating the market for the firm's products as well as initiating a relationship with the client.
- **Production**- The production phase is mainly responsible for designing and documenting the products based upon the requirements of the client as well as incorporating the firm's beliefs and style into the products.
- **Delivery** - The delivery phase of the firm is mainly responsible for ensuring the execution of the designed product to suit the requirements of the client guided by the firm's specifications and operating style.
- **Post-delivery**- This phase follows after the completion of the construction. The post-delivery phase is usually a stage where a limited warranty period is exercised as per the contract agreement for engaging both the design firm as well as the builder in case of any defect in the construction. A post occupancy evaluation may also be done at this stage. Figure 9 presents the complete diagrammatic representation of an organization in terms of its functional responsibilities.

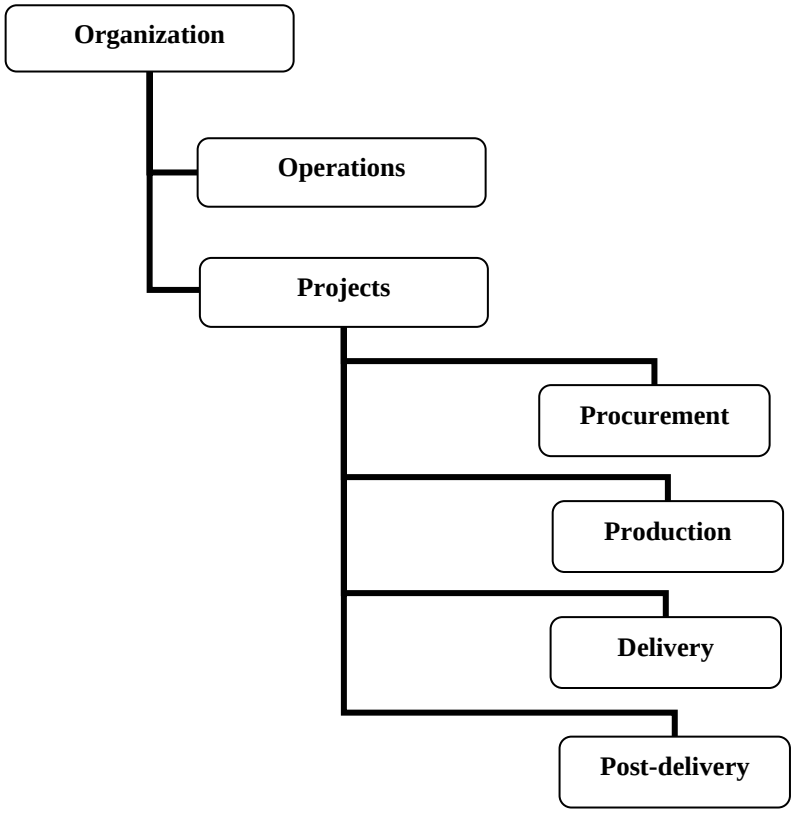


Figure 9: The phases in the projects segment.

I have devised the terminology of each of the four phases with the aim to reflect the main objectives of the project during these phases. The procurement phase is where the firm puts in all its energy to procure the project. The production phase is where the main objective or result is to produce the construction documents, which will enable bidding and construction. The delivery phase is where efforts are directed to establish a team that will build and deliver the product. The post-delivery phase is where efforts are coordinated mainly to close the project after delivery.

3.3.1 Cyclic Nature of Project Life.

The logic behind the above segregation of the projects segment can be diagrammed as in Figure 10. A project life is a cyclic process in terms of responsibilities and roles of personnel involved. My survey of five architectural organizations, support the fact that a project starts at the predesign or project initiation efforts followed by some project definition or programming in the beginning stages. I have grouped these activities collectively under the procurement phase. This is followed by the schematic design, design development and construction documentation. I have grouped these activities collectively under the production phase. The final stages of the project focus on the bid, and the construction process. These I have classified under the delivery phase. The project closure usually occurs with a limited warranty period as per the contract agreements between the architect, the client and the contractor. This constitutes the post-delivery phase.

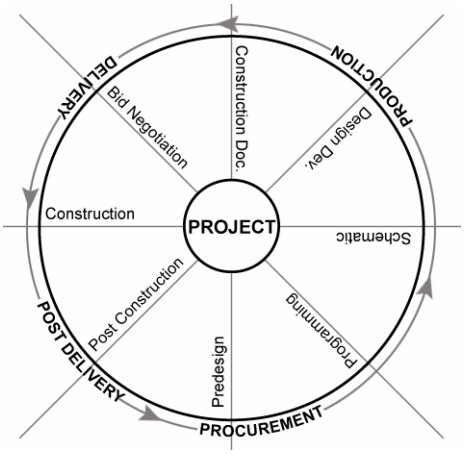


Figure 10: The cyclic nature of an architectural project.

The process is cyclic in the fact that the responsibility at the end of the project usually returns back to the same personnel that initiated the project. In some cases it is the marketing personnel, and sometimes it is the project manager, and sometimes a principal.

3.3.2 Diagramming Technique for the Projects Segment

During the course of my diagramming, I will concentrate upon the projects segment of an architectural organization and diagram the integration of systems during the four stages within this segment. This will be done by studying the degree of involvement of the seven systems described earlier at each of the above four stages in a project cycle. As mentioned earlier, each of these four stages will be controlled by the Administration and management system (A). At the most abstract level considered in this research, an architectural firm may be diagrammed as shown in Figure 11.

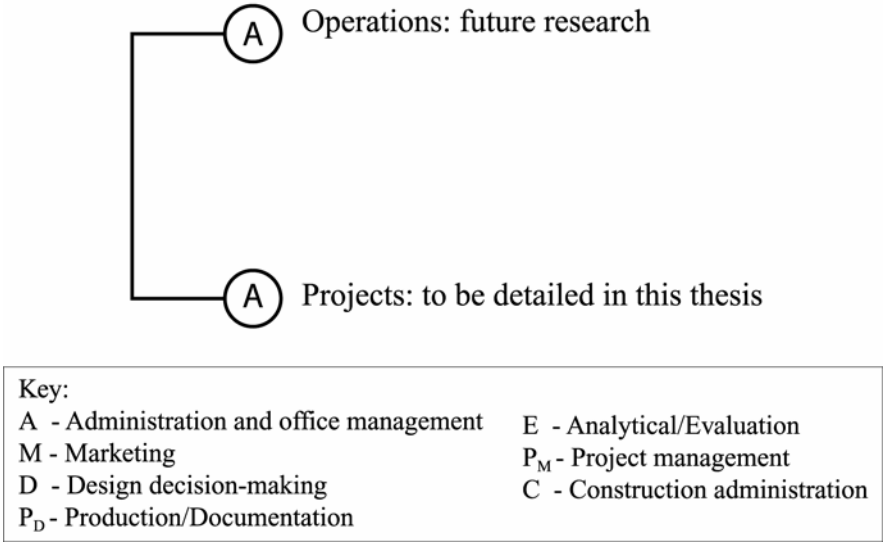


Figure 11: An organization divided into two administrative segments- operations and projects.

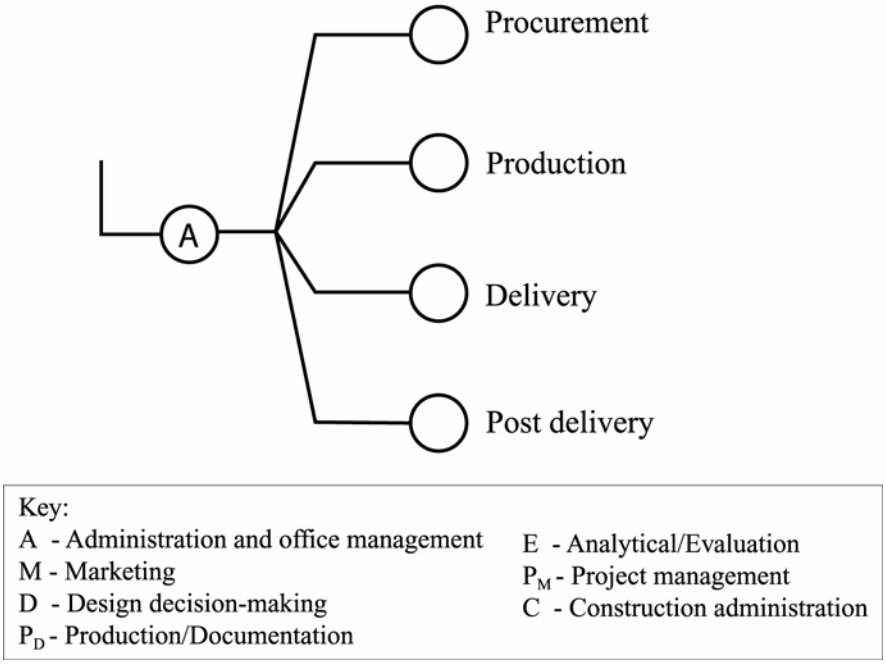


Figure 12: The projects segment can be divided into four sub-segments or phases.

Figure12 presents the four stages in the projects segment. This research focuses specifically upon the projects segment.

In the following paragraphs, I explain a few examples of diagrams that represent different phases during the project cycle in architectural firms.

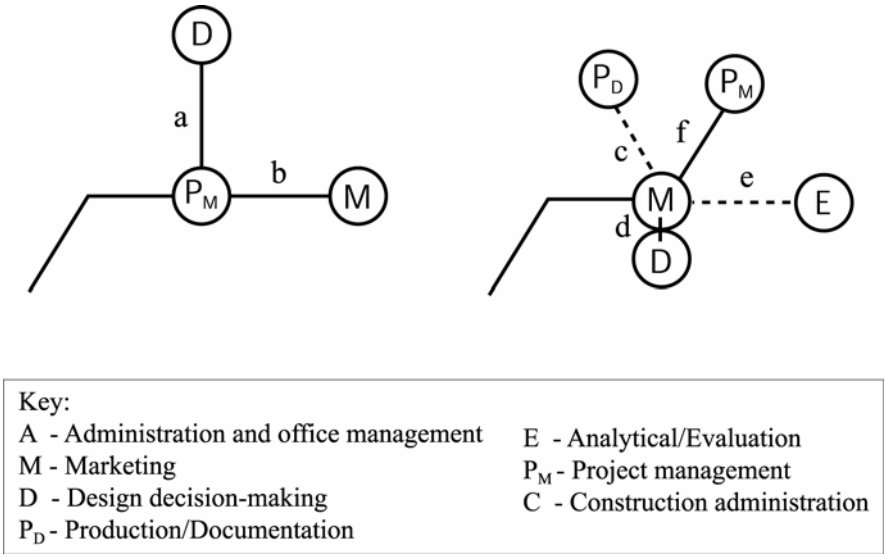


Figure 13: Two examples of integration of systems at the procurement level.

Figure 13 shows some examples of integration of systems in the procurement phase. The arcs connecting nodes signify the following:

a. Connected relationship between Project management (P_M) and Design decision-making (D). Personnel are in same reporting hierarchy and communicate through both formal and informal encounters. Although they work closely during certain stages of a project, the personnel have distinctly different responsibilities.
b. Connected relationship between Project management (P_M) and Marketing (M). The relationship between personnel is the same as the previous one.
c. Remote relationship between Marketing (M) and Production/ Documentation (P_D). Personnel are in separate reporting hierarchies and communication between them is very rare or indirect.

d. Touching relationship between Marketing (M) and Design decision-making (D) means that the personnel are in separate reporting hierarchies, yet are frequently in touch with each other through shared committees or formal meetings.

e. Remote relationship between Marketing (M) and Analytical/ Evaluation (E) reflects minimal contact between these two systems.

f. Connected relationship between Marketing (M) and Project management (P_M) represents a situation where the personnel in both the systems coordinate through meetings although they are in different reporting hierarchies.

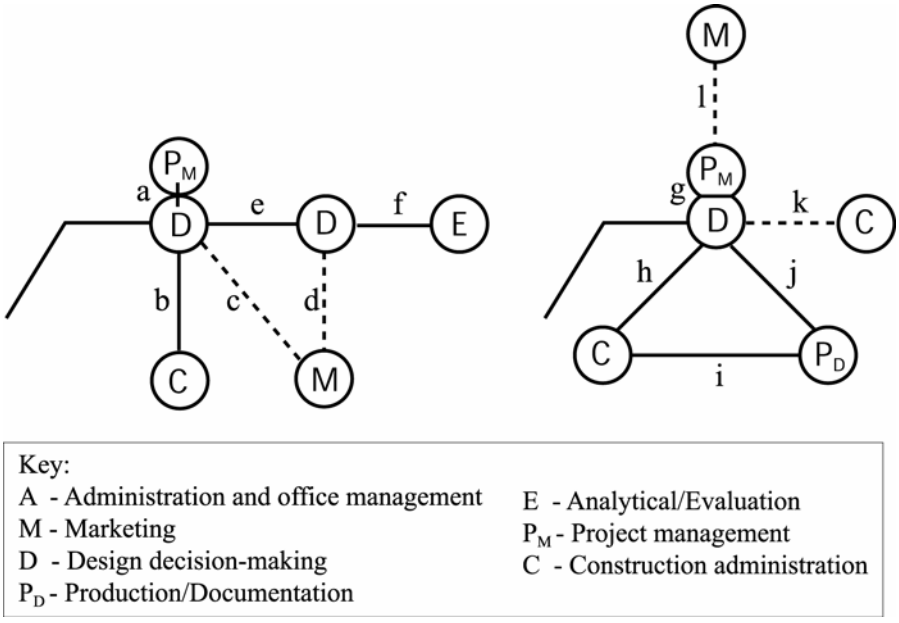


Figure 14: Two examples of integration of systems during the production phase.

Some examples of integration of systems in the production phase are illustrated in Figure 14. The arcs and nodes in these diagrams have the following interpretation:

a. Touching relationship between Design decision-making (D) and Project management (P_M) suggests regular formal interaction between personnel in different hierarchies.

b. Connected relationship between Design decision-making (D) and Construction administration (C) suggests that the two functions are performed in separate hierarchies but are coordinated through frequent informal meetings.

c. and d. Remote relationship between Design decision-making (D) and Marketing (M) represent minimal or indirect interaction between personnel in both these systems.

e. Connected relationship between Design decision-making (D) and Design decision-making (D) suggests a close interaction between the two different titles within the same hierarchy.

f. Connected relationship between Design decision-making (D) and Analytical/ Evaluation (E) represent a situation where personnel in both the systems work closely through repeated meetings or discussions.

g. This represents a meshed relationship between Design decision-making (D) and Project management (P_M). Personnel are in the same reporting hierarchy, and work closely through frequent informal encounters. Their roles and responsibilities often overlap each other.

h. Connected relationship between Design decision-making (D) and Construction administration (C) suggests that the personnel in the two systems coordinate through frequent and informal meetings even though they are in different reporting hierarchies.

i. Connected relationship between Construction administration (C) and Production/ Documentation (P_D) reflect a close interaction between the personnel in two systems through frequent formal and informal encounters.

j. Connected relationship between Design decision-making (D) and Production/ Documentation (P_D) reflect the frequent coordination between the design and production personnel who are incidentally in the same reporting hierarchy here.

k. Remote relationship between Design decision-making (D) and Construction administration (C) suggests minimal interaction between personnel in the two systems.

l. Connected relationship between Project management (P_M) and Marketing (M) represents the close relationship between personnel in the two systems, which takes place through informal discussions, and frequent brainstorming.

Some examples of integration in the delivery phase are discussed in Figure 15.

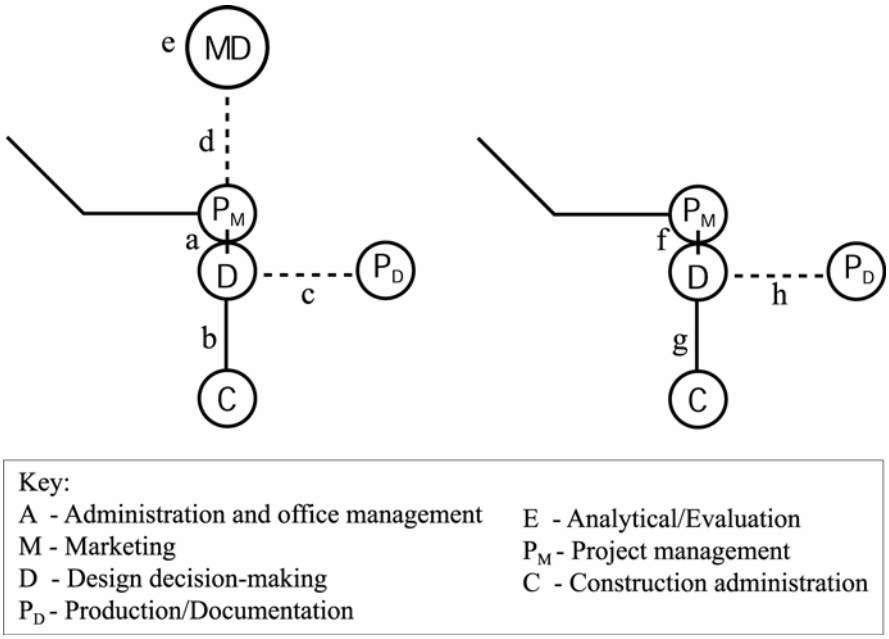


Figure 15: Two examples of integration of systems during the delivery phase.

a. Touching relationship between Project management (P_M) and Design decision-making (D) exists when the personnel in the two systems interact formally at regular meetings.
b. Connected relationship between Design decision-making (D) and Construction administration (C) takes place when the personnel in the two systems coordinate closely even though they are in different hierarchies.
c. Remote relationship between Design decision-making (D) and Production/ Documentation (P_D) suggests that there is minimal or indirect contact between personnel in both these systems.

d. Remote relationship between Project management (P_M) and Marketing/ Design decision-making (MD) suggest that very little or no direct coordination occurs between the two systems.
e. This represents a unified relationship between Marketing (M) and Design decision-making (D). Different roles are combined under the same title or position.
f. Meshed relationship between Project management (P_M) and Design decision-making (D) occur when two systems in the same hierarchy work very closely to coordinate issues.
g. Connected relationship between Design decision-making (D) and Marketing (M) suggests that the personnel in these two systems work closely through frequent informal meetings and discussions.
h. Remote relationship between architectural team leader- Design decision-making (D) and architectural intern- Design decision-making (D) suggest little or indirect interaction between the personnel in the two systems.

Some examples of integration in the post-delivery phase and their explanations are illustrated in Figure 16.

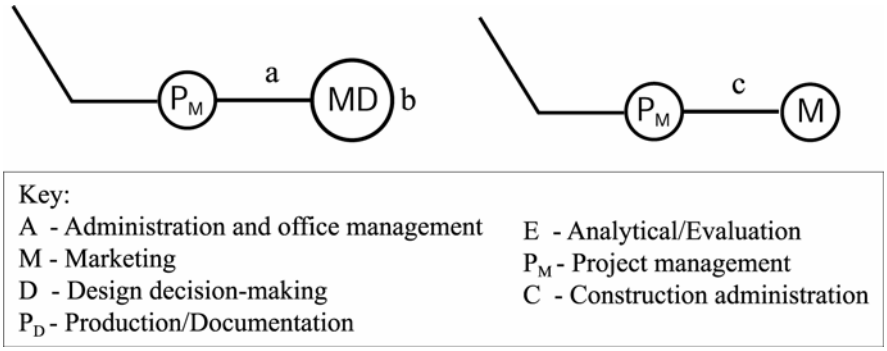


Figure 16: Two examples of integration of systems during the post-delivery phase.

a. Connected relationship between Project management (P_M) and Marketing/ Design decision-making (MD) suggest a close interaction between the personnel in the two systems through frequent informal meetings.
b. Unified relationship between Marketing (M) and Design decision-making (D) represent different responsibilities and roles unified under a single title.
c. Connected relationship between Design decision-making (D) and Marketing (M) suggest frequent informal interaction between personnel in the two systems.

The diagrams above represent the roles of personnel in the firm during different phases in a project cycle. They do not represent the titles of personnel in any way nor any particular department or group in the firm they may belong to. They are classified here based on their responsibilities that correspond to the seven systems in the organization, including the levels of integration between the different systems.

In the following subsections, I have used similar diagrams to represent each of the four stages in the projects segment of the five architectural firms. Those diagrams can be understood clearly with the help of the notes in the current section.

4 CASE STUDIES AND APPLICATION OF THE BUILDING SYSTEMS INTEGRATION HANDBOOK THEORY

I interviewed five large architectural firms in Texas to gather information on the management structure and processes they use to handle architectural design projects. The first subsection will describe the method employed in conducting the interviews, and the process that enabled me to diagram each of the subject firms. The next five subsections describe each of the five firms in detail, illustrated with ball diagrams. I will compare and contrast the final diagrams of the five firms in the next section of this thesis and discuss my observations.

4.1 Discussion of Case Study Method

Four architectural firms were initially short listed based upon personal contacts of faculty advisors. Three of these firms are located in Houston, Texas, and one in San Antonio, Texas. The firm in San Antonio was ultimately omitted due to the unavailability of a suitable appointment schedule with the principal of the firm. One firm in Dallas was selected through the personal contacts of another professor. A fifth firm was selected in Dallas through my personal contact with a current employee at that firm. Three of these firms (Firm I, III, and V) are Matrix organizations and two of them (Firm II, and IV) are Studio organizations.

A short introductory letter was sent to the contacts at each of these five firms explaining the nature of this research and requesting an appointment. This letter was followed by an e-mail to establish direct communication with the contact persons. Once an appointment was granted to me, I reconfirmed it through a telephone call.

I was able to establish contact with the Vice Presidents in three of the firms, among whom I was eventually introduced to the Managing Principal in one of the firms for the interview. Among the remaining two firms, I was able to conduct an interview with the Managing Principal in one of them and with the Senior Vice President in the other. The interviews were conducted informally, and documented using a brief questionnaire along with my personal notes during the course of the interview. The subjects signed a consent form before the interview. All these documents that were used during this process were formally cleared through the Institutional Review Board (IRB) at Texas A&M University. Copies of each of these have been attached in Appendix-A of this thesis.

The interview was thus conducted with a single person at each of these firms. The questions were directed to gather information on the demographics of the firm as well as its organizational structure. I also tried to understand the roles and titles in the firm as well as the nature of the communication that occurred between each of the personnel during a project cycle. I interpreted this information to establish the degree of involvement of each of these personnel in one or more roles and their inter-communication during each stage of a project cycle. This helped me to diagram this information into levels of integration and finally diagram the complete projects segment. The following subsections present the diagrams at each stage of a project cycle in each of the five firms, while the complete diagrams of these firms are presented in the next section to understand and compare the diagrams of all the five firms at once. To protect the privacy of participants, I have concealed the names of the subjects, their firms and

also any related references to their official websites, from where I have obtained additional information.

I have explained the ball diagrams for each of the four phases in the projects segment for Firm I in more detail than the others to avoid repetition of ideas. However, the diagrams for the other firms can be easily understood using Firm I as an example, as well by referring to the notes in section 3.

4.2 Firm I

4.2.1 Company Demographics

Firm I has been in operation for over half a century. Its roots are in Texas, but it operates 16 offices located all over the United States. The primary service of the firm is construction management and project management (60%), while the remaining 40% of its services is distributed to architecture, facility assessment, environmental services and construction. The payroll of the firm is 550. The corporate office in Houston employs about 100 people. A majority of the architects and engineers in the firm have a basic bachelor's degree, while the managers have a master's degree.

4.2.2 Disciplinary Groups

The four major service groups in Firm I at their Houston office are:

- Architecture
- Construction
- Facilities, program and project management
- Information technology

Three other groups in the firm, which exist besides the above four, are:

- Planning- The planning group is usually a part of the Architecture group and is responsible for the facilities planning.
- Human resources and administration- This group is responsible for the hiring of personnel and their benefits.
- Environmental services- This group basically comprises of engineers and scientists who are responsible for the assessment and evaluation of the environmental qualities related to each project. Some of their tasks include complying with environmental standards, site assessments, geological investigations, land use planning, and socioeconomic evaluations.

4.2.3 Roles and Titles

Titles within each group reflect the primary responsibility of the person. The major titles and corresponding tasks of some of the above major groups are described in this section.

The Architecture group is mainly responsible for master planning and architectural design. The various personnel in this group and some of their job descriptions are listed below.

- Group leader

  The leader of the campus master planning helps with the project definition, technical research, and client interaction.

- Operations officer
- Project manager
- Director of technical excellence

The director of technical excellence is mainly responsible for quality control on architecture projects, as well as training architects with CADD and building codes.

- Senior architectural project manager

The senior project manager is responsible for the delivery of project definition and programming services.

- Marketing officer
- Architectural intern

The architectural intern is responsible for producing construction documents, solving design details, and assisting project architects with project management and construction administration.

- Project coordinator

The project coordinator assists project architects and managers during project development and construction.

- Architectural team leader

The architectural team leader works with the production and development of construction documents.

- Graphic design coordinator

The graphic design coordinator is responsible for creating presentation materials, computer-generated renderings, 3-D design studies and schematic design drawings.

There are other senior personnel in the firm who oversee the architectural programming and applying software solutions to various pre-design services, as well as

lead the production team through the design and development of construction documents and supervision of the administration of documents during construction.

The Construction group is a stand-alone group with the following roles and titles:

- Group leader
- Operations officer
- Senior project manager
- Senior estimator

  A senior estimator is responsible for mechanical and electrical estimation. A separate estimator/ project manager is responsible for the conceptual projects, budgets and change orders. There are other senior personnel in charge of general and specialized construction projects.

- Project manager

  The project manager is responsible for the mechanical engineering aspects of the projects.

- Construction superintendent

  The construction superintendent oversees all construction.

The Facilities, program, and project management group is mainly responsible for facility and utility assessments. Some of the main titles and roles in this group are listed below.

- Group leader

  The group leader is responsible for national efforts in facility condition assessments, portfolio financial projections, and program and project management.

- Operations officer

The operations officer is in charge of overseeing administration, human resources, financial planning, recruiting, and client rapport.

- Senior project manager

The senior project manager is responsible for including client account management and technical leadership on project assignments.

- Project manager

The senior project manager works on assessments for colleges, and educational and commercial facilities and is in direct contact with the client. Other project managers are responsible for facility and utility assessments on educational, commercial, governmental and industrial complexes. They also provide technical assistance on power quality issues.

- Facilities assessor

The director of the facility assessment programs is responsible for the application of technology to facility assessments and portfolio financial projections.

- Marketing manager

The marketing manager for the facilities group is responsible for the coordination and maintenance of facility assessment, design/build, project management and construction management marketing materials, including proposals, presentations, and statement of qualifications.

The Information technology group is in charge of the company website, maintenance of the data base, web-based correspondence, etc. The various titles and roles in this group are described below.

- Group leader
- Director
- Programmer/ Software developer

  The programmers and software developers lead the software development for Firm I's custom software and other web applications. Some of the team members are responsible for selling, deploying and supporting Firm I's suite of facility management software.

- Marketing coordinator

  The marketing coordinator is in charge of marketing, training, and writing resources, in addition to consolidating, organizing, and distributing information.

- IT administrator

  The IT administrator is responsible for maintenance of the Firm I's servers as well as the upkeep of the networking and electronic infrastructure both locally and nationally.

- Graphic designer

  A graphic designer creates the images for corporate marketing materials and designs the layout for the print and web publications.

Other members of the group provide desktop, server, and network support to the Houston office, and also coordinate with other Firm I offices as network support specialists.

4.2.4 Phases in a Design Project (the Projects Segment)

The major phases and subsequent stages during a project life cycle at Firm I are described here. The procurement phase involves the following major stages:

- Predesign,
- Project definition, and
- Project initiation

The production phase comprises of the following stages:

- Schematic and design development (master planning), and
- Construction documentation

The delivery phase has two major stages. These are:

- Bid negotiation, and
- Construction.

Following construction, there is an additional stage comprising the post-delivery phase:

- Post construction.

4.2.5 Diagramming the Stages in the Projects Segment

For Firm I, I have assumed that the facilities group is part of the system that I refer to as Project management (P_M). Similarly, the graphic designer is assumed to be part of the system referred here as Analytical/ Evaluation (E). By the definition in section 3, a

project manager in architecture is a meshed relationship between the systems referred here as Project management (P_M) and Design decision-making (D). Similarly, the technical architect is a meshed relationship between the systems referred here as Analytical/ Evaluation (E) and Design decision-making (D).

The degree of involvement of personnel or functional groups during each of the above phases are stated and diagrammed in the following paragraphs. The procurement phase consists of the predesign, project definition, and the project initiation stages.

The following personnel play an important part during the predesign stage:

- Project manager (architecture)
- Marketing manager (facilities)
- Marketing officer (architecture)
- Graphic designer (IT)

The project manager in architecture works with the marketing personnel in architecture and facilities in their efforts to procure projects. The IT group supports by providing corporate marketing materials and presentation materials.

The following personnel are usually involved during the project definition stage:

- Senior project manager (architecture)
- Leader in master planning (architecture)
- Group leader (facilities)
- Project manager (facilities)
- Marketing officer (architecture)

The main task during this stage is to prepare the work plan or road map of the project. It is also important to define the scope, schedule and fees for the project, during this stage. The senior project manager in architecture leads the process with the leader in master planning. Personnel from facilities are responsible for the facilities and utility assessments. The marketing officer provides a smooth transition for the client from the initial process to the design process.

During the project initiation, the following personnel are important:

- Senior project manager (architecture)
- Team leader (architecture)
- Architectural intern
- Graphic design coordinator (architecture)
- Accounts group

The senior project manager works closely with the architecture team leader to provide initial shape to the project with programming services. The graphic designer manages the graphic presentations when required. Architectural interns also assist the senior architects at this stage with production tasks. The accounts group might be involved indirectly throughout the production stage overseeing financial issues related to the projects.

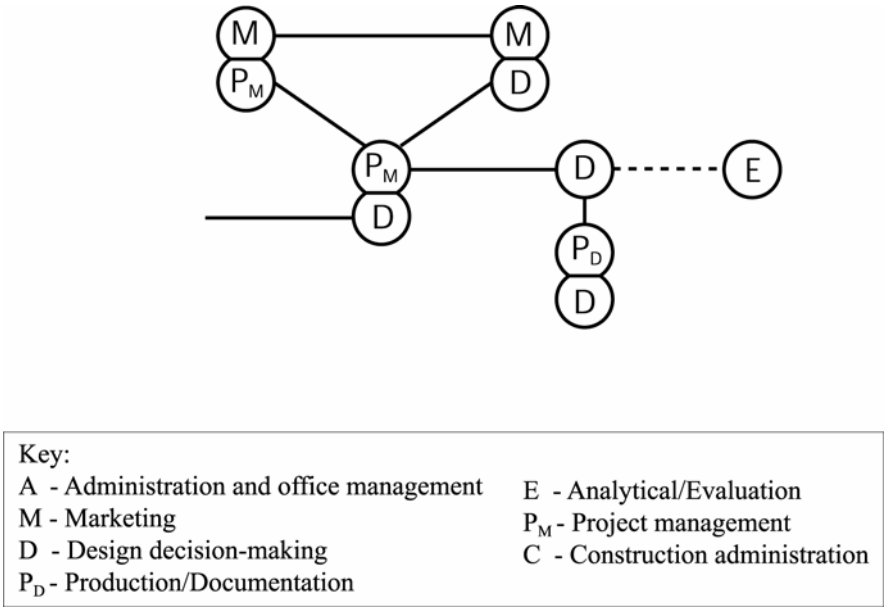


Figure 17: The diagram of the procurement phase at Firm I.

Figure 17 is a summary of the activities that take place during the procurement stage in Firm I. As portrayed in the diagram, the project manager in architecture is the main person in charge in this phase of the project cycle, but works closely with the marketing personnel (who are incidentally in the same reporting hierarchy), and the marketing personnel in the facilities group.

The systems P_M and D are in the same reporting hierarchy and are in constant interaction. Hence the systems have been represented in a meshed relationship. Similarly the systems M and P_M are in a meshed relationship since they are in the same hierarchy and also have overlapping responsibilities. The systems M and D are also in the same hierarchy and in constant contact. The three meshed systems have a connected relationship among themselves as they work closely through frequent informal and formal interactions, although they are in separate or similar reporting hierarchies.

The project manager in architecture also communicates a great deal with the team leader in architecture, who in turn works with the architectural intern for production of initial drawings. The graphic designer is sometimes involved at this stage.

The systems P_D and D are in a meshed relationship signifying a constant interaction between them since they are in the same reporting hierarchy. They have a connected relationship with the system D signifying frequent meetings of informal nature. The system E, which represents the graphic designers interact rarely, hence have a remote relationship with the system D.

The production phase consists of the design development, and the construction documentation stages.

During the design development (master planning) stage at Firm I, the following personnel play an important role:

- Senior project manager (architecture)
- Team leader (architecture)
- Project manager (facilities)
- Architectural intern
- Accounts group

The senior project manager and the team leader in architecture lead the design process at this stage. The project manager in facilities oversees the facility requirements. Some members of the design group and the architectural intern help mostly with the production.

The following personnel play an important role during the construction documentation stage:

- Senior project manager (architecture)
- Team leader (architecture)
- Technical architect
- Architectural intern
- Accounts group

The senior project manager along with the team leader produces the construction documents. The technical architect is responsible for quality control at this stage. Some members of the design team and the architectural interns assist during this process with production work.

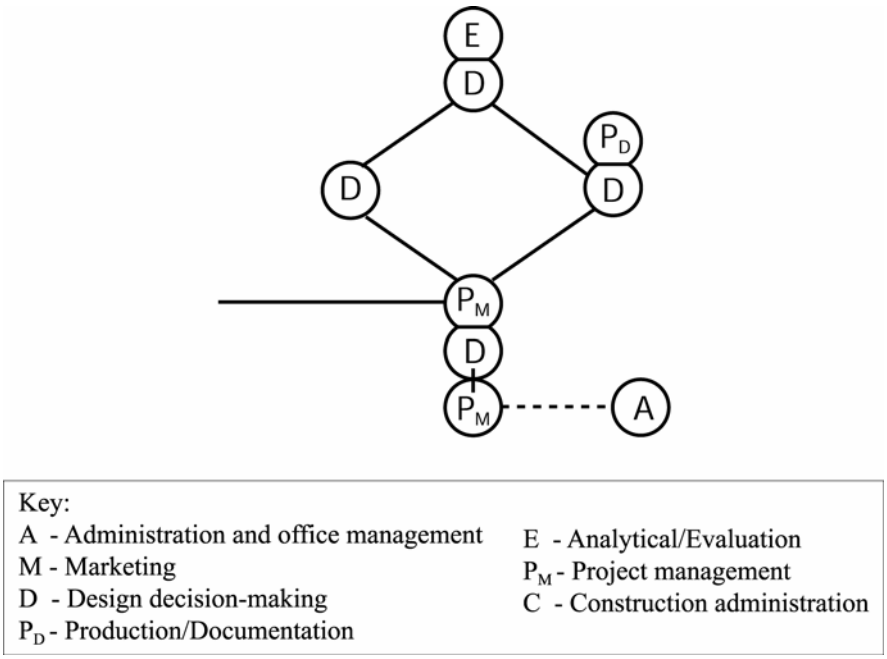


Figure 18: The diagram of the production phase at Firm I.

Figure 18 diagrams the production phase constituting the design development and construction document stages. Once again, the project manager in architecture plays an important role in this phase. This person works closely with the team leader in architecture, the production personnel in architecture, and the technical architect in architecture. He has a touching relationship with the project manager in facilities through occasional communication.

The systems P_M and D are in a meshed relationship as they are in the same reporting hierarchy as well as are in constant touch with each other. This meshed system plays the lead role at this stage, which is suggested by its immediate proximity to the node connecting it to the system A (not shown here; refer Figure 39). The meshed system of P_M and D are in a touching relationship with the system P_M signifying a regular formal interaction between the two although they belong to different hierarchies. The meshed system of P_M and D are also in a connected relationship with the system D, the meshed system of E and D and the meshed system of P_D and D suggesting frequent informal interaction. The meshed system of E and D represents the technical architect in the architecture group. The technical architect has overlapping responsibilities of an evaluative role and that of a designer. The system P_D and D are also in a meshed relationship signifying constant interaction between the two systems while being in the same hierarchy.

The accounts group (which is assumed here as part of the system called administration and office management) sometimes reviews the financial issues with the

project manager in facilities. The accounts group is represented by the system A and is in a remote relationship with the project manager being limited by interactions through appointments only.

The delivery phase at Firm I consists of the bid negotiation and the construction stages.

The bid negotiation stage brings the following personnel into the forefront:

- Project coordinator (architecture)
- Technical architect
- Project manager (facilities)

The project coordinator defines the terms of the bid negotiation along with the help of the technical architect and project manager.

The following personnel are important during the construction stage:

- Project coordinator (architecture)
- Construction superintendent
- Project manager (facilities)
- Technical architect

The construction superintendent and the project manager coordinate closely with the project coordinator during the construction. The technical architect assists the project coordinator in making technical decisions.

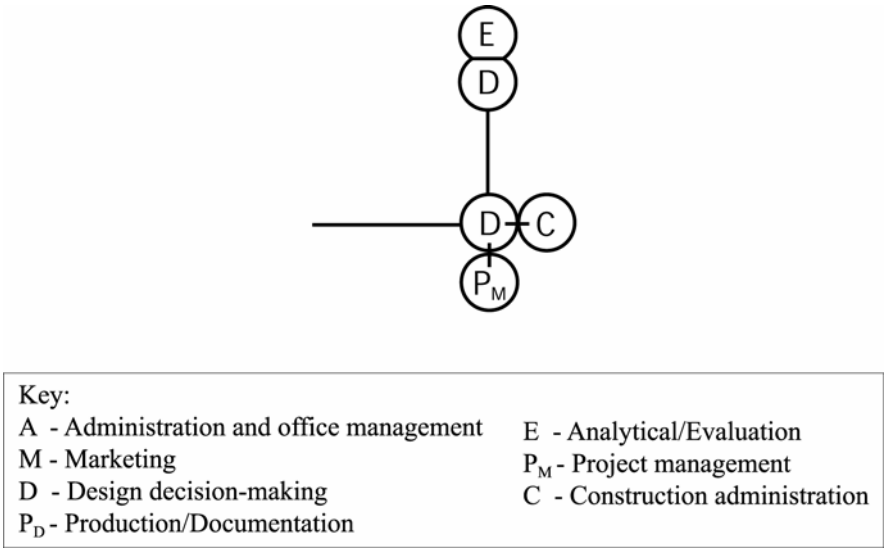


Figure 19: The diagram of the delivery phase at Firm I.

Figure 19 captures the delivery stage at Firm I. The delivery stage comprising of the bid negotiation and construction stages is summarized in the above diagram. The project coordinator in architecture plays an important role here with close communication with the project manager in facilities and personnel in the system referred here as construction administration (C). The project coordinator in architecture is represented by the system D here. This system is in a touching relationship to the systems P_M and C, signifying regular formal meetings although they are in different reporting hierarchies.

The technical architect in architecture also plays a prominent role by working closely with the project coordinator in architecture. The technical architect is represented by the meshed system of E and D, similar to the case in the previous phase. This meshed system is in a connected relationship with the system D as they interact through regular formal meetings although being in the same hierarchy.

The following personnel play a crucial part during the post construction stage in the post-delivery phase:

- Project manager (facilities)
- Marketing officer (architecture)

After the construction the project manager in facilities follows up on the performance of the designed structure. The marketing officer assists the project manager.

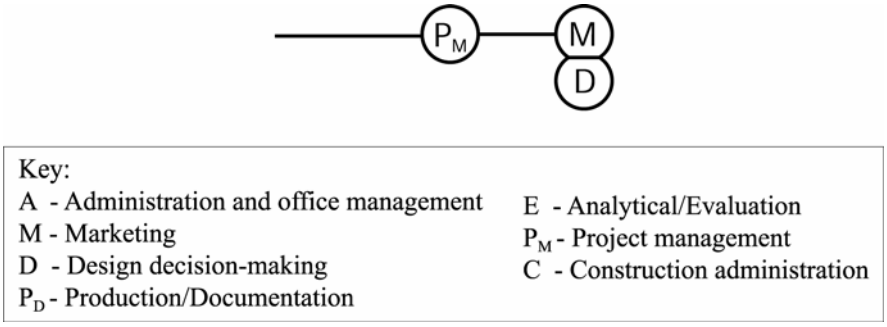


Figure 20: The diagram of the post-delivery phase at Firm I.

Figure 20 portrays the post-delivery phase at Firm I. For the post-delivery phase the project manager in facilities is the main person in charge, but working closely with the marketing personnel in architecture. The system P_M is directly connected to the node from the system A (not shown here; refer Figure 39). This system is in a connected relationship with the meshed system of M and D. The meshed system of M and D represent a constant interaction between the two systems with overlapping responsibilities within the same hierarchy.

The complete diagram for the projects segment at each of the five architectural firms is presented in section 5, where they have been discussed in more detail to compare and contrast them.

4.3 Firm II

4.3.1 Company Demographics

Firm II is a 38 year old firm with its headquarters in San Francisco, with more than 16 offices located all over the US and abroad. The firm offers services in a wide range of areas including education, workplace, entertainment, hospitality, retail, brand strategy, and urban design.

The size of the firm is 1800 employees worldwide, with the office at Houston employing about 180 people. A majority of the architects and engineers in the firm have a bachelor's degree, while most of the managers have a master's degree.

4.3.2 Corporate Setup

A chairman heads the firm. There is a vice chairman and chief executive officers and presidents. They make up the board of directors. There is also an executive council of ten members, while each office has one or more vice presidents.

4.3.3 Studio System

Firm II has used the studio system for a long time. Primarily, the firm is divided into studios which are managed by studio directors.

Each studio is led by one or two studio directors, and is run independently but are not financially responsible. At a given time, more than one studio can have the same studio directors, although they might be working on entirely different projects. The firm

currently has nine active studios dealing with architectural design projects, planning or interior projects, as well as graphics and branding projects. The studio directors meet twice a week to review the progress of all the projects of the company.

The studios basically consist of a project manager, designers, technical personnel, and planners. The average size of a studio is 20-25 people.

4.3.4 Departments and Support Groups

The firm uses external engineering consulting group that specialize in structures, civil, mechanical, landscape and traffic planning. Similarly an external estimation consultant is often called upon to provide preliminary and final estimation for a project.

Apart from the studios, Firm II has a marketing group and an accounts group. A single person currently manages the human resources aspects. Two studios comprised of interior designers and graphic/ branding experts form a consulting group. These groups are explained further in the following points:

- The marketing group consists of five people headed by a marketing manager. The marketing group works closely with the studio directors to procure new projects and maintain relations with the client.
- The accounting group is responsible for handling employee perks and benefits, as well as the financial issues related to each project.
- The human resources department helps with the hiring procedures by working closely with the studio directors, or managers of the other departments.

- The consulting group is made up of members of two studios specializing in interior design and graphics/ branding. They work closely with the design studios during the programming stage to give a feasible direction to the design.

4.3.5 Diagramming the Stages in the Projects Segment

The procurement phase at Firm II consists of the predesign and programming stages. The following personnel play an important role during the predesign stage:

- Studio director
- Marketing manager
- Studio members (architects and programmers)

The studio director works closely with the marketing manager to formulate proposals for an incoming project. The members of the studio follow it up with more details.

The programming stage has the following personnel playing a leading role:

- Studio director
- Technical group
- Consulting group
- Engineering consultants

The studio director employs a technical team to help in the code analysis at a very early stage. The interior group (consulting group) is involved to provide direction to the design even before it reaches the schematic stage. The client as well as some engineering consultants may be involved at this stage to program the goals and objectives of the project clearly.

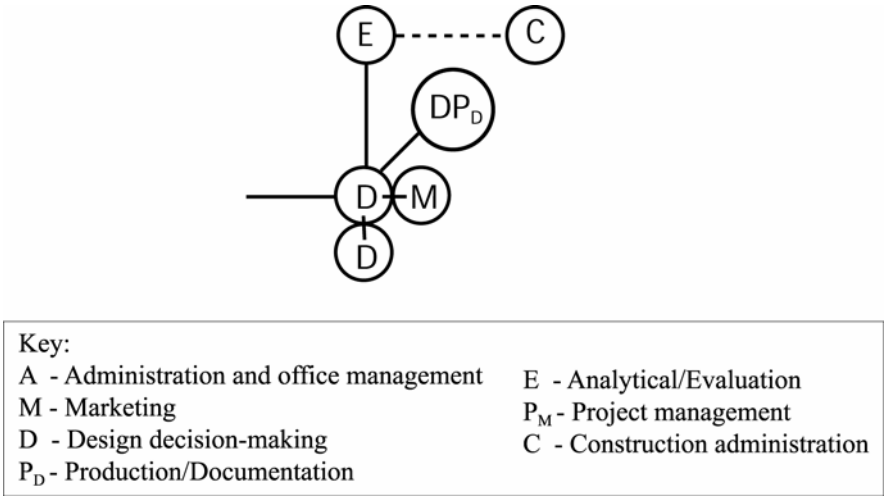


Figure 21: The diagram of the procurement phase at Firm II.

The procurement phase at Firm II is diagrammed in Figure 21. The studio director is represented here as part of the system referred here as Design decision-making (D). Similarly, the interior group (consulting group) is part of the Design decision-making (D) system, although they are under a different reporting hierarchy than the studio director in this firm. The technical group is represented here as part of the system called Analytical/ Evaluation (E) while the engineering consultants are assumed to be part of the system called Construction administration (C). The studio members at this stage are mostly involved for production purposes, and are classified here as a unified relationship between the systems Production (P_D) and Design decision-making (D).

The production phase at Firm II consists of the schematic design, design development and construction documentation stages.

The schematic design stage brings the following personnel to the forefront:

- Studio director
- Project leader
- Consulting group
- Estimation consultants

The studio director shares his responsibilities from this stage with a project leader appointed from within the studio. The consulting group and an external estimation group support the development of a schematic design.

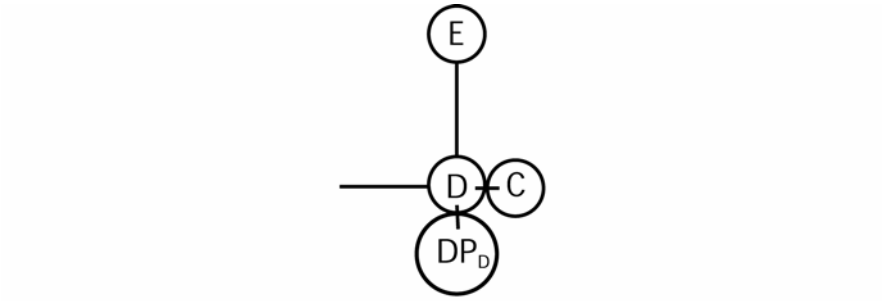
The following personnel are important during the design development and construction documentation stage:

- Studio director
- Project leader
- Technical group

The project gradually shifts from the design development stage to the construction documentation stage by shifting the focus from the design to the technical aspects of the project. The technical group, which is part of a studio, plays a more important role during the construction documentation stage.

The basic tasks during these stages are:

- to develop documents that explain the design to the client and consultants,
- to adjust and modify the design successfully to fit the requirements and pricing.



Key:
A - Administration and office management
M - Marketing
D - Design decision-making
P_D - Production/Documentation
E - Analytical/Evaluation
P_M - Project management
C - Construction administration

Figure 22: The diagram of the production phase at Firm II.

Figure 22 summarizes the activities and roles during the production phase at Firm II. The estimation consultants have been represented under the system called Construction administration (C), and are in a touching relationship with D as they interact regularly through formal meetings. The project leader is part of the system called Design decision-making (D) but has an equal amount of responsibility with production of drawings, which is a part of the system called Production (P_D). Hence this person is represented here as a unified system of D and P_D.

The technical group is represented here as the system Analytical/ Evaluation (E), based on their role during this phase. This system is in a connected relationship with the system D as they are in the same reporting hierarchy and have frequent informal discussions.

The delivery phase at Firm II is defined by the bid negotiation, and construction stages:

The following personnel play an important role during the bid negotiation:

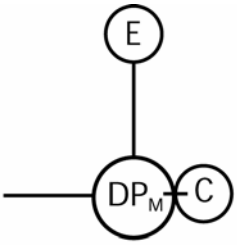
- Studio director
- Project leader
- Technical group

The construction documents are submitted for bids and tenders during this stage and a contractor is selected to execute the project. The project leader takes charge at this stage to represent the client and review the work of the contractor and also reviews the payments made to the contractor. The technical group supports the project leader.

The following personnel are important during the construction stage at Firm II:

- Project leader
- Contractor

The project leader makes regular inspections of the construction assisted by the studio architects and is also considered the construction administrator at this stage.



Key:
A - Administration and office management
M - Marketing
D - Design decision-making
P_D - Production/Documentation
E - Analytical/Evaluation
P_M - Project management
C - Construction administration

Figure 23: The diagram of the delivery phase at Firm II.

Figure 23 portrays the delivery phase at Firm II. The project leader's responsibility here includes that of a project manager. Hence he is represented here in a unified relationship between the systems Design decision-making (D) and Project management (P_M). This unified system is a connected relationship with the technical group represented here as E. The contractor represented as C is a touching relationship with the unified system of P_M and D as these two systems interact regularly through formal meetings.

The post-delivery phase at Firm II consists mainly of the post construction stage, which includes limited warranty period, depending upon the contract between the client, the architect, and the contractor.

The following personnel are responsible during the post construction stage:

- Project principal
- Marketing manager

A project principal appointed from among the studio directors may review the projects after completion along with marketing personnel.

Key:
A - Administration and office management
M - Marketing
D - Design decision-making
P_D - Production/Documentation
E - Analytical/Evaluation
P_M - Project management
C - Construction administration

Figure 24: The diagram of the post-delivery phase at Firm II.

Figure 24 diagrams the firm at post-delivery phase. The project principal's responsibilities include that of a project manager while being in the design team (studio). Hence he is represented here as a unified system of D and P_M. The system M comprising of the marketing personnel is in a touching relationship with the unified system, and interacts through regular formal discussions.

4.4 Firm III

4.4.1 Company History and Demographics

Firm III has its roots in the early 1940s and derived its present structure in the mid 90's. It has developed into a 230 person architecture and engineering firm focusing on educational projects. It is focused exclusively on innovative educational facility design. The firm has been named one of the Nation's leading K-12 educational design firms through their service to education. Firm III's services include site selection, programming, bond issue planning and public relations assistance, master planning, architectural design, interior design, project management, and all related engineering required for a complete educational facility.

Although the home office is located in Dallas, this firm has satellite offices located throughout Texas, Maryland and Virginia. These offices have collectively produced school projects in Texas, New Mexico, Arizona, California, Virginia, Maryland, North Carolina, and Florida. With more than 2,000 projects completed nationwide during the last half century, Firm III stands apart with considerable experience in every aspect of school design.

A majority of the professionals in the firm have a basic bachelor's degree in architecture, a few engineers hold a bachelor's degree in engineering, and most managers hold a bachelor's degree.

4.4.2 Disciplinary Groups

The firm consists of the following groups, distinguished primarily by tasks that they perform:

- Marketing
- Programming
- Project management
- Office management and administration including human resources
- Finance (accounting)
- Production (design, graphics, quality control, and specification)
- Structural design

Characteristic features of some of the above groups are as follows:

The marketing group is the interface group between the project teams and the client. Their main task is to establishing new contacts by research or retaining existing ones through correspondence by visits, conferences and even dinners.

The production group is mainly in charge of the conceptual design and design development. They are partly involved during the development of the construction document and bid negotiation. The technical architect plays a pivotal role during the construction document, bid negotiation and construction phases, coordinating details and ensuring constructability. He is also the main interface between the contractor and the

client during the construction stage. The senior personnel in the group are also responsible for interviewing when hiring new design staff.

The office management and administration group oversees the procedures and processes followed in the firm. The human resources group is responsible for the administrative aspects of hiring.

4.4.3 Diagramming the Stages in the Projects Segment

A summary of Firm III's architectural process, from conception through completion and beyond and their diagrammatic representation is explained in the following paragraphs.

The procurement phase consists of the predesign and programming stage at Firm III. The following personnel play an important role during the predesign stage:

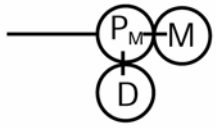
- Project manager
- Marketing personnel

The programming stage at Firm III brings the following personnel to the forefront:

- Project manager
- Marketing personnel
- Programming

Programming is the first step in conceptualization of a new facility and is without a doubt the most important phase in the architectural process. In the programming phase a school is built in words. Programming establishes the criteria required to serve the desired educational program. Programming is a critical phase in the architectural process because every decision throughout the development of a school

facility project is first cross- referenced against the program to ensure the integrity of the school in relation to educational objectives. At the beginning of every project, Firm III meets with school officials to guide the district through the development of the project's educational program. Once the goals and parameters are set they can then move to the second stage of the planning process.



Key:
A - Administration and office management
M - Marketing
D - Design decision-making
P_D - Production/Documentation
E - Analytical/Evaluation
P_M - Project management
C - Construction administration

Figure 25: The diagram of the procurement phase at Firm III.

Figure 25 represents the procurement phase at Firm III. The project manager being in immediate proximity to the system A (not shown here; refer Figure 41) plays the pivotal role here. This system is in a touching relationship with the programming personnel (represented as D), and the marketing personnel (represented as M). The systems are in separate reporting hierarchies yet get together regularly through formal meetings. Programming is considered here as a predesign activity and hence categorized under the system D.

The production phase at Firm III consists of the schematic design, design development, and the construction document stages.

The following personnel play an important role during the schematic design stage at Firm III:

- Project manager
- Project architect
- Director of design
- Programmer
- Graphics

Schematic design is the next step in the architectural process. This step is broken into two phases. The first phase is the on-site design. Once these basic designs have been developed during the on-site design process, the architects bring their sketches and notes back to the office and begin developing a more comprehensive set of schematics for the school.

In the second phase of schematic design all the basic elements of a project's design are fleshed out, including such things as confirmation of spaces, space relationships, and square footages. In this stage of the design process, architects rework the drawings from the on-site design. Schematic design is where a project's concept is fine-tuned and cross-checked against the educational program.

Design development is the next stage in the production phase, where the following personnel play an important role:

- Director of design

- Project architect
- Project manager
- Production member
- Graphics

Design development is the step in the architectural process where the project becomes real. This is when decisions regarding design and construction issues are made. Design development is also the beginning of the construction documentation phase and includes basic elements such as elevations, building sections, furniture layouts, floor plans, code reviews, structural and mechanical solutions, roof plans, and wall sections. All finishes and colors are selected during this phase as well. Design development encompasses the first 35 percent of the construction documents phase and thus explains the project well enough to get bids on a project. The director of design also has a responsibility to evaluate the project at this stage.

Construction documentation is the final major step during the production stage. It results in the production of the construction drawings and specifications. The following personnel play lead roles at this stage:

- Project manager/ technical architect
- Project architect
- Engineering personnel
- Production member
- Marketing personnel

This is the phase that details how a project is meant to be built. The construction documentation phase writes the instructions for the contractor. It is a continuation of design development and documents every last detail necessary for construction. Another important element of construction documentation is that these detailed documents protect the school district and the architect in court should something go wrong with construction.

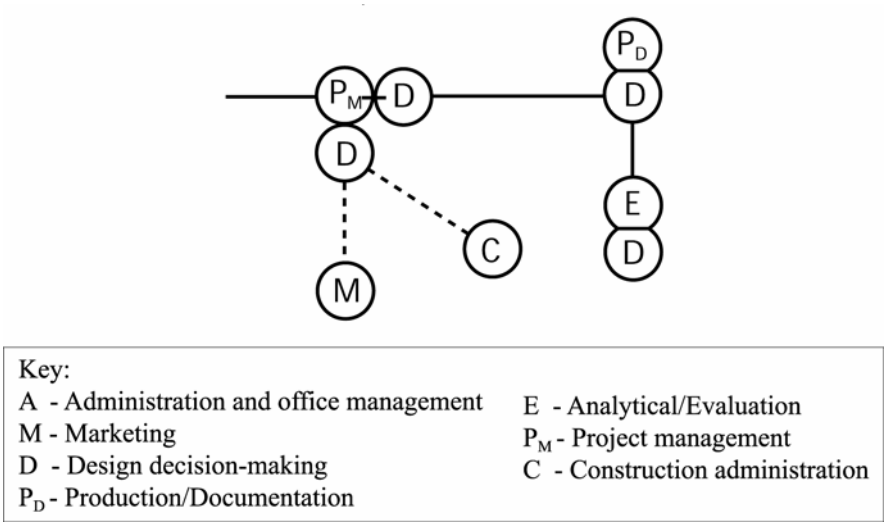


Figure 26: The diagram of the production phase at Firm III.

Figure 26 diagrams levels of integration between the systems in the production phase at Firm III. The project manager works closely with the project architect and the director through regular formal interaction. Hence the system P_M and the two D's representing the project architect and the director of design are in a touching relationship. These three touching systems are in a connected relationship with the production team which is represented by a meshed relationship between P_D and D. The production team is itself in

a connected relationship with the Evaluation system (E) representing the technical architect. The technical architect is represented by a meshed relationship between the systems E and D.

The marketing and construction personnel interact very rarely with the architect through special appointments. Hence these two systems represented here by M and C respectively, are in remote relationships with D.

The delivery phase at Firm III consists of the bid negotiation, and the construction stages.

The following personnel are important during the bid negotiation stage:

- Project manager/ technical architect
- Marketing personnel
- Project architect

Bidding can be conducted as early as the end of design development or towards the end of construction documentation. Firm III follows several construction delivery methods, such as Construction Management At-Risk, Construction Management Agency, Competitive Bid, and Competitive Sealed Proposals. Appendix-B provides more details.

The construction stage brings the following personnel in the forefront:

- Technical architect/ project manager
- Marketing personnel

Firm III's unique project management system assigns a registered architect to each project. This project manager maintains daily contact with the contractor and

routinely visits the construction site, often daily, to protect the integrity of the construction documents and the project. From start to finish (and beyond), the project manager is always available.

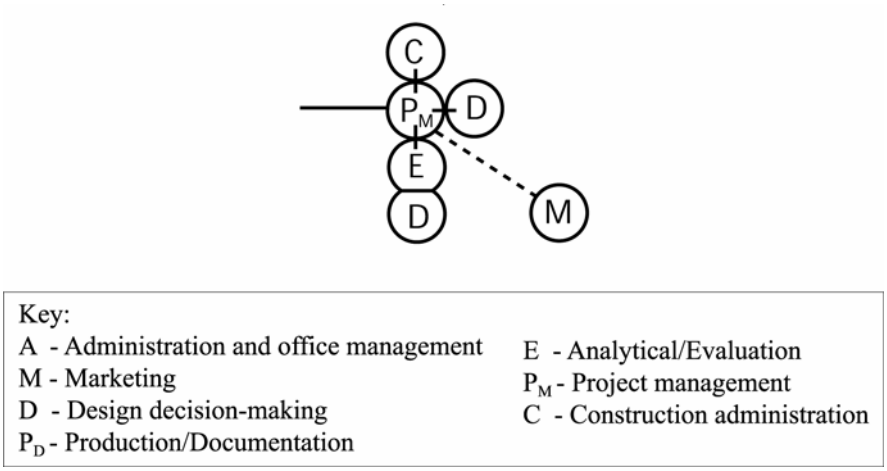


Figure 27: The diagram of the delivery phase at Firm III.

Figure 27 portrays the delivery phase at Firm III. The project manager works closely with the technical architect through regular formal meetings. Hence P_M has a touching relationship with the meshed system of E and D, which represents the technical architect. P_M is also in a touching relationship with the system C and D, which represent the contractor and the project architect respectively. The marketing personnel represented by M is in a remote relationship with P_M since the system is very rarely associated in this phase.

The post-delivery phase is primarily defined by the post construction stage at Firm III. The following personnel play an important role during the post construction stage:

- Marketing personnel

- Architects

Firm III feels strongly that their services extend beyond completion of a project. They stay with the project through the first year after completion to make sure any problems that may develop are resolved. Firm III agrees on a limited warranty period with the owner and the contractor, usually nine to 10 months after the substantial completion date, noting any items that may need attention under the warranty.

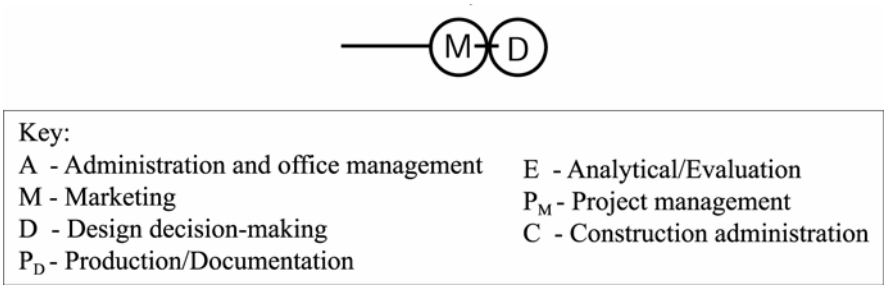


Figure 28: The diagram of the post-delivery phase at Firm III.

Figure 28 is a diagrammatic representation of the post-delivery phase at Firm III. The marketing personnel represented by M are in a touching relationship with the architects represented by D. They correspond regularly through formal discussion in this phase.

4.5 Firm IV

4.5.1 Company History and Demographics

Firm IV was founded in 1938. It is one of the largest architectural firms in the US, with a staff of nearly 250. The Dallas office has nearly 200 employees. The firm also has offices in Dallas, Fort Worth, New York, Miami and London.

The firm specializes in Aviation, Education and Corporate design sectors, and is ranked within the 150 top design firms on the Engineering News Record listings. For the aviation industry, Firm IV provides services in master planning of airports and terminal design, including airport and airline facilities. For the education sector, the firm designs facilities from pre-Kindergarten to college education. This firm has worked with several major corporate to design headquarters and office buildings as well as helping in adaptive reuse of buildings.

Firm IV also provides services for corporate interior design and most recently has expanded the healthcare market.

A majority of the professionals in the firm hold a bachelor's degree in architecture. A few engineers hold a bachelor's degree, while most managers hold a master's degree.

4.5.2 Studio System

Primarily, the firm is divided into studios that are managed by principals, who in turn report to the managing principals of the firm. The vice presidents or associates report to the principals of the firm.

The studio is conceived as a small firm by itself with about twenty to thirty people in each studio. The studio reflects the personality and style of the principal. Each studio can have one or more principals, vice presidents and associates. Studios are divided by market sectors.

Studios may hire new members from outside the firm with the help of the human resources group or may swap members among themselves to ensure operability. The studios basically consist of a project manager, architects, programmers, and construction

administrators. Figure 29 reflects a typical studio organization.

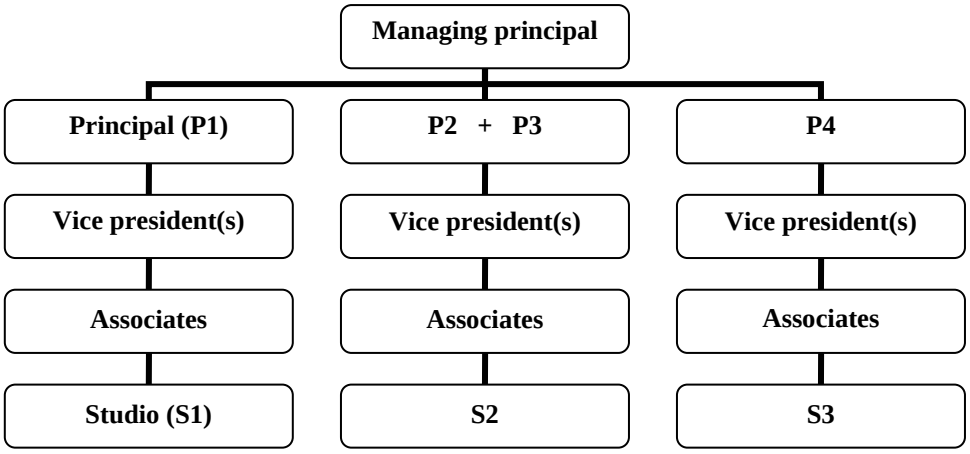


Figure 29: The studio organization.

4.5.3 Support Groups

Apart from the studios, Firm IV has support groups to assist in the smooth performance of the firm. They are the marketing, administration, technical support, media lab, and institution design review committee.

The marketing support group has two parts, one that works in-house and the other outside. The outside marketing group is in charge of seeking prospective clients in the firm's expertise areas. The in-house marketing group is in charge of preparing proposals, preparing interviews with clients, preparing presentation slides and brochures.

Administration support consists of the accounting and human resources groups. The accounting group is in charge of processing the accounts related to projects as well as dealing with the financial aspects of the employees and their benefits. They work closely

with the technical support staff. The human resources group works with the respective groups or studios that need to hire new personnel.

The technical support primarily helps to maintain the intranet facilities of the organization. It also works closely with the accounting group to maintain financial records of the employees on the intranet for easy reference.

The media lab is a small group of about 5 people, who support the firm with their high end graphic requirements that includes renderings, walk through presentations, and advertisement materials.

The institution design review committee (IDRC) is comprised of two permanent members (a managing principal and a principal in the firm). The other members of the IDRC are the principals of the studio whose work is under review at any particular instance.

4.5.4 Phases in a Design Project (the Projects Segment)

The major phases during a project life cycle at Firm IV are similar to the previous three firms. The firm believes that the stages of schematic design, design development, and construction document can be basically described as Computer Aided Design (CAD), as most of the time is spent on drawings. I refer to these stages as the production phase in this research.

4.5.5 Diagramming the Stages in the Projects Segment

The IDRC is an evaluation team consisting of members of the administration. Hence it is represented in the following diagrams as a unified relationship between the systems- Administration (A) and Analytical/ Evaluation (E). The role and responsibility of the

designer rotates between design and production during the middle stages of the project cycle. Hence this position is referred as a unified relationship between Design decision-making (D) and Production (P_D).

The procurement phase involves the project procurement and the project initiation stages.

The following personnel play an important role during the project procurement stage:

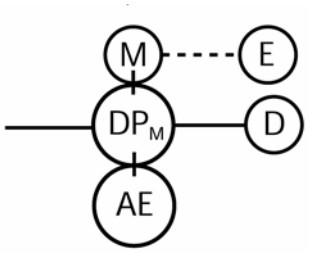
- Marketing personnel
- Principal
- Media lab

This stage mainly involves sending proposals and attending interviews by the prospective clients. The marketing personnel are the forerunners at this stage, closely supported by a principal, who is selected as soon as there is a prospective project. The media lab supports their efforts with graphic and visual reinforcements.

The project initiation stage requires the following personnel to assume leading roles:

- Project manager
- Designer/ Programmer
- Institution design review committee (IDRC)
- Administration

At this stage, predesign services include programming and research. Firm IV does not believe in separating programming and design activities, hence the two are always there before and during their CAD stage.



Key:
A - Administration and office management
M - Marketing
D - Design decision-making
P_D - Production/Documentation
E - Analytical/Evaluation
P_M - Project management
C - Construction administration

Figure 30: The diagram of the procurement phase at Firm IV.

Figure 30 portrays the procurement phase at Firm IV. The project manager in the architecture group is represented by a unified relationship between D and P_M. The IDRC is represented here by a unified relationship between the systems A and E. The two unified systems are in different hierarchies and interact through regular formal meetings or discussions. They are hence in a touching relationship. The system M representing the marketing personnel is also in touching relationship with the unified D and P_M system. The media lab represented by E is indirectly or very rarely associated, hence has a remote relationship with M. The designer/ programmer is part of the studio and is represented by D. This system is in a connected relationship with unified D and P_M system since they are in the same hierarchy and meet informally.

The production phase is comprised of the schematic design, design development, and construction document stages.

The following personnel are important during the schematic design stage:

- Project manager
- Designer
- Programmer
- IDRC

Primarily the following personnel handle the design development:

- Project manager
- Designer (responsibility includes production)
- Programmer
- IDRC

The following personnel play an important role during the construction document stage:

- Project manager
- Designer
- Programmer
- IDRC

The above three stages are mainly managed by the project manager. The designer and the programmer closely support the project manager. The IDRC is involved during the final moments of each of these stages. The administration support takes care of the accounting issues as well as any need for new personnel from outside the firm.

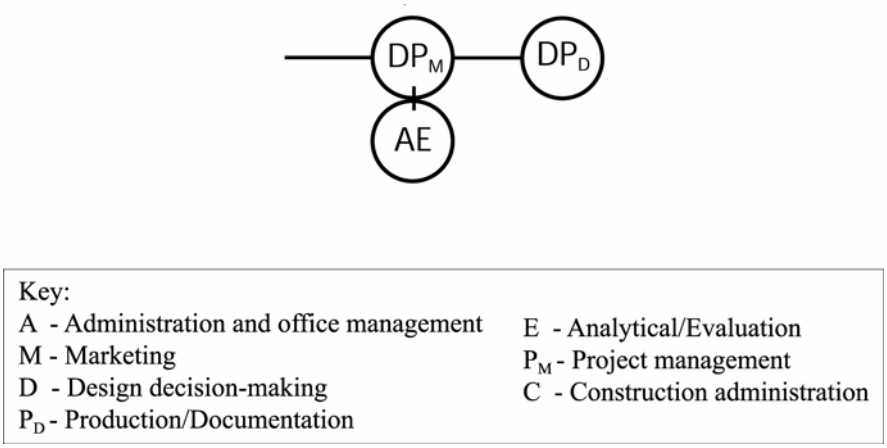


Figure 31: The diagram of the production phase at Firm IV.

The interaction between different roles is portrayed in Figure 31. The project manager in architecture represented by a unified relationship between D and P_M is in a touching relationship with the unified system of A and E (representing the IDRC). The production team is represented by a unified relationship between D and P_D. This is in a connected relationship with the project manager as they are in the same reporting hierarchy and meet informally.

The delivery phase is identified by the bid negotiation and the construction stages. The bid negotiation stage is where the following personnel play an important role:

- Project manager
- Construction administrator
- IDRC
- Designer
- Programmer
- Administration

The project manager is still in the forefront at this stage, with close support from a construction administrator from inside the studio. The IDRC is involved in reviews during crucial moments. The designer and programmer have a low level of involvement due to the absence of any addendum drawings. The administration is also involved with issues related to financial transactions.

The following personnel are primarily involved during the construction stage:

- Project manager
- Construction administrator

The project manager works closely with the construction administrator at this stage.

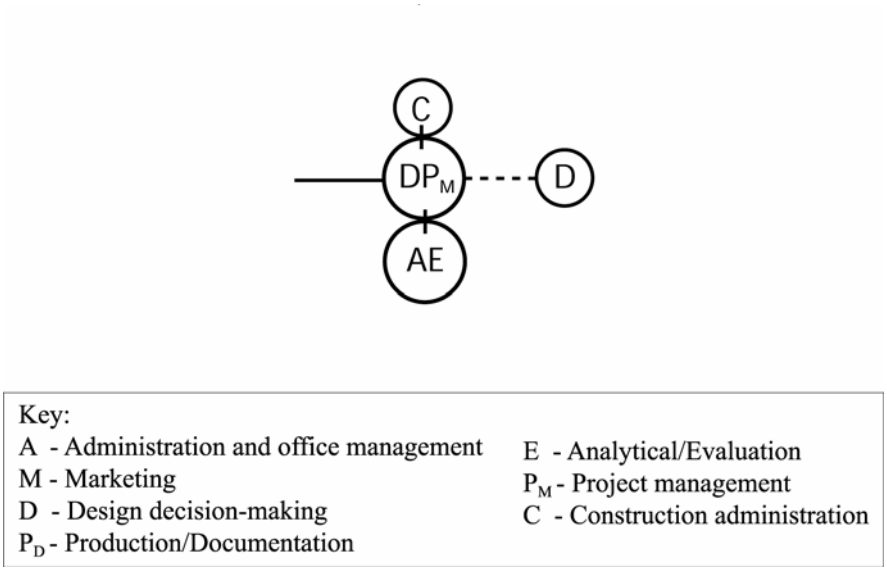


Figure 32: The diagram of the delivery phase at Firm IV.

Figure 32 captures the delivery phase at Firm IV. The project manager represented by a unified relationship of D and P_M is in a touching relationship with the unified

systems of A and E, which represent the IDRC. The former is also in a touching relationship with the construction administration, represented by C. The designer/ programmer represented by D are very rarely consulted by the P_M at this stage.

The following personnel play an important role during the post construction stage (part of the post-delivery phase):

- Marketing personnel
- IDRC

The post construction stage mainly involves a limited warranty period, as well as efforts of the marketing personnel in maintaining the relationship with the client to generate chances of new commission. The IDRC may be involved in reviewing the success of the project after completion. The administration support exists to ensure completion of fees transactions. Post occupancy evaluation is rarely done.

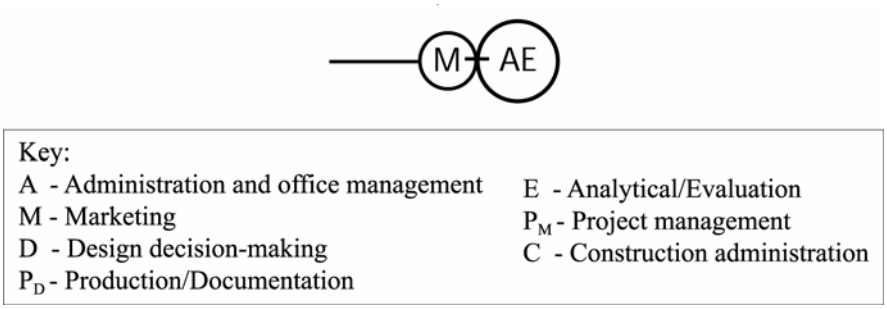


Figure 33: The diagram of the post-delivery phase at Firm IV.

Figure 33 captures the post-delivery phase at Firm IV. The marketing system M is in a touching relationship with the unified system of A and E, representing the IDRC.

4.6 Firm V

4.6.1 Demographics

Firm V is a global provider of design and project delivery services. It is a half a century old firm founded in St. Louis in 1955, with more than 20 offices in the US and world-wide. Its primary markets include corporate complexes, health care, public and institutional facilities. The firm's specialty groups serve clients in several market areas including aviation, commercial, corporate, cultural, educational, mixed-use and residential facilities. They also handle projects in the area of judiciary, sports, transportation, science and technology.

The 1,600 professionals at Firm V are linked across a network of offices in North America, Latin America, Europe, and Asia. A majority of the professionals in the firm hold a bachelor's degree.

4.6.2 Hierarchy of Top Management and Corporate Role

In the Houston office, the head of the office is the Chief Administrative Officer (CAO). Some firms call this role "Managing Principal." Below the CAO is the Management Committee, which the CAO chairs. The Management Committee is comprised of Discipline Directors (Architecture; Interiors; Engineering; Operations; Marketing; Accounting/Finance). These individuals are either Senior Vice Presidents or Vice Presidents. Figure 34 illustrates the hierarchy of the top management at Firm V.

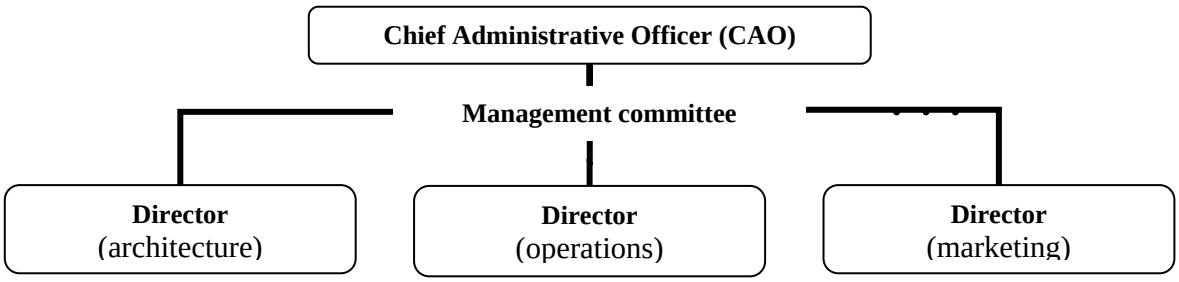


Figure 34: Hierarchy of the top management at Firm V.

Each individual office manages its own finances with indirect oversight by the corporate Finance Committee and the corporate Chief Financial Officer (CFO). Poor performing offices receive more input and guidance from the central administration. Highly profitable offices receive little or no input. Annual budgets for marketing and operations are established by the management committee in the 4th quarter of each year for the following year. The central administration also establishes the guidelines for salaries (based on role and seniority) and benefits packages available to its employees.

4.6.3 Disciplinary Groups

Primarily, the firm consists of a group or teams segmented by discipline. I have described them in some detail here, mentioning the constituents of the groups:

The Architecture (including planning) group consists of a design director, a project designer (or senior designer), and a technical architect. They are mainly in charge of the conceptual design and design development. The technical architect is responsible for the overall discipline coordination of the construction drawing package, for the constructability of the building design, and for code compliance and specifications. This

person is also the main interface between the contractor and the client during the construction stage.

The engineering group primarily consists of the engineering director, and the senior technical engineers in structural, electrical, and mechanical discipline.

The interior design group consists of the interior design director and the senior interior designer.

The operations (project management) group is headed by the director of operations.

The marketing group is the interface group between the project teams and the client. Their main tasks are establishing new contacts by research or retaining existing ones. The marketing director is responsible for overall marketing strategy and sales. The business development manager is responsible for marketing and sales in specific markets (i.e. Health Care; Criminal Justice; Hospitality/Retail). The marketing coordinator is responsible for production of proposals, presentations, marketing database, and market research.

The accounting/ finance group is lead by the director of accounts.

The programmers are headed by a senior facilities programmer.

The human resources group is managed by the human resources manager. The group is responsible for the administrative aspects of hiring. An executive administrator (working closely with human resources) is responsible for the staffing and management of clerical, administration support, receptionist, and other general support staff.

4.6.4 Phases in a Design Project (the Projects Segment)

The major phases during a project life cycle at Firm V are similar to the previous four firms except that the procurement stage at the firm consists of the predesign and facilities programming.

4.6.5 Diagramming the Stages in the Projects Segment

The degree of involvement of personnel or functional groups during each of the four phases are described and diagrammed in the next few paragraphs. The procurement phase is defined by the predesign, and facilities programming stages.

The following personnel are most active during the predesign stage at Firm V:

- Marketing director
- Project manager/ project designer

The predesign stage involves project procurement and proposals to the client. The director of marketing operations plans the marketing strategy in specific market areas. The project manager and the project designer coordinate closely with him to present ideas to the potential clients.

Facilities programming stage brings the following personnel in the forefront:

- Facilities programmer
- Marketing personnel/ project designer
- Project manager
- Architects

The facilities programming stage basically involves the programming of requirements, goals and scope of the project. The facilities programmer takes charge,

with support from the marketing director and the project designer. The project manager who is also the director of operations gets involved in the meetings with the client to allow him to make a smooth transition to the design stage.

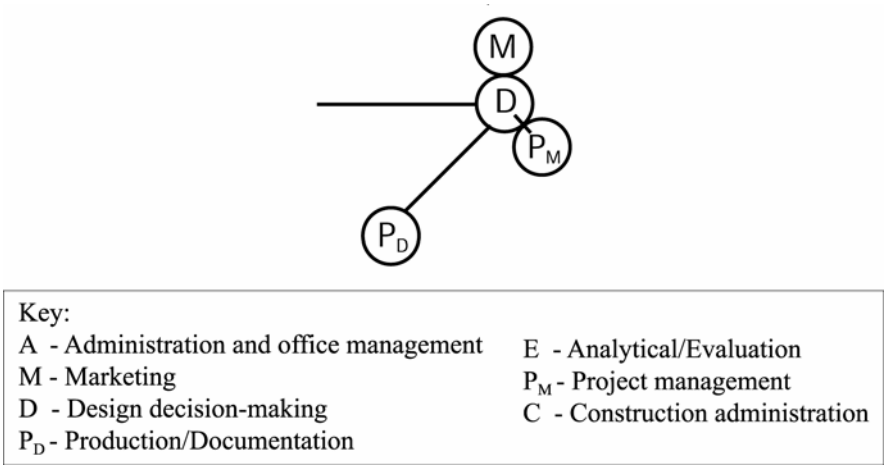


Figure 35: The diagram of the procurement phase at Firm V.

Figure 35 represents the procurement phase at Firm V. The marketing director represented by M is in a touching relationship with the project designer, represented here by D, as they correspond regularly through formal meetings. They are also under separate reporting hierarchies. The architects taking care of the production activities at this stage, are in the same hierarchy as the project designer and are in a connected relationship. The project manager is in a separate hierarchy and is in a touching relationship with D.

The production phase consists of the schematic design, design development, and construction document stages.

The schematic design stage is handled primarily by the following personnel:

- Project architect
- Project manager
- Marketing personnel
- Architects/ interns (responsibility includes production)

The project architect works closely with the project manager and the marketing personnel to develop the concept for the project.

Design development stage brings the following personnel together:

- Project manager
- Project architect
- Interior designer
- Marketing personnel
- Architects/ interns

The project manager coordinates the development of the design along with the project architect. The interior designer is also involved to a great extent. The marketing personnel follow the developments closely.

The following personnel help actively during the construction document stage:

- Project manager/ technical architect
- Project architect/ Production team
- Engineering personnel
- Interior designer
- Marketing personnel
- Architects/ interns

At this stage the project manager works closely with a technical architect to ensure constructability by coordinating details with the project architect and the engineering personnel. The marketing personnel are helpful to a certain extent on account of his familiarity with the client's needs. The junior architects and interns assist with the production tasks.

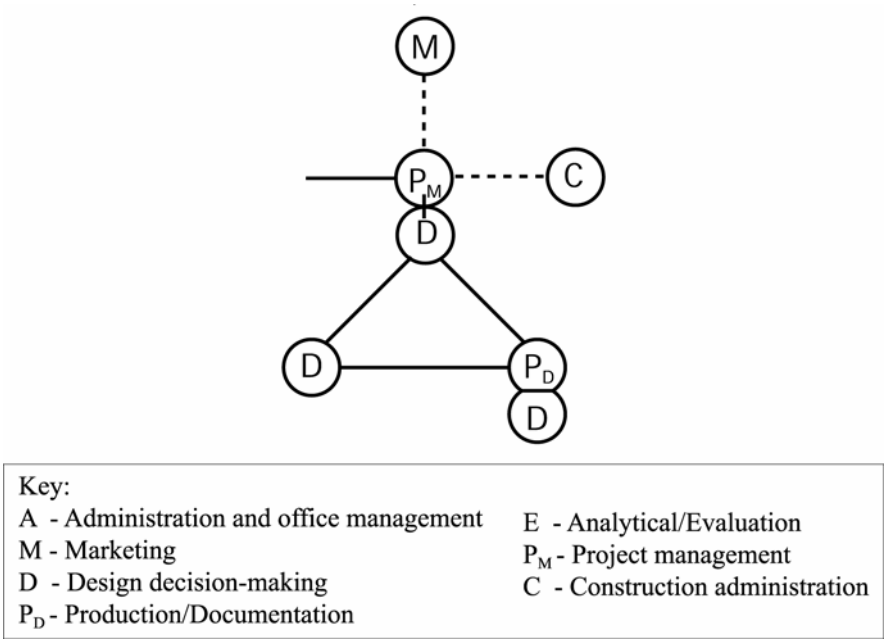


Figure 36: The diagram of the production phase at Firm V.

Figure 36 diagrams the production phase at Firm V. The project manager represented by P_M is in a touching relationship with the project architect represented by D. The interior designer is also represented by D and the production team is represented by a meshed relationship between P_D and D since some of the architects and interns have overlapping responsibilities of both design and production work. The systems D (interior

designer) and P_D/ D (interns) are in a connected relationship with the system D which represents the project architect. The systems M and C represent the marketing and engineering personnel respectively. They are very rarely associated at this stage and hence are in a remote relationship.

The delivery phase involves the bid negotiation and construction stages.

The following personnel play an important role during the bid negotiation stage:

- Project manager/ technical architect
- Project architect
- Marketing personnel
- Contractor

The project manager works closely with the technical architect as well as the project architect to help in the bid negotiations. The marketing personnel are still there to follow up on the progress of the project.

The construction stage brings the following personnel together:

- Technical architect/ project manager
- Marketing personnel
- Contractor

The technical architect takes the lead but works closely with the project manager to coordinate smoothly with the external contractor or client interface that enables construction. The marketing personnel again follow the developments closely.

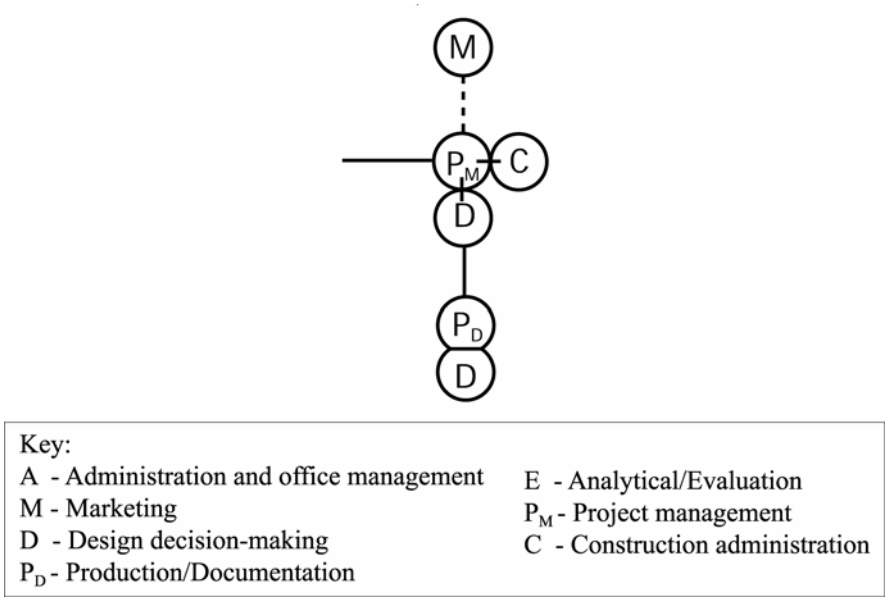


Figure 37: The diagram of the delivery phase at Firm V.

The delivery phase at Firm V is portrayed in Figure 37. The project manager (P_M) and the project architect (D) are in a touching relationship being in different hierarchies and in regular formal meetings. These are in a connected relationship with the meshed systems of P_D and D, representing the interns who are involved in the production work. The system M representing the marketing personnel are very rarely in contact and hence in a remote relationship. The contractor represented by C is in a touching relationship with the project architect represented by D.

The post-delivery phase is marked by the post construction stage. The following personnel come together during the post construction stage:

- Project manager
- Marketing personnel
- Contractor

- Architects

The marketing director is again back in the picture reviewing the success of the project and following up with meetings with the client to maintain the relationship. This person works closely with the project manager at this stage. Sometimes architects are also involved in this process in case modification drawings are needed and also to increase the dimension of the company-client interface.

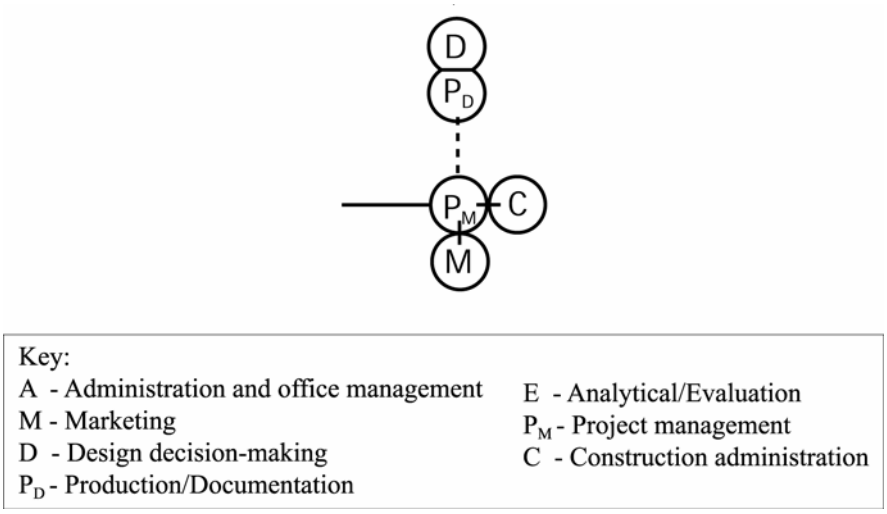


Figure 38: The diagram of the post-delivery phase at Firm V.

Figure 38 is a representation of the post-delivery phase at Firm V. The project manager represented as P_M is in a touching relationship with the marketing personnel represented here as M. They are in separate reporting hierarchies and meet regularly over formal meetings. The contractor represented by C is in a touching relationship with P_M while the interns responsible for the changes in drawings and represented here by a meshed system of P_D and D are sometimes needed and hence in a remote relationship.

5 DISCUSSION AND CONCLUSIONS

In this section, I discuss the applicability and the usefulness of the Building System Integration Theory for organizations. Following this, I present the diagrams of the projects segment in each of the five interviewed organizations. A discussion of my observations follows. The limitations and possible anomalies in this research are expressed in the end, along with the scope of future research.

5.1 Applicability and Usefulness of the Building Systems Integration Handbook Theory

It is possible to apply the Building Systems Integration Theory to architectural organizations and diagram them in a fashion similar to the buildings. The diagrams representing the project cycle of each firm reveal the nature of the interaction of each of the systems in the firm at any particular stage of the project cycle. For example, a quick look at the procurement stage of Firm I reveals that the project manager and the marketing personnel play an important part during this stage while working very closely with the designers.

The diagrams also reflect the relationships of personnel in the organization in terms of the roles and responsibilities during the project cycle rather than the relationships of the personnel in terms of their titles and the hierarchy. This is a unique characteristic of these diagrams when compared to the traditional organizational charts. These diagrams also do not reveal the sequence of actions during a stage in a project unlike some work-flow diagrams for organizations. The ball diagrams are complementary to the information portrayed in organizational charts and work-flow diagrams.

5.2 Diagramming the Projects Segment

The combination of the diagrams of the four phases of the projects segment in Section 4 produces the complete diagram of the projects segment. The Administration and management (A) system coordinates the four phases namely, procurement, production, delivery, and post-delivery. The complete diagrams of the projects segment are presented from Figure 39 through Figure 43.

The Administration and management system is responsible for the way projects are handled. This system comprises partly of the corporate committees, who define the guidelines and policies for performance and conduct. The other part is the lower administrative staff, who oversee the financial decisions related to each project as well as the issues related to human resources and employee benefits.

Firm I, and V are matrix organizations, while Firm III is a generalist/ matrix organization. Firm II, and IV are studio organizations.

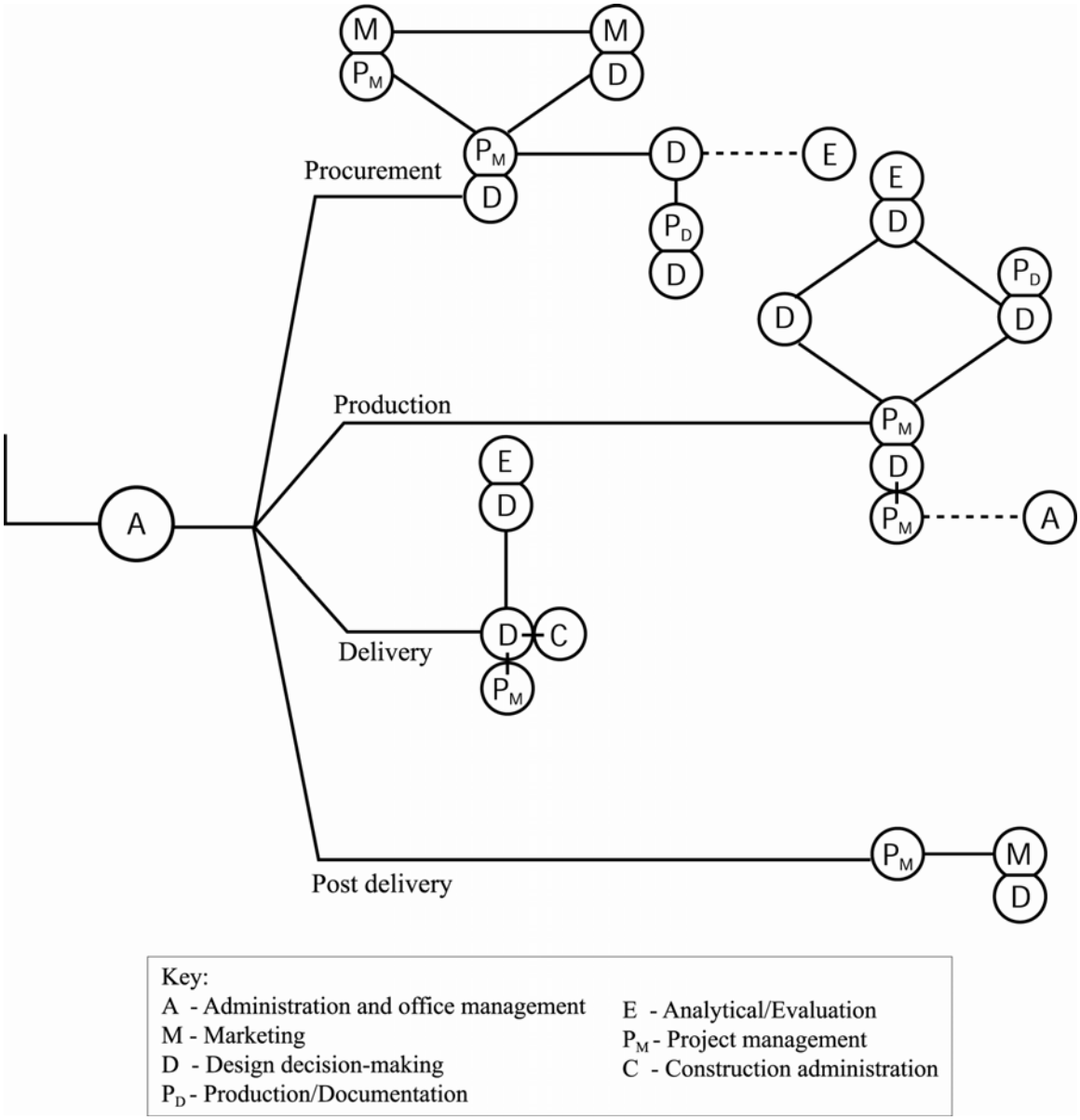


Figure 39: The integration diagram of the projects segment at Firm I.

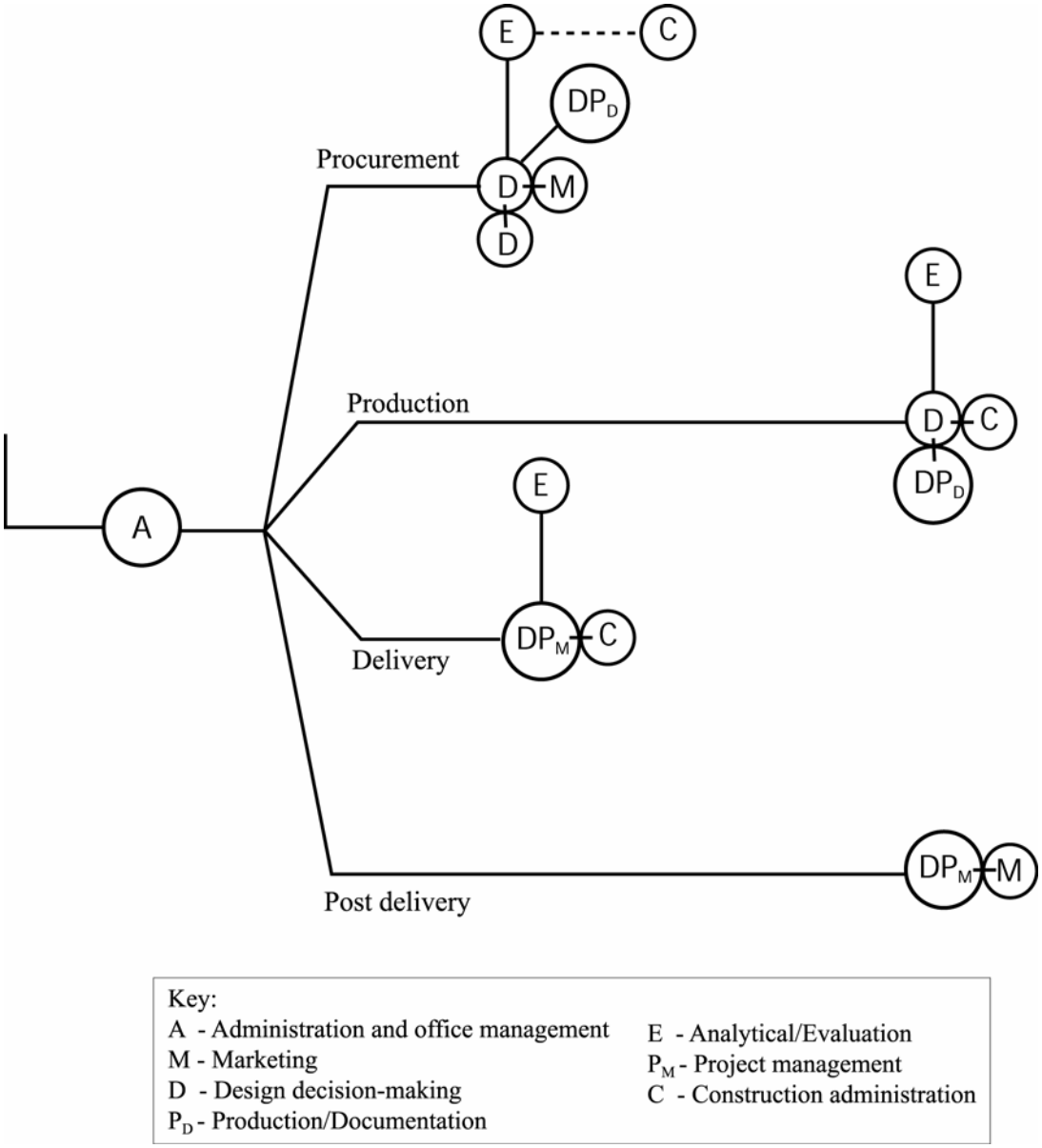


Figure 40: The integration diagram of the projects segment at Firm II.

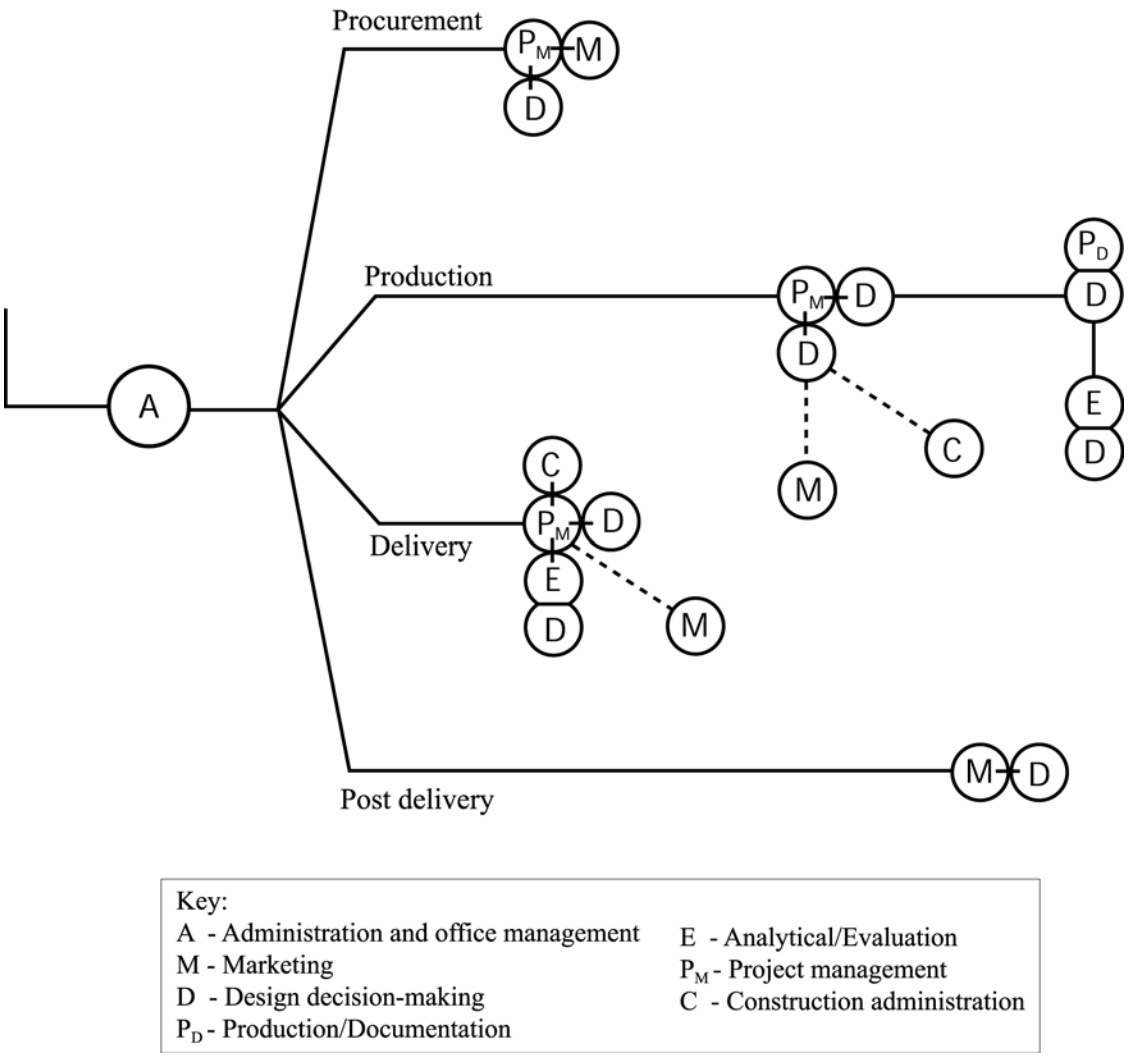


Figure 41: The integration diagram of the projects segment at Firm III.

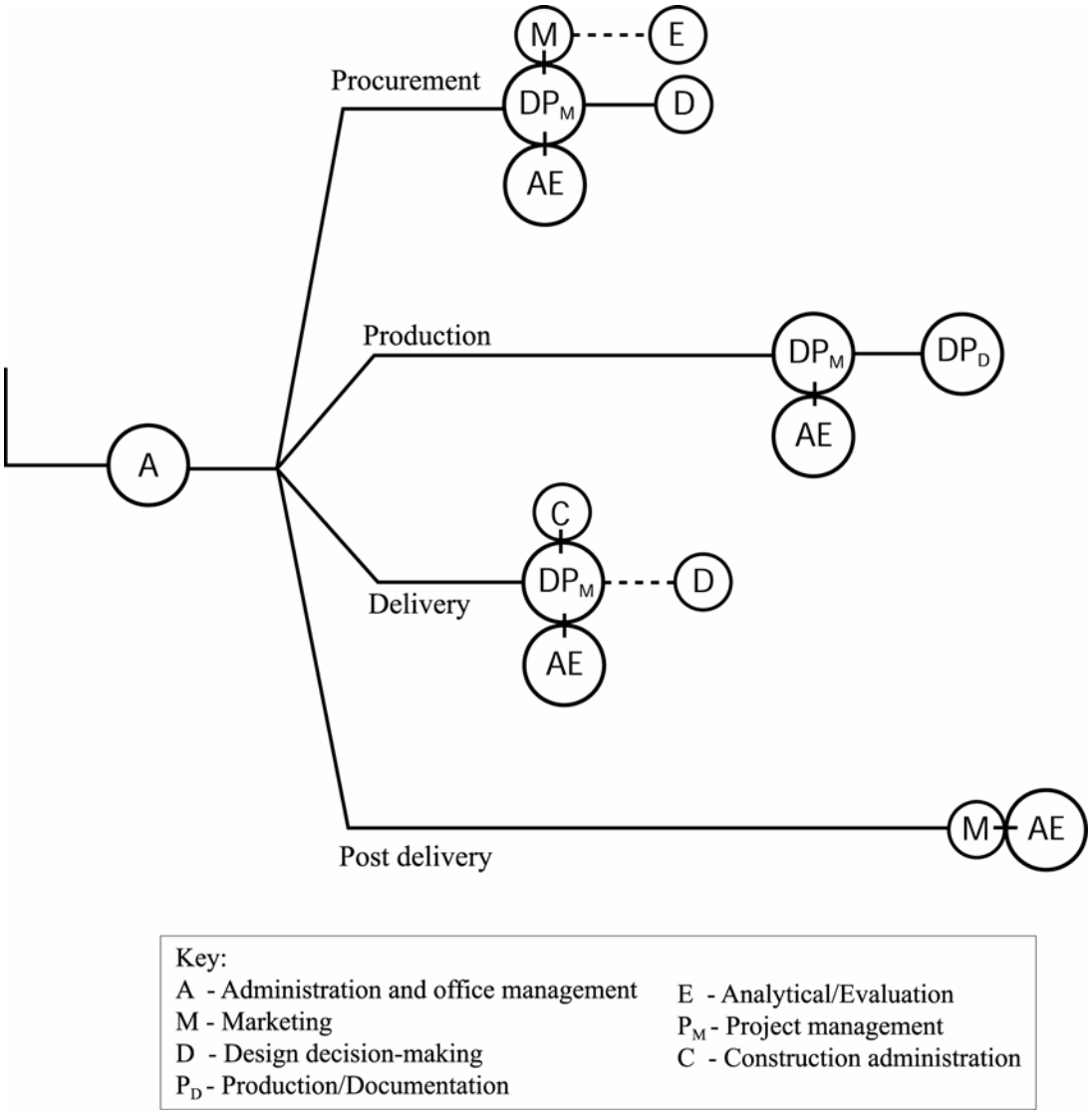


Figure 42: The integration diagram of the projects segment at Firm IV.

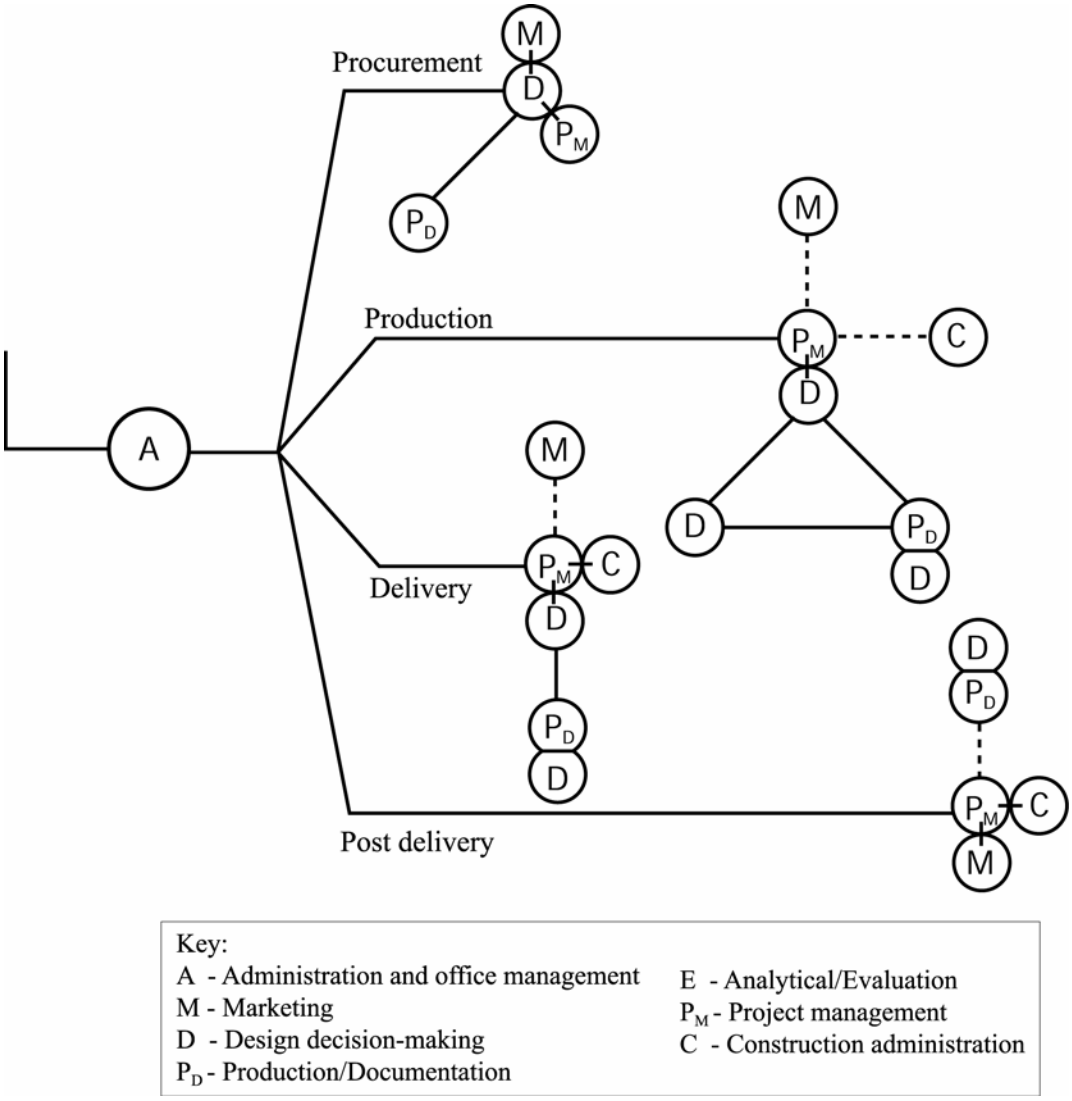


Figure 43: The integration diagram of the projects segment at Firm V.

5.3 Observations

There is a noticeable complexity in diagramming of the matrix organizations as compared to the studio organizations. I am assuming here that more number of balls and hence increased amount of relationship in the diagrams, suggest more complexity. Firm I, Firm III, and Firm V, which are the matrix organizations have 28 balls, 21 balls, and 23

balls respectively. Firm II, and Firm IV, which are studio organizations, have 16 balls, and 15 balls respectively. Further observations are as follows:

5.3.1 The Role of the Project Manager

Each of these diagrams representing the projects segment of the five architectural firms points out the importance of the role of a project manager. In most of the cases, the project manager seems to play the pivotal role in the project cycle. This importance of a project manager is suggested by the proximity of a system denoted by P_M to the nodes that connect directly to the system denoted by A. Also, more number of nodes generating from the P_M to connect to other systems suggest the central role of the project manager. The project manager in most cases is also part of the Facilities Management group, and this role may be assigned under the title of a facility manager.

Firm I, III, and V are instances of Matrix organization while Firm II, and IV, are Studio organizations. As evident in Section 2.2, each of these two kinds of organizations has project managers in predominant roles. Hence the diagrams in Section 4 are able to portray this argument very closely.

5.3.2 Relationship of Project Management and Production with Design

A striking difference between the matrix organizations and the studio organizations is revealed in these diagrams from the relationships between the project manager and the production personnel.

In a studio organization (as in case of Firm II, and IV), the project manager and production personnel are diagrammed as a unified relationship with the Design decision-making (D) system. In case of matrix organizations (Firm I, III, and V), the project manager and production personnel are diagrammed in a touching, connected or meshed

relationship with the Design decision-making (D) system. This reflects the nature of a Studio organization where the studios are self-sufficient groups with in-house design, production and project management personnel. The studio leader is responsible for creative leadership and also meeting schedules. This may produce an organization more focused on image and design.

5.3.3 Role of External Consultants during the Project Cycle

Design of services in a building is an activity that involves both technical and design issues. My investigation of the example architecture firms has revealed that in most cases, the services design is done by external consultants, whom I would put under the system I define as Construction administration (C). But, since the services design is also a design activity that cannot be done without coordinating with the architectural design team, this activity would have a certain level of integration with the Design decision-making system. Since the systems in question come together at certain aspects of the project although they are in different reporting hierarchies, there is a ‘touching’ level of integration between the Construction administration (C) and Design decision-making (D) systems. This concept in a project cycle needs to be investigated further by interacting with the external consultants serving these firms.

Further, the relationship of a client with the project team during the project cycle has been left out in this research and needs to be investigated in more detail.

5.4 Limitations and Possible Anomalies in the Survey

Two limitations are possible in this kind of research. Each of the surveys involved a single subject at each of the five architectural firms. There is a possibility of the data collected being biased as there was no second subject to confirm it, though in most cases

I have tried to get a second opinion based on the information available on the company websites.

The relationships between systems in a building are based upon physical positions of each of the systems with respect to one another. In the case of human organizations, the exact nature of the relationship at any given time in the project cycle is arguable, and difficult to pinpoint exactly. This issue creates a need to make this kind of a survey more extensive to claim definitive results.

It is also too early to point out the exact implications of the diagramming method for the design process of architectural firms surveyed during this thesis. Although we can see some noticeable trends, it is difficult to support any claims on the basis of a small sample of just five architectural firms. Based upon the observations indicated later in this section, the inadequacy of the nature of survey is also evident. Time permitting, the survey should have been more detailed in terms of investigating the role of the architect as a manager, as well as the nature of interaction of the client, the different external project consultants, and also the end user.

5.5 Future Work

Surveying more firms will probably reveal a pattern in the degrees of integration between systems. A survey to study the operation and management style of some firms will help to establish the system integration for the operations segment that I described earlier in section 3.3. As in the case of buildings, we would also be able to derive a set of performance mandates.

There exists a relationship between organizational hierarchy and aspects of cultural values within a single large professional service firm (Burke, 1997). A study of the

organizations with a focus on values would also help to establish the effects of cultural values on the organizational model I propose.

I can make no claims of reliability for the diagrams. Future work could determine whether a consensus among experts can be reached for the diagrammatic portrayal of a firm. Studies could determine whether people can be trained to produce accurate diagrams.

5.6 Responding to the Hypothesis

The concepts of BSIH theory for buildings has been expanded to fit into the vocabulary of architectural business organizations. Similarly to the BSIH, there can be seven distinct systems to represent an organization as stated in Section 3. These systems are:

- Administration and office management (A)
- Marketing (M)
- Design decision-making (D)
- Production/ Documentation (P_D)
- Analytical/ Evaluation (E)
- Project management (P_M)
- Construction administration (C)

The dynamics of an organization in terms of the roles and relationships of the personnel during a project cycle can be represented diagrammatically by establishing the levels of integration between the seven systems . The five degrees of integration, namely remote, connected, touching, meshed, and unified can be distinctly identified as in Table 1, in Section 3. Further, the levels of integration between the seven systems in an

organization, through the four phases in a project (procurement, production, delivery, and post-delivery) can be diagrammatically represented by ball diagrams. These diagrams not only deliver a unique representational language, but suggest an effective method to study the cohesive nature of organizations.

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APPENDIX A: IRB DOCUMENTS

CONSENT FORM

Title of study: Adapting the Building System Integration Method to Portray Architectural Organizations

I am one of the 5 participants willing to take part in a survey to generate information on organizational structures in architectural firms. I was selected as a possible participant in this study because I am one of the top representatives of my firm. This survey will be approximately 20 minutes long and will be conducted on the premises of my firm.

If I desire to participate I will answer the questionnaire provided to be by the investigator of this research. Any information obtained in the study will remain confidential. The researcher will use the information for further research analysis.

There are no costs to me associated with this study. Participation in this study is entirely voluntary. Withdrawing from the study at anytime will not affect my status as a professional or in any other fashion. There are no personal benefits if I decide to participate.

"I understand that this research has been reviewed and approved by the Institutional Review Board – Human Subjects in Research, Texas A & M University. For research related problems or questions regarding subjects' rights, I can contact the Institutional Review Board through Dr. Micheal W. Buckely, Director of Support Services, Office of Vice President for Research at (979)458-4067."

If I have any questions about this research, I can ask the researchers or their graduate advisor. If I have additional questions during the study, the researcher and/or graduate advisor will answer them. They can be contacted at:

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I have read and understand the explanation provided to me. I have all my questions answered to my satisfaction, and I voluntarily agree to participate in this study. I have been given a copy of this consent form.

_____
Name of subject typed/printed

_____ _____
Signature of subject Date

_____ _____
Signature of Principal Investigator(s) Date

PROTOCOL FORMAT

I have read the Belmont Report. "Ethical Principles and Guidelines for the Protection of Human Subjects of Research" and subscribe to the principles it contains. In light of this Declaration, I present for the Board's consideration the following information, which will be explained to the subject about the proposed research:

1. SELECTION AND SOURCES OF SUBJECTS
    a) **Source and Number:** Managers or principals of about 5 architectural firms.
    b) **Method of recruitment and selection:** Recruitment will be by referral from faculty members.
    c) **Age and gender:** The participants will be 18 + and this group will comprise of both male and female participants.
    d) **Compensation:** No compensation.
    e) **Location and duration of experiment:** The survey will be conducted on the premises of each of the concerned architectural firms. Each survey will last approximately 20 minutes.
    f) **Steps to ensure anonymity of results and response:** All publications and public presentations will avoid use of names of individuals or companies.
    g) **Investigator's relationship with subject**: There is no relationship between the subjects and me (the investigator).

2. EXPERIMENTAL PROCEDURE
    The purpose of this research is to build an effective mechanism to diagram the degree of integration that exists between the departments of some successful business organizations. This will be done by following the system integration methods and principles described in the *Building Systems Integration Handbook*, and applying them to an organizational system.

    The survey will be conducted by means of a concise questionnaire, presented verbally to one of the top representatives in each of the five architectural firms. An official letter endorsed by the advisor will be first sent to the company representative to inform him of this survey and request an interview. Further, this will be followed up with an e-mail and telephone call to confirm the appointment. The questionnaire will be completed by the researcher in the presence of the participant during an informal interview with him on the premises of the firm.

    The information thus collected will be analyzed to understand the existing organizational structure of the interviewed firms. I will then diagrammatically represent the levels of integration between the departments in those firms.

    Copies of the proposed official letter, e-mail and the final questionnaire are attached for your review.

3. RISKS AND BENEFITS TO SUBJECTS
    There is no risk to the subject in this experiment. Participants must voluntarily choose to participate and may withdraw with no consequences. All participants will be provided with a copy of the final report of the research.

E-MAIL CORRESPONDENCE

Sub: Request for an appointment for a MS thesis requirement
Ref: My letter dated _____

Dear Sir:

This is a follow up on the letter dated _____, which was sent to you requesting an appointment for an interview with respect to my thesis.

Kindly let me know a convenient time to call you up and set up an appointment for the same.

Regards,

Amitava Sinharay

Graduate Student (MS in Arch.)
College of Architecture
Texas A&M University
College Station, TX -77843.

e-mail: amitava@tamu.edu
ph: 979.695.6826 (res)

POSTAL CORRESPONDENCE

(Date)

To:
_____
_____
_____

Cc: _____

Sub: Request for an appointment to conduct research in organizational structure of architectural firms.

Dear Sir:

I am a MS in Architecture student at the College of Architecture, Texas A&M University. The purpose of this letter is to request for an appointment to interview you for information about the organizational structure of your firm and its working style. This interview will be for approximately 20 mins., and the information will be used to support ideas in my thesis titled- Adopting the Building System Integration Method to Redefine Architectural Organizations. The research is being conducted under the direction of Dr. Mark J. Clayton, Executive Associate Dean of the College of Architecture.

This interview would be conducted on your premises with the permission of the Institutional Review Board (IRB), Texas A&M University. The information would be used confidentially for the purpose of the requirements of my MS thesis.

Kindly grant me an appointment within the next couple of weeks, at your convenience. I will contact you by e-mail and telephone in the next few days.

Thanking you.

Sincerely,

Amitava Sinharay
Graduate Student (MS in Arch.)
College of Architecture
Texas A&M University
College Station, TX -77843.

e-mail: amitava@tamu.edu
ph: 979.695.6826 (res)

SURVEY QUESTIONNAIRE

Name of the firm:

Do you have an Organizational chart?

Demographic information:

- **Age of the firm: _____**
- **Strength of the firm: _____**
- ' **Strong-idea firm,** ' **Strong-service firm,** ' **Strong-delivery firm.**
- **Primary market for the firm: _____**
- **Average professional educational level in the firm** (check the appropriate boxes)**:**

	Bachelors	**Masters**	**PhD**
Architects	'	'	'
Engineers	'	'	'
Managers	'	'	'

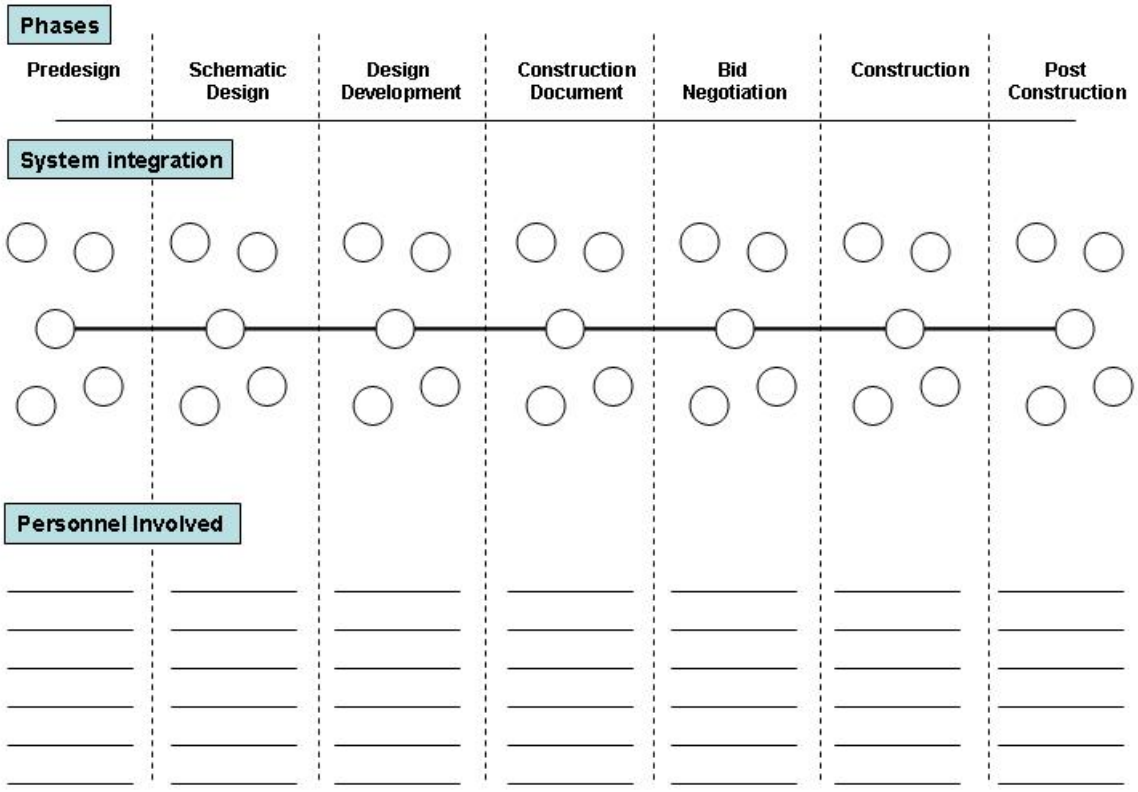
Select the existing sections (functional systems) in your firm (check the appropriate boxes)**:**

' HR ' Marketing ' Administration ' Structural ' Design
' Civil ' Planning ' Construction ' Interior Design ' Project Mgmt.
Other: _____, _____, _____

What are the job titles in each section (functional system)?

Human Resources	
Design	
Structural	
Construction	
Project Management	

Other titles: _____, _____, _____


Phases
Predesign
Schematic Design
Design Development
Construction Document
Bid Negotiation
Construction
Post Construction
System integration
Personnel Involved

Notes:

APPENDIX B: FIRM IV CONSTRUCTION METHODOLOGY

Construction delivery methods at Firm III

There are several construction delivery methods available. Following are brief descriptions of the most common delivery methods:

1. Construction Management (CM) At-Risk allows the owner to interview and select a fee-based firm to manage construction before design is completed. The construction manager and the architect work together to develop and estimate the design. A guaranteed maximum price (GMP) is provided by the CM, who then receives proposals from and awards contracts to subcontractors. The final construction price is the sum of the CM's fee and the subcontractor's bids. The owner will not pay more than the GMP and retains any savings.

2. Construction Management (CM) Agency differs from CM At-Risk in the lack of a guaranteed maximum price. Here, the owner contracts with both a construction manager and an architect, but signs separate contracts with each subcontractor to actually perform the work.

3. Competitive Bid is a linear process where one task follows completion of another with no overlap. Plans and specifications are completed then advertised for bids. Contractors bid the project exactly as it is designed with the lowest bidder awarded the work.

4. Competitive Sealed Proposals is similar to Competitive Bid, with two major exceptions. First, proposals are evaluated against published criteria, one of which is price. An award is made to the firm providing the best value. Second, competitive Sealed Proposals allow modifications to the proposals before bids are accepted, which allows the owner to negotiate a change of scope before accepting the bid.

VITA

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Education

Texas A&M University, College of Architecture, College Station, TX
M.S. in architecture, December, 2003

Indian Institute of Technology (formerly Univ. of Roorkee), Dept. of Architecture and Planning, Roorkee, India.
Bachelor of Architecture, January, 1998

Areas of Interest

Organizational Theory, Design Methods, Usability Engineering, Human Factors