

**Effective Partnering in an
Innovative Procured, Multi-Cultural Project**

by

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Submitted to the Department of Civil and Environmental Engineering in
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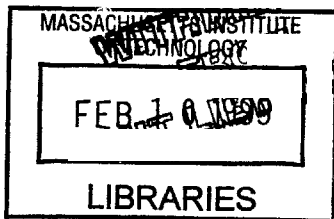
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ABSTRACT: Effective partnering has shown to improve projects in numerous aspects including cost, schedule, safety, quality and claims. As the benefits have become more recognized, partnering has become a more common practice in North America; however, partnering in multi-cultural environment has some additional challenges that have not been fully understood for partnering applications in such environments. This multi-cultural environment involves ethnical differences, but, more importantly, differences in professional cultures and corporate cultures. This thesis describes some lessons learned from the Tren Urbano project in San Juan, Puerto Rico, a 17.2 km heavy rail project. The Tren Urbano has an innovative procurement strategy of turnkey with multiple primes, which combined with the multi-cultural, multi-phase environment offers a new set of challenges for obtaining an effective partnering environment.

This thesis looks at these challenges in the Tren Urbano Project and categorizes the issues into project (or initial), operational and resulting factors. The initial factors include the procurement, number of culture, and the initial partnering efforts in a project. The operational factors include the existence of champions for the objectives of the project, the effectiveness of task duplication in the organization, the role of the turnkey contractor acting as part owner, and a continued support for the partnering effort. Last, the resulting factors include the effectiveness of the claim management on the project, lack of micro-management, and the resolution of conflicts for site transfer. This thesis discusses each factor as part of each category of issues and makes some recommendations for the Tren Urbano Project and other projects with similar characteristics. Finally, the interrelationships of these factors are modeled using system dynamics and the behaviors of operational and resulting factors can be seen for different input, of the various initial factors. The model demonstrates that the partnering effort in the Tren Urbano project was adequate for a traditional procured, limited culture project. However, for a project like Tren Urbano, much more partnering efforts is needed to achieve the same results than in such traditional project.

Thesis Supervisor: Feniosky Peña-Mora, Assistant Professor of Civil and Environmental Engineering

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CHAPTER 1

INTRODUCTION

Large civil engineering projects with many parties, each with their own culture, interests, priorities, objectives, positions, and contract arrangements, can lead to a complex network of inconsistencies in which conflicts can occur. As a tool to avoid conflicts, partnering has been used in many projects. However, in complex projects, which also tend to be more prone to conflicts, partnering can be especially necessary but also more challenging. This chapter explains why this research is important and the methodology to avoid potential conflicts through partnering in innovatively procured, multi-phase, multi-cultural projects such as the Tren Urbano Project in Puerto Rico.

1.1 MOTIVATION

The construction industry in North America has been using partnering for over ten years to effectively improve schedules and quality at the same time that it looks to reduce costs and claims in a project (Altoonian et. al., 1996). As partnering becomes more and more common, new innovative delivery methods may start relying on partnering in the procurement strategy to realize the benefits of a particular delivery method. Thus, to make the innovative delivery method successful, partnering becomes even more essential than for a traditional delivery method, and the cost of poor partnering can prove to be tremendous.

This paper uses Phase I of the Tren Urbano (i.e., Urban Train) Project in San Juan, Puerto Rico as a case study to demonstrate lessons learned from an innovative procured project. It is a \$1.5 billion, 17.2 km heavy rail transit line with 15 station scheduled to be completed in November 2001. The Tren Urbano Project also poses additional challenges, as partnering must occur in a multi-phase, multi-cultural

environment. The multi-ethnic cultural differences play a role, but the multi-corporate cultures and multi-professional cultures that occur in a multi-phase, multi-party environment play an even larger role in the challenge of developing such innovatively procured project effectively.

1.1.1 Background of the Research

The development of large-scale civil engineering projects requires the collaboration of individuals from different specialties in order to address all the different issues that need to be resolved for the successful completion of the project. During the entire life cycle of the project, hundreds of organizations belonging to different specialties may participate. The roles and positions every organization takes are regulated by the contract agreed to prior to the beginning of the project. Each contract is of a different type, which lead to varied positions and also varied interests in their contract. The resultant network of relationships and interests becomes extremely complex, and lead to many interest inconsistencies. In order to finish the project successfully, all parties have to work with each other closely and reconcile their different interests and conflicts. It is often hard to find a settlement at this level of complexity that satisfies all the interests of all the participants in the project. Thus, for most conflict resolutions, many participants spend great amount of time and money resolving those conflicts. In addition, when conflicts are not addressed quickly and effectively, the collaborative mode of the participants can be affected creating a hostile environment in which progress on the development of the project is slow or stagnant.

To overcome these differences, research has been undertaken on a Collaborative Negotiation methodology (Peña-Mora and Wang, 1997) to resolve conflicts effectively and efficiently. The collaborative negotiation methodology integrates game theory (the study of rational behavior in situations involving interdependency), negotiation theory (the study of the human interactions between parties designed to enhance the interests of the players) and a generic negotiation model (representation of typical parties, structure, relationship, and attributes). This integrated model can also be affected by global collaboration (study of cultural negotiation differences, and negotiating over different time zones and long distances) and project delivery systems (contractual structure of the project participants).

The research presented in this thesis builds on prior research in the areas of collaborative negotiation (Peña-Mora, Kennedy, and Wang, 1997, Peña-Mora and Wang, 1997) and will be supported by research currently conducted at MIT on global negotiations (Peña-Mora and Kwok, 1998) and on the effects of delivery systems on the negotiation process (Peña-Mora and Tamaki, 1998). Thus, the research presented

in this thesis will expand and develop the existent theory of collaborative negotiations further in combination with other research being done at M.I.T.

As part of the collaborative negotiation methodology research effort at M.I.T., this research will focus more on the conflict prevention part of collaborative negotiation methodology. In the construction industry, a collaborative approach for conflict prevention has been called “Partnering”, and, thus, “Partnering” will be used in this thesis as a synonym for a collaborative approach. In addition, this research takes the Tren Urbano Project as a case study to illustrate the ideas of partnering as a conflict prevention mechanisms and as a foundation for effective implementation of a collaborative negotiation methodology.

1.2 RESEARCH GOALS AND SCOPE

This research proposes to identify the areas of potential conflict among the parties involved in the Tren Urbano project in San Juan, Puerto Rico and generalize the issues for any innovatively procured, multi-cultural, multi-phase project. This thesis focuses on partnering as a way of conflict avoidance. To understand the environment in which partnering takes place, the procurement strategy, organizational structure, information flows, and multi-culture interactions of Tren Urbano will be characterized. This will give the background to understand why partnering is more important in innovatively procured projects than for a traditionally procured project.

In innovatively procured, multi-cultural, multi-phase projects, a set of factors affect the effectiveness of partnering, in addition to the factors that affect partnering in traditional procured projects. These additional factors have varied effects at different stages of the project, some are more important initially, some other factors occur as end result. All these factors are interrelated, and their relationships will be modeled using a system dynamics modeling technique. The model will show how the factors change over time of the project depending on different set of initial project and partnering variables. The behavior of these factors will show that partnering is especially important in projects with a lot of uncertainties due to innovatively procurement and multi-culture, multi-phase aspect of the project than in traditional projects.

1.2.1 Benefits to Tren Urbano

As described in Section 1.1.1, large projects with many parties each with their own cultures, interests, priorities, objectives, contract arrangements, and positions can lead to a complex network of inconsistencies in which conflicts can occur. Because of the Tren Urbano Project has an unusual delivery system divided in phases and the project consists of numerous parties of various ethnic, corporate, and professional cultures, potential conflicts become even more complex and more likely to occur. By identifying potential conflicts early in the Tren Urbano project and recommending changes to avoid these conflicts, a less hostile environment and collaborative environment will occur. These recommendations aim for a smoother project management and collaboration among all project members. The true benefits to the Tren Urbano Project will be the improvements on the schedule and budget of the project because less time and money will be used to resolve conflicts. Instead, more effort can be used to improve the overall goals of the project for further improvement of the cost and schedule. These recommendations will also improve quality as more innovative solutions are found when a collaborative approach is used. Thus, recommendations for a collaborative approach for the Tren Urbano Project can improve cost, schedule and quality. Even if changes stemmed from the findings of this thesis are not possible to implement under the current contractual relationships, these recommendations will be made for future delivery systems in the additional phases of Tren Urbano.

1.3 ORGANIZATION OF THESIS

The thesis will be divided into eight chapters. After this introduction chapter, the Tren Urbano Project will be described in terms of its procurement strategy, organization, information flows and some conflicting situations. The third chapter will discuss the project management requirements for any project such as Tren Urbano. The fourth chapter will describe the tools that will be used to address these requirements: Partnering and System Dynamics. Partnering will be the main tool studied in this thesis with system dynamics modeling technique as a support tool for clarifying how partnering or the lack of it can impact the project over time. In the fifth chapter, partnering will be discussed specifically in relevance for the Tren Urbano Project. In this chapter the specific needs for partnering is discussed and then the partnering effort that has been undertaken in the Tren Urbano Project is described.

The next two chapters evaluate and analyze partnering for Tren Urbano and then generalize these points to any project, which is innovatively procured and multi-cultural like Tren Urbano. The first of these, Chapter 6, classifies and categorizes the factors vertically over time into project (or initial), operational, and resulting factors, and then divides the factors horizontally into partnering and organizational issues. The second analysis chapter, Chapter 7, then looks at the components effect on each other. System Dynamics is used to model the relationships in a complex network. The model can then be run over time with, without or different degree of partnering. This will show how partnering can be crucial to reducing conflicts and claims. Finally, Chapter 8 will conclude this thesis looking at recommendations specifically for the Tren Urbano Project and then for any innovatively procured, multi-cultural project.

CHAPTER 2

PROJECT DESCRIPTION

The Tren Urbano (i.e., Urban Train) Project is a heavy rail transit that is being built in multiple phases. Currently the project is in the design and construction phases of the first alignment and is concurrently planning for additional alignments. The planning for operations and maintenance of Alignment 1 is also currently on the way. In this chapter the description of the project presented first, which consists of a general description of the project including the parties involved and their contractual relationships. Next, the organizational structure of the project is discussed, and the information flows which occur in such organization are discussed. Some conflicting situations in Tren Urbano are also discussed in order to provide the necessary background to understand the analysis of partnering in the Tren Urbano Project in later chapters.

2.1 GENERAL DESCRIPTION

The Tren Urbano Project is a heavy rail transit being developed in San Juan, Puerto Rico. The first alignment of the project, Alignment 1, is a 17 km line with 15 stations with maintenance facilities and operations and the administration building. This first phase of the project is expected to be completed in November 2001 and cost \$1.5 billion. As seen in Figure 1, this project is broken into 7 sections of approximately 2.5 km with an average two stations per section.

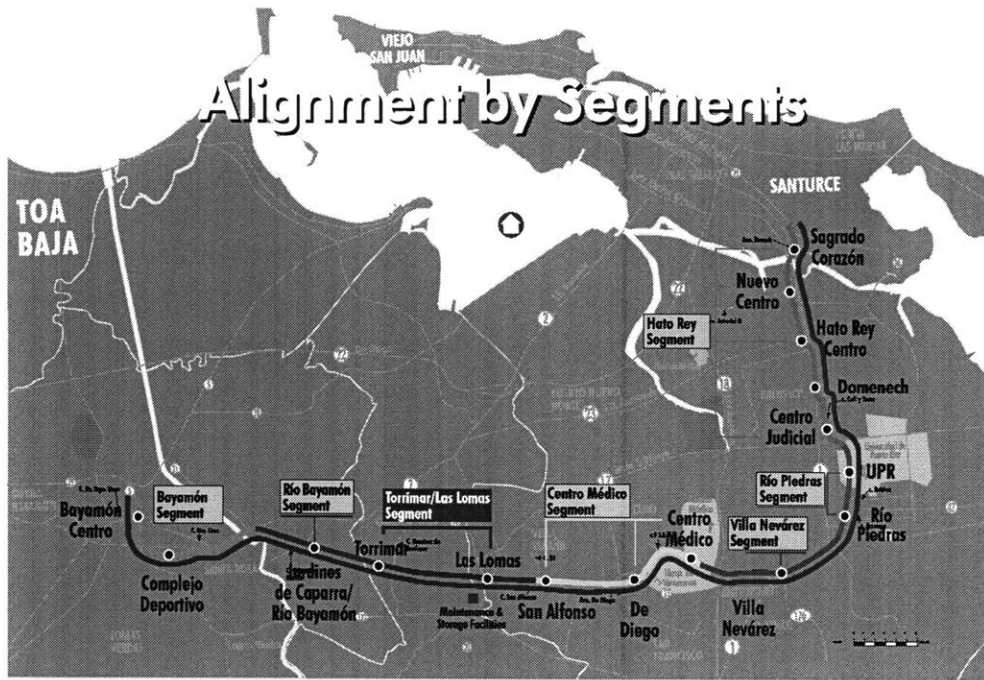


FIGURE 1: ALIGNMENT OF TREN URBANO BY SEGMENTS

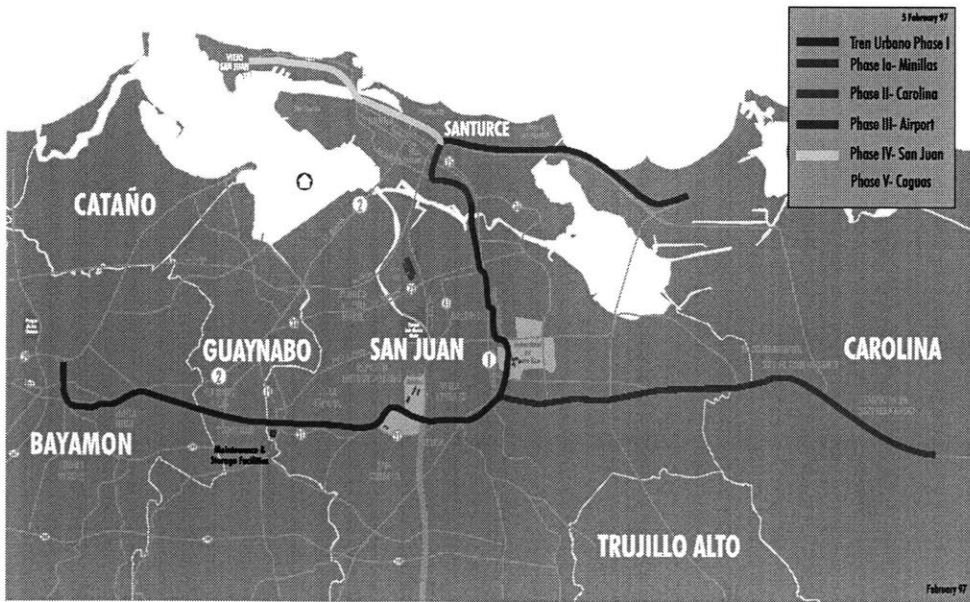


FIGURE 2: FUTURE ALIGNMENTS OF TREN URBANO

The sections are 60% elevated, 30% at grade, and 10% tunnel. The continuous line in Figure 1 represents the systems, i.e. tracks, vehicles, controls and power supply that is performed by one contractor.

Future phases are currently under planning and preliminary design as can be seen in Figure 2. This will form a rail network for San Juan, Puerto Rico that will greatly reduce the auto congestion problems that the city is currently facing.

2.2 PROCUREMENT STRATEGY

The procurement strategy (also called delivery method) of a project is the method that the design, construction, maintenance and operations are contracted out in order to achieve the various objectives of the project. The delivery method of a project can be classified as one of the standard delivery system categories such as design-build, turnkey, multiple prime, or construction management. Projects may also have a combination of the standard delivery methods, in which case it would be called a hybrid delivery method. The reason for selecting a delivery method may vary depending on the owner's objectives, project objectives, external factors, the owner's own capabilities of managing the work, or the speed that the project needs to be built.

To meet its objectives and needs, a delivery method was selected for the Tren Urbano Project. The owner's objectives for the Tren Urbano project (Dieterich, 1998) were to reduce exposure to political climate by having fast-track construction, to receive federal funding, and to remain in control of the project. Also, the objectives included high quality, technology transfer to Puerto Rico, and local involvement in the design and construction of the project. Each of these objectives warranted different procurements. The need for quick timing warranted a design/built delivery method. The need for federal funding and high quality design and construction warranted a turnkey procurement. The technology transfer and local involvement requirements warranted a multiple prime procurement. In addition, the owner had no prior experience in heavy rail construction, therefore, a construction management procurement method was warranted to ensure proper oversight of the project by the owner or a representative.

In order to encompass all these justified delivery methods, Tren Urbano selected a hybrid of all of them. The Tren Urbano Project delivery method, thus, has characteristics of various delivery methods: Turnkey, Design-Build, Construction Management, Design-Build-Operate, and Multiple Primes. In

In addition, the Tren Urbano Project has one contractor (STT) oversee and be responsible for other participants without proper formal contractual authority which further complicates the hybrid delivery method creating great number of uncertainties. A summary of the hybrid of delivery methods used in Tren Urbano can be seen in Table 1. Below the table are descriptions of how the Tren Urbano Project uses each of the delivery methods.

TABLE 1: TYPES OF PROCUREMENT INCLUDED IN TREN URBANO'S HYBRID APPROACH

	Types of Procurement	Party	Also referred to as
1	Turnkey	Siemens Transit Team (STT)	Turnkey Contractor
2	DBOT		
3	Construction Management (at no risk)	GMAEC	Owner's Consultants
4	Multiple Primes	Alignment Section Contractors (ASC)	Civil Contractors
5	Design-Build		

- 1. Turnkey Contractor.** One entity develops and delivers the project to the owner as one package. Essentially the owner buys the complete project from one organization. In Tren Urbano, STT is responsible for the complete integrated project.
- 2. Design-Build-Operate-Transfer (DBOT).** The same entity designs, builds and operates the project. In Tren Urbano, STT does the design, construction and operations.
- 3. Pure or Agency Construction Management (at no risk).** The owner holds the contracts with the designer and contractor(s), but another agency manages the contracts in behalf of the owner. In the Tren Urbano Project, GMAEC performs construction management for the owner, but they do not hold contracts with any of the designers, constructors or operators and therefore are not exposed to any risk.

4. **Multiple Prime Contractors.** The owner first hires a designer, then procures several contractors. In the Tren Urbano Project, there are seven prime contractors.
5. **Design-Build (DB).** The design and construction is procured as one entity and the construction starts before the design is finished. Often the same entity or partnership does both design and construction. In the Tren Urbano Project, the civil contractors perform design together with construction.

The contractual layout of parties in the Tren Urbano Project using this hybrid delivery method can be seen in Figure 3. It can be seen that the owner, the Tren Urbano Office, has direct contracts with their consultants, the ASC's and STT, and STT has no contractual relationship with the ASC's. Further detail will be given in section 2.2.1 to 2.2.3 for each party and each part of the Tren Urbano Project's hybrid delivery method.

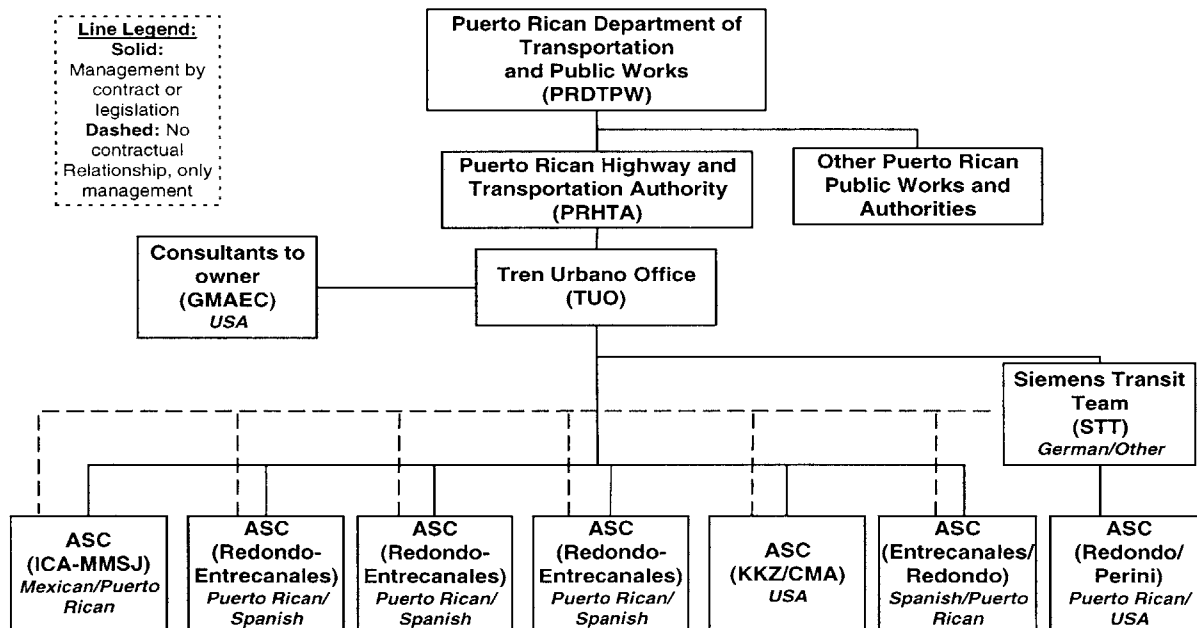


FIGURE 3: DELIVERY METHOD OF TREN URBANO

2.2.1 Turnkey Contractor with Design/Build/Operate Contract

Typically the construction costs of public infrastructure projects in the U.S. double. In Puerto Rico, highway construction costs have often increased by 200-300% (Salvucci, 1997) primarily due to numerous change orders and claims. In an effort to study possible reductions in the number of change orders and claims, among other factors, several US federal turnkey demonstration projects have been procured with the idea that one entity would deliver the project as a whole, and, thus, the cost and schedule would improve over conventionally procured projects (Volpe Institute, 1998).

As one of the four current federal turnkey demonstration projects, Tren Urbano has characteristics of a turnkey project. The major contract, the Systems and Test Track Turnkey (STTT) contract held by Siemens Transit Team (STT) has the aim of delivering the project to the owner with all the parts integrated as a turnkey project would. As a member of the Siemens Transit Team under Siemens lead, Parson Brinkerhoff (PB) has responsibility for integrating the project of all the contractors on the project. The STTT contract also includes design and construction of fixed facilities of one section of the track (Test Track), systems throughout the complete alignment (e.g. control systems, tracks, vehicles and power), and operations and maintenance for 5+ years. Thus, STT performs design, construction and operations and it also performs a management role for the remaining civil facilities performed by the other multiple prime contractors.

2.2.2 Multiple Prime, Design-Build Contractors

The remaining fixed facilities are contracted out in six multiple prime design-build sections. The turnkey contract combined with the multiple primes creates an innovative hybrid delivery method as shown in Figure 3. The fixed facilities were divided into six roughly equal sections in order to involve smaller local companies. The idea was to build a base of local transit knowledge instead of having one giant contract in which local companies, typically smaller, would be unable to bid on. The six multiple prime contractors, known as alignment section contractors (ASC), were procured for design and construction of the civil work consisting of 60% elevated, 30% at grade, and 10% tunnel.

The bidding process resulted in most of the fixed facilities contracts to be held by the Puerto Rican firm, Redondo. Thus, a single local company became a larger player in the Tren Urbano project

than initially anticipated. Also, STT contracted its fixed facilities work out to the same local contractor. Thus, it can be challenging to keep the role of the large local contractor separated between the role of prime contractor and the role of subcontractor.

Note also that the Turnkey contractor does not have any contractual link (shown as dashed lines in Figure 3) with the other prime contractors for which it must coordinate and manage. The lack of contractual arrangements can often lead to difficulties in enforcement that is essential for effective management. This becomes one of the key reason why partnering is critical in the project, as it is discussed in Section 5.1, Why Partnering is Especially Important in Tren Urbano.

2.2.3 Construction Management at No Risk

The owner of Tren Urbano, the Puerto Rican Highway and Transportation Authority (PRHTA) with no prior transit projects on the island, uses a consortium of consultants to provide transit design and management expertise. The consortium is known as the General Management, Architecture and Engineering Consultants (GMAEC) and it consists of Daniel, Mann, Johnson & Mendenhall, Frederic R. Harris, Inc., Eduardo Molinari & Assoc., and Barrett & Hale. The consultants managed the procurement of the contracts in the preliminary stage and are now performing construction management duties such as project controls and technical reviews of the designs. The owner and owner consultants form an integrated organization physically located in the Tren Urbano Office.

2.3 TREN URBANO MANAGEMENT ORGANIZATION

Identifying the organizational structure of the managing parties of the Tren Urbano Project, PRHTA, GMAEC, Siemens, and PB will enable a more detailed understanding of the framework of the Tren Urbano project. This will provide some more insight into how the project is being managed which is used as background for in analysis Chapters, 6 and 7.

The description in this thesis of the Tren Urbano management organization is divided into two parts. These two parts correspond to the two office buildings in which the management functions take place. The first office, called in the Tren Urbano Office (TUO), consists of the PRHTA and its consultants, the GMAEC, that together form an integrated organization. The second office is the headquarters of the

Siemens Transit Team (STT). STT consists of various parties, such as Siemens and Parsons Brinkerhoff (PB), which are also integrated into one organization. These two distinct organizations, TUO and STT, will therefore be described separately in this section.

The TUO organization will be described first in Sections 2.3.1 to 2.3.3. This organization has several organization charts as it has been viewed from several perspectives, three versions are described in this thesis, but many more exist. The first organization presented is the working project organization that casts a view of how the project actually functions in the view of some project participants. The next organization presented shows one official version. Third, the project implementation organization presents another official version of the organization. The differences between these organizations are discussed.

The major differences in the organizational charts occur because of conflicts in integrating the GMAEC reporting lines with the PRHTA reporting lines; i.e., the PRHTA employees have reporting lines from prior work for the PRHTA on other projects, and the GMAEC has its own project manager and hierarchy in its organization. Since the GMAEC is a consultant for PRHTA it becomes difficult to have PRHTA reporting to GMAEC employees. Also, confusion in the organization and confusion in the responsibilities and authority for each project participants becomes apparent with these organization charts.

Last, in Section 2.3.4, the STT organization will be discussed independently from the TUO organization as the TUO and STT organizations functioning separately. The next section, Section 2.5: Information Flows, will then show how these two organizations interact.

2.3.1 Working Project Organization

One view of the TUO organization is shown in Figure 4. This is a reflection of how some members of Parson Brinkerhoff (PB) and GMAEC perceive the organization. Parsons Brinkerhoff is a partner in the Siemens Transit Team responsible for the quality and the integration of the entire project. The GMAEC, as a consultant to PRHTA, works on behalf of the owners' interests, which also includes such items as quality. Although working in different teams, GMAEC and PB found this to be the closest to the true working organization chart.

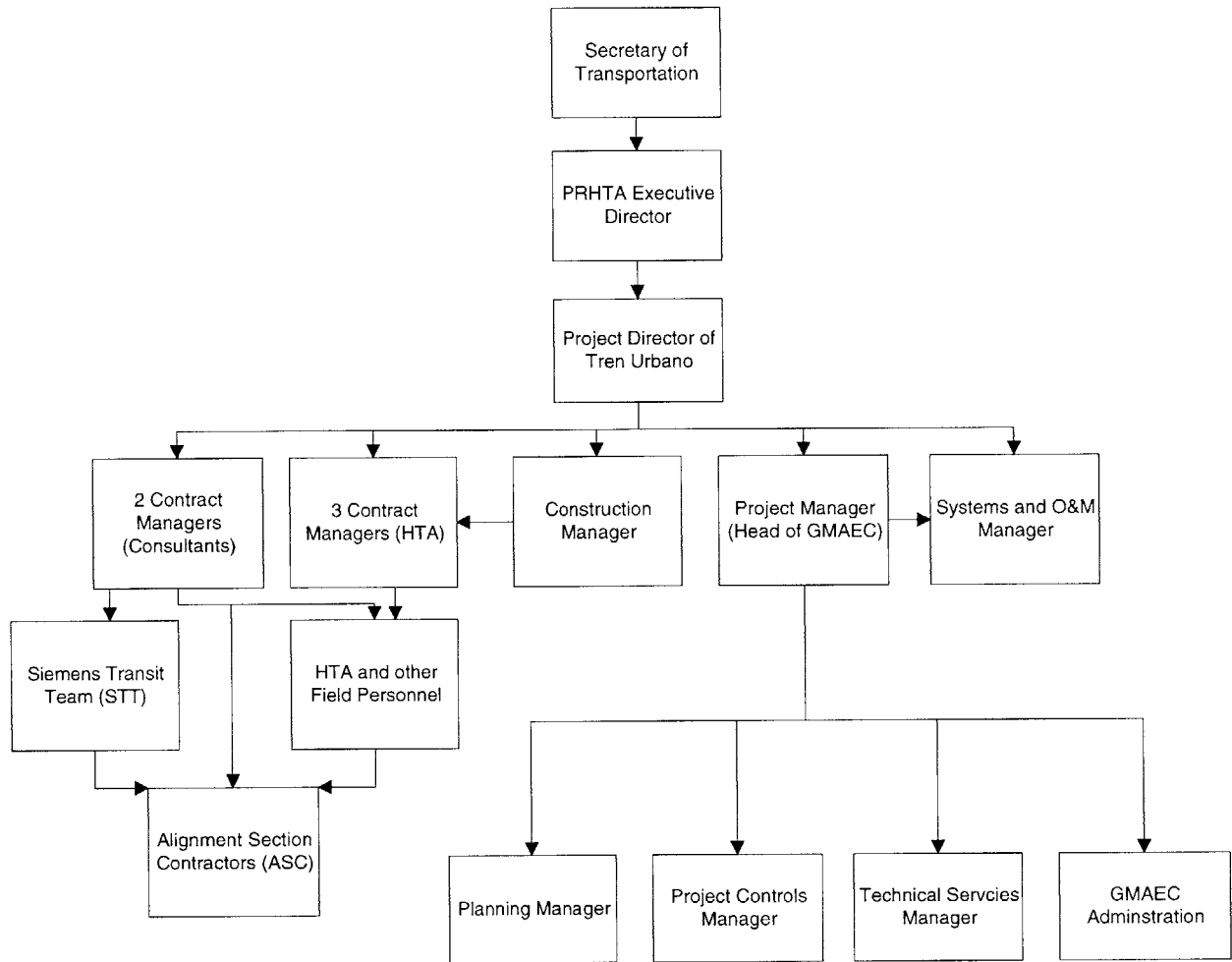


FIGURE 4: WORKING PROJECT ORGANIZATION

Shown on the top of the project organizational chart is the Secretary of Transportation whose role is to oversee the external issues to the project such as public relations, and federal funding for the project. Under the Secretary is the Executive Director of the PRHTA who is the contracting officer for the Tren Urbano project. His duties include signing and approving all designs, change orders, budget changes, and schedule changes. A PRHTA employee must do the signing of any legal document because of the existing local laws, and most of the TUO's employees are external consultants. Thus, final approvals are given by the Executive Director. An important comment on such role has been that a great effort needs to be made to delegate authority to lower levels in order to prevent any bottleneck in the information flow. Delegation of authority for approvals will ensure a more timely approval routing structure.

The Project Director of the TUO, who serves under the executive director of the PRHTA, manages the internal workings of the project. He has five contract managers reporting to him and three assistants to guide him in leading the Tren Urbano project. The three assistants consist of a Project Manager, Construction Manager and a Systems Manager.

The Project Manager managed the procurements of the current contracts and, thus, provides a base for implementing these contracts. The project manager is also the head of the GMAEC. The project manager heads five divisions in the GMAEC, each with a division manager. The divisions include systems/operation and maintenance, planning, project control, technical services, and administration. Note that the systems divisions' manager is also an assistant to the project director. It should also be noted that although the GMAEC is a separate organization than the TUO, the project organization does not reflect differences between TUO and GMAEC employees.

Continuing down the organizational chart, another branch coming from the project director consists of the contract managers (CM). Seven major contracts have been awarded each with their own contract manager who is the contractors' contact with the authority. Three PRHTA employees serve as CMs for the five sections of fixed facilities/alignment work. They report informally to the Construction Manager due to prior working relationships in the PRHTA. The remaining two CMs are consultants hired for their expertise in the technical field of the contracts they monitor. Informally they also report to the Systems/O&M Manager as part of the GMAEC team.

The major contract for all the systems work such as tracks, lighting, and control panels has been awarded to Siemens. Parson Brinkerhoffs (PB), as part Siemens team, also oversees the work performed by the other six section contractors in terms of operations and maintenance, transit issues, and interface coordination. Thus, the contractors' work is being monitored in a matrix format with three dimensions consisting of the CMs, PB, and the project director's assistants as can be seen in Figure 5 (Salvucci, 1998).

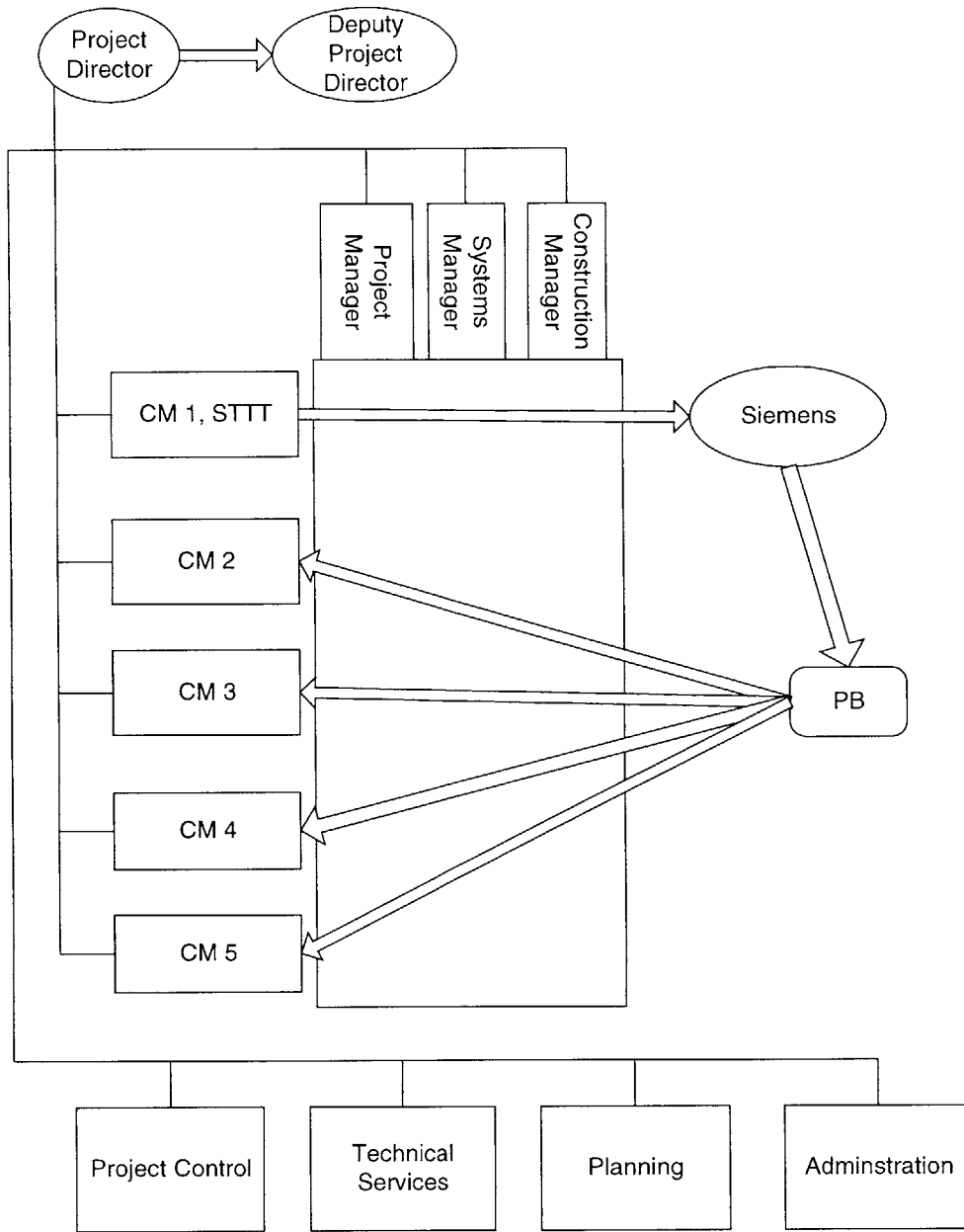


FIGURE 5: WORKING MATRIX ORGANIZATION

2.3.2 Official Project Organization

The organizational chart shown in Figure 6 (see Appendix A for further detail) is the organization documented by the GMAEC. Note that the Siemens/ Parsons Brinkerhoff (PB) role of management is not reflected in this chart although it is acknowledged on the working organization as presented in Section

2.3.1. This could indicate that STT/PB’s role is documented and perceived more as a supporting role than an important managerial role. This organizational chart shows the Project Manager above the Construction Implementation Manager and the CM’s below the Construction Implementation Manager.

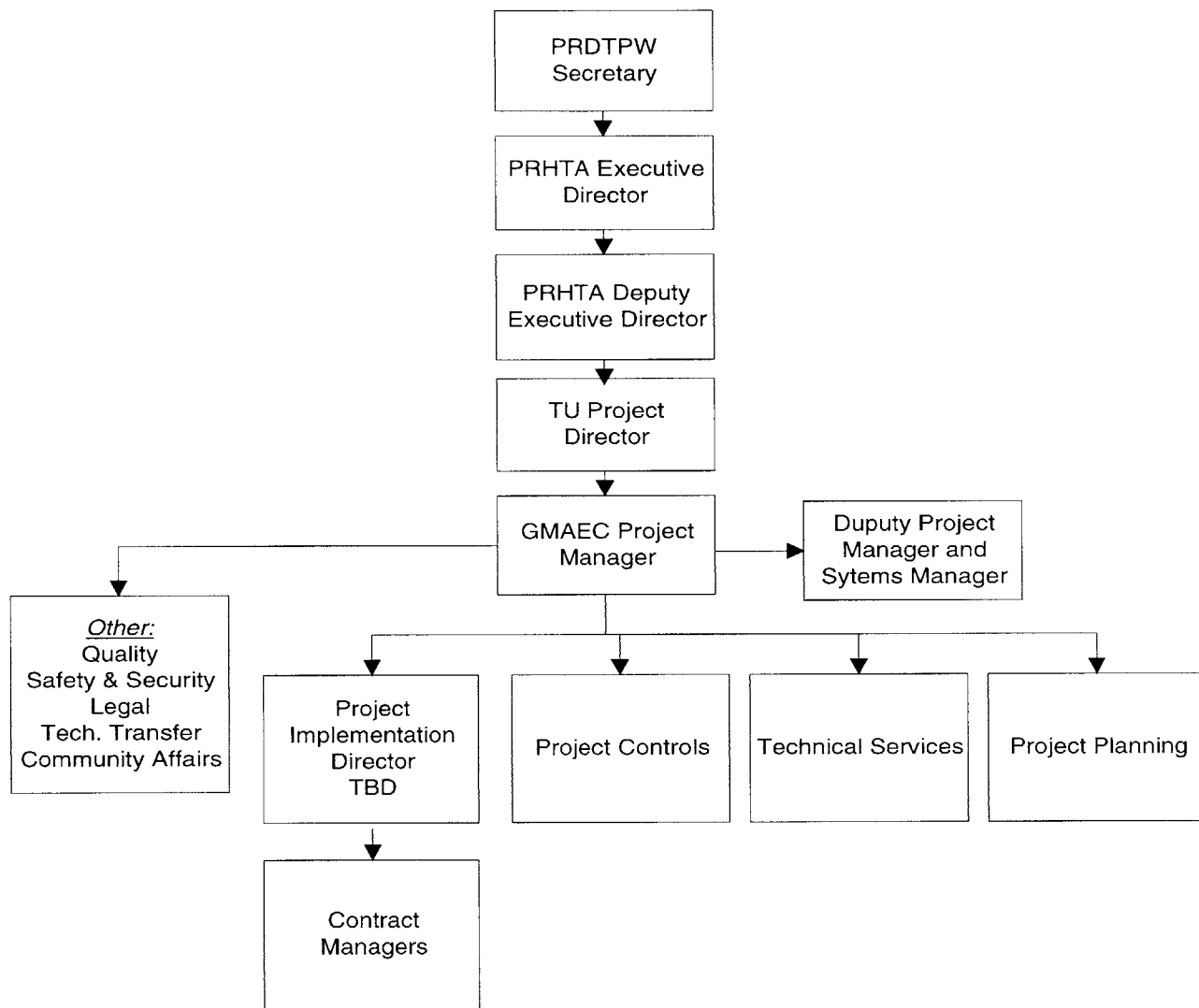


FIGURE 6: GMAEC’S OFFICIAL ORGANIZATION CHART

However, this chart shows that the Implantation Manager is “to be assigned” and the Construction Manager from the Working Project Organization (see Figure 4) is not even shown. This would indicate that the GMAEC does not recognize the Construction Manager as the Implementation Manager. Also, as this organizational chart was formed by the GMAEC, it shows GMAEC employees in higher ranks than some of the PRHTA employees, contrary to the Working Organization in Figure 4.

Therefore, this has quite a few discrepancies from the working organization which creates some problems on how the roles are documented and how they are undertaken.

2.3.3 Project Implementation Organizational

The organizational chart in Figure 7 gives a more detailed view of the project implementation director and his staff in the fact that the Project Implementation Director has been renamed as Construction QC. For more detail see Appendix B.

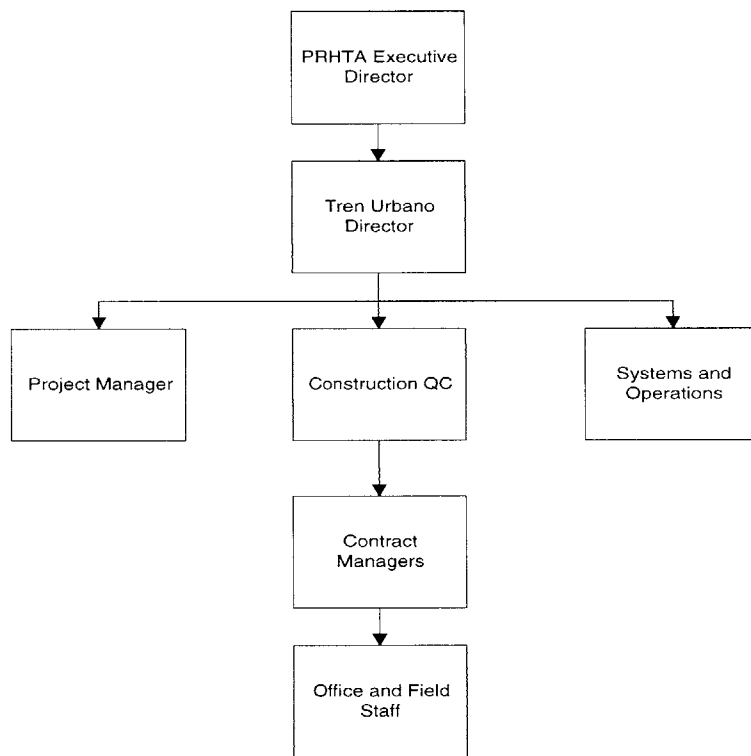


FIGURE 7: IMPLEMENTATION ORGANIZATION

The implementation organization shows the CM's reporting to the Construction Manager, who reports to the Project Director. This chart is similar to the working organization chart in Figure 4 in that the Project Manager, the Construction Manager, and the Systems and Operations Manager are equal assistants to the Project Director. However, this differs from the working organization in that the Contract Managers are not reporting to the Project Director as in the working organization. Actually, the contract

managers tend to report even further up the ladder to the PRHTA Executive Director. This occurs because the PRHTA Contract Managers uses old PRHTA reporting lines.

In summary, this thesis presents three versions of the numerous versions of the TUO organization. Further conclusions are drawn in Section 2.3.5 on the implications of the views of the organization. Next, the STT organization is presented in one format.

2.3.4 Siemens Transit Team Organization

Siemens Transit Team (STT) plays a significant role in the management to the Tren Urbano project, thus, the team organization must be identified in order to understand the framework in which STT operates. The organization is important because this will provide the basis for which information flows occurs with the Tren Urbano Organization and other contractors, and it will provide a better understanding of the organization of the tasks STT is responsible for.

The numerous tasks STT is responsible for is divided among its many members. The biggest member is Siemens Transportation Systems who will design and provide what is known as the systems. Systems included such items as vehicles, signaling, power supply, yard & shop equipment and elevators and escalators for all the civil sections. Alternate concepts, Inc, another partner, will do the operations and maintenance. Yet another member, Parsons Brinkerhoff, is responsible for the integration of the civil sections with each other and with the systems work. Another member, Juan Requena & Associates is the engineer of record and will do utility coordination and electrical design for the "test track" section. Another member, Lord/Mass, will do the communication and install the systems. A subcontractor to the partnership, Redondo/ Perini JV, will design and construct the fixed facilities for one of the seven alignment sections. These are the major players of STT, but many more parties are part of the Siemens Transportation Team, further details can be seen in Appendix C.

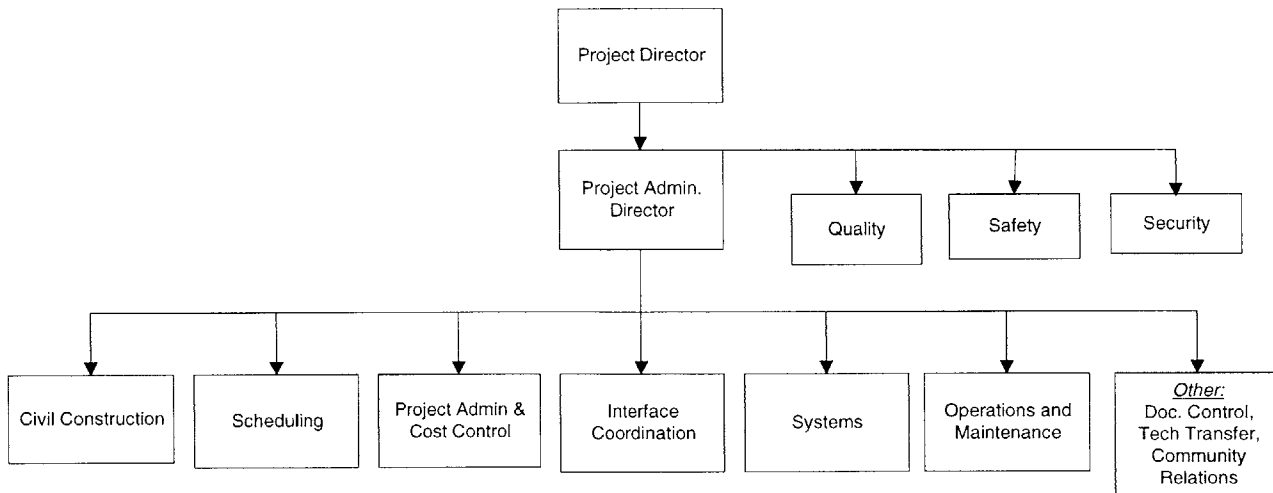


FIGURE 8: STT ORGANIZATION

Each team member has their own organization chart, but the overall management is integrated into one STT organization structure that is summarized in the chart in Figure 8. More details can be seen Appendix C, but Figure 8 should give a good and satisfactory overview. In Figure 8, it can be seen that the Project Director and his assistant, the Project Administration Director are the top managers. Horizontally below are the following sections, each with their own manager: Project Administration and Cost Control, Engineering/Construction Interface Coordination, Systems, Engineer of Record, Operations and Maintenance, Configuration Management & Document Control, Civil Construction, and Scheduling. Each of these departments generally corresponds to one member of the team.

In summary, the organization has top Siemens management and everybody else is horizontally below. It is organized in such a way that the director sees most issues internally between members, and any external correspondence goes through the Project Director as well. This reliance on the Project Director can create bottlenecks in information flows. It also ensures tight control over what information and documents leaves the organization, which thus makes it more difficult for members of the STT organization to work freely with members of other organizations such as the GMAEC.

2.3.5 Organization Summary

Three versions of the TUO organization have been discussed in this section: the perceived working organization, the GMAEC perceived official organization, and the perceived implementation organization. The numerous perceptions indicate that there is no clear organizational structure which creates great confusion in the reporting path for the members of the organization. Next, the STT organization was discussed; and although STT has many responsibilities in the owners interest, the fact that STT has its own, separate and sometimes duplicated organization indicates that STT is perceived more as just another contractor without a need to integrate with the owner's team. In the next section, Section 2.4, the various cultures present in the project will be discussed. The organization of the Tren Urbano Project will also set the framework in which the organizational flows take place, as will be discussed in Section 2.5.

2.4 MULTI-CULTURAL ENVIRONMENT

Tren Urbano is being built in a multi-cultural environment as numerous parties are brought together by the delivery method. The multi-cultural environment can be viewed from several angles: multi-ethnic, multi-corporate, and multi-professional. In addition, Tren Urbano is concurrently in different development phases: planning for the next alignments, design and construction of Phase I alignment and preparation for operations and maintenance of Phase I. These multi-cultural and multi-phase categories may overlap, for example, the construction managers tend to be Puerto Rican and the design managers tend to be mostly North American. Hence, often the Puerto Rican versus North American issues actually take root in design versus construction issues. Each culture has its own way of conducting business and when combined with other cultures, parties may be less at ease, and the working relationship poses additional challenges.

2.4.1 Multi-Ethnic Cultures

The Tren Urbano project is being built in the Puerto Rican culture where the Puerto Rican owner and the Puerto Rican ASCs have a long history of working together in an island where everyone knows everyone. In this community, relationships are very important and often take high priority in a project. This very old relationship has build many highway projects to dramatically improve the highway network on the island.

Within this relationship, the Siemens Transit Team must manage the ASCs dominated by one local contractor with strong tie and long history working with the owner. This is quite a challenge for STT, which itself consists of numerous cultures. STT consists of the German company Siemens with experience in train design, US companies Parsons Brinkerhoff with construction management experience, Alternate Concepts, Inc. with experience in operations and maintenance, and others. The numerous parties coupled with the intricate delivery method create a complex network of cultures that must interact both in Siemens own contract and the Tren Urbano Project as a whole.

2.4.2 Multi-Corporation Cultures

Problems in a multi-corporate environment could occur due to differences in business practice or differences in common knowledge. There may be problems such as one entity would perceive the US codes as common knowledge, and non-US contractors, unfamiliar with US codes, disagree and have a difficult time at interpreting. For example, difference of opinions was triggered for a constant in a contract. A non-US contractor took the constant at a face value and later redid some calculations for a segment of the project. A US party claims common sense should have prevented recalculations based on the constant value, as the US codes would indicate if interpreted correctly. This has lead to a long dispute over recalculations and who should pay for that effort. Similarly, the contract language may be interpreted differently based on what is common in contractual relationships in the different home culture leading to many discrepancies and disputes.

2.4.3 Multi-Professional Cultures

Different professions have different cultures as priorities and objectives of each profession differ and each profession requires different characteristics to be successful. For example, designers are valued for high quality, whereas contraction managers are more valued for low cost on time project performance within the quality parameters of the designers. Thus, if the different professions work together there is great potential for conflict.

The different cultures also might downplay the importance of other professions. For example, a management team, which has worked solely with construction management, sees the need to cut the design review cycle down to improve the schedule of a design-build project. This may, however, cause rift with the design managers because designers consider a shorter deign review cycle as a compromise to the design quality. Each profession champions their work.

2.4.4 Multi-Phase

The multi-phase aspect of Tren Urbano also results in various conflicting priorities. Tren Urbano is currently planning for the next alignments, designing and constructing simultaneously Alignment 1, and preparing for the operations and maintenance of Alignment 1. Often, immediate issues take higher priority than the long-term issues. Thus, since construction tend to be more immediate than other phases, it can be a challenge to balance priorities and resources between all phases.

These are examples for how the differences in culture can cause strains in the already complex set of relationships defined by the procurement strategy. Effective partnering can ease and/or prevent these strains. Effective partnering requires trust in the other parties; and with cultural differences, the partnering process becomes additionally challenging. Chapter 5, 6, and 7 presents partnering and how partnering can improve any project like Tren Urbano.

2.5 INFORMATION FLOWS

Within the context of the multi-cultural organization, information flows take place. Information flows represents the processes by which data is exchanged among the contractors, the management parties, and all the other parties involved in the management and development of the project. Identifying the processes will give further understanding of the management of the project and will, along with the understanding of the delivery method and organization, be used for analysis in Chapters 6 and 7. In order to identify the parties involved in data exchanges as well as what type of relationships exist with each data exchange activity, the following structures and information flow are identified and modeled:

- Design Review/Approval
- Schedule Approval/Changes
- Change Orders
- Request for Information
- Field Inspection
- Lessons Learned
- Process for Notifying One Party of Another Party's Changes
- Progress Payments

Although this list of information flows does not include all possible types, it provides a good basic understanding of how information typically travels between organizations, within organizations and where decisions are typically made. Some of these procedures are formal and for a more detailed review of the formal processes within TUO and STT refer to Tren Urbano's manual of Procedures (TU, 1996) or STT Manual of Procedures (STT, 1997). This section will not go into detail on every procedure as the manuals do, rather, it will explain the basic flows in the Tren Urbano Organization and explain flows *between organizations*, which are not diagrammed in the manuals.

Some procedures discussed in this section such as lessons learned and process for notifying one party of another party's changes are informal, meaning that there are no official procedures. These procedures will show information flows when it is not restricted by procedures.

Overall, the data flow will involve organizational units who generate information, review information, approve submittals, or store the information on a hard copy or electronic files. The role of each party in the data flow will help determine where important decisions are made and where critical integration of information takes place.

2.5.1 Early Procedures and Processes

The information flows in this chapter will be based on actual procedures observed and on the official procedures from the TUO Manual of Procedures (TU, 1996). However, before the Manual of Procedures was written, there were official procedures that TUO project participants followed. These protocols were available during the Oct. 6-7, 1997 Quality Summit in San Juan. They were in a form of a general Contractor Submittal Protocol for Design and Non-Design as well as Contractor Request for Information. Copies of these protocols can be seen in Appendix D. These procedures were listed in numerical order and not diagrammed at the time. Diagrams of these procedures have been made into flow charts by the author of this thesis in order to clarify the information routing Diagrams (see Appendix D). Each step in the official protocol has been numbered. The numbers correspond to a movement of information. As some steps of the protocol do not correspond to documents changing hands, some numbers in the protocol are not shown in the flow charts.

The non-design submittals include CPM schedule, work plan, progress reports and updates on schedule. The procedure for non-design protocols depends on the type of information that is reviewed. The difference in routes of review occurs because different information requires different departmental reviews and each department is organized differently. To clarify these procedures further, a distribution matrix of reviewers and submittals is included in Appendix D. This protocol serves as a compact document for various procedures and can be use as a quick reference guide for project participants and can be used as a summary for describing information flows.

These protocols are important to note because their give an understanding how procedures have developed through the timeline of the project. They are also noteworthy because they point out that the procedures were only being formed at the beginning of the project and that project participants began the project without detailed procedures. The reason that the procedures were not fully explained at the beginning of the project was because the project is fast tracked and there simply were too many other issues to resolve and not yet enough personnel on the project at first to write out all the procedures at

once. One should note, however, that these protocols set the tone of the project in terms that the Siemens Transit Team was not clearly included in the procedures.

The protocols were the original procedures, which served as the basis for which other procedures formed. These protocols are important because they give understanding of how the procedures of the project and perceptions of various parties' roles developed. The TUO manual of procedures (TU, 1996) was not written until later, but it is also more useful because it is more updated, detailed and is, hence, used for the remainder of Section 2.5.

2.5.2 Design Review/Approval Process

The design, performed by the contractors, is submitted to the owner and STT for review and approval in many stages of completeness. The design approval occurs when 100% design has been reviewed, and therefore the approval process is really integrated with the review process although it requires some additional signatures. Major changes of the design would follow the change order process discussed in Section 2.5.4 and therefore not included in this section. This section will show the role of each party to the process as well as the integration between the parties. The process is not always exactly like the official procedures spell out. Therefore, in Section 2.5.2.1 the actual procedures are described and then they are compared to the official procedures in Section 2.5.2.2. The actual procedures include the whole process of design including parties such as STT. The official procedures give a more detailed review of the design review/approval within the TUO.

2.5.2.1 *Actual Design Review Procedures*

The initial 30% design was completed by the GMAEC prior to bidding of the contracts. At this time, the contracts have been awarded and all construction is being designed by the contractor or by his/her partners/subcontractors. The specifications for the designs are provided in the contracts except for any specifications directly related to transit design. These specifications such as train loading and location of electrical conducts must be provided by Siemens in the form of an Interface Manual. The design review process described below is for the review of the alignment section contractor's designs, not the initial 30% design. For a summary, see Figure 9.

As seen in Figure 9, the alignment section contractor submits designs to the TUO's Contract Manager (CM) who submits the designs to technical services which mostly consists of GMAEC personnel. Siemens also receives the designs from the contractor and reviews all designs according to three criteria. First, the designs are checked for acceptability in terms of standards for transit systems' standards. This review may include such checks as sign locations, stations' usability, and ability for expansion joints to handle rail expansions. Second, the designs will be reviewed to ensure all construction will be integrated properly. Last, Siemens will review the designs from an operational and maintenance point of view. Siemens sends their comments to the CM who sends it to Technical Services in the GMAEC. Technical services reviews the comments, but does not necessarily always integrate the comments with their own comments due to the tight time schedule for design reviews. This is shown as a dashed line in Figure 9. After technical services (mostly GMAEC staff) reviews the design, a copy of Siemens comments will also be sent to the contractor. This is done in order for the contractor to have STT's comments as early as possible and not having to wait for technical services to send Siemens' comments to the CM and then to the contractor.

The original designs, which were passed from the CM to the GMAEC Technical Services, will be routed to the appropriate design reviewers in technical services. Each design reviewer spend most of their time reviewing the designs for one or two of the contracts. The designs will be reviewed for structural correctness, calculation errors, and compliance with codes and regulations. The route of reviews in the GMAEC shown in Figure 9 is the actual route based on interviews with GMAEC's Technical Services' personnel and differs from the manual of procedures. This actual route is shorter and has less steps because of the lack of sufficient time to route the design through the various reviewers in the contract specified 15 working days allowed for a design review. After reviews are complete, the designs will be routed back to the CM who will send the comments back to the contractor.

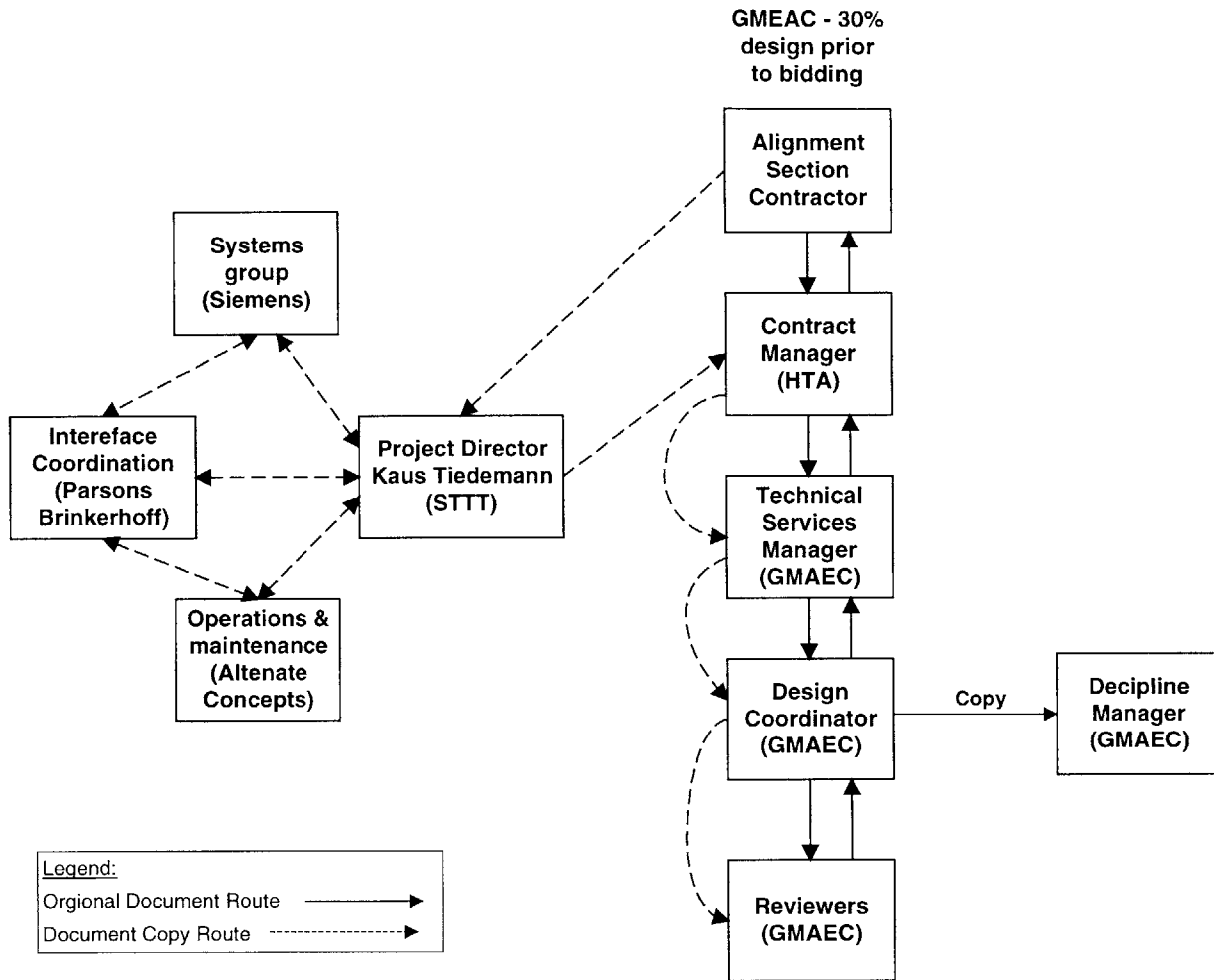


FIGURE 9: DESIGN REVIEW PROCESS OF ALIGNMENT SECTOR CONTRACTORS' DESIGNS

The design review comments from the GMAEC and Siemens are not integrated in the Tren Urbano Office as the official procedures specify, but technical services asserts that they ensure that the contractor does not receive conflicting comments from GMAEC and STT. The contractor, however, will already have received STT's comments before they receive a verification that there are no conflicting comments between GMAEC and Siemens. Thus, the contractor may not feel comfortable using STT's comments before the GMAEC's verification arrives, and, hence, there may not be a lot of benefit to give the alignment section contractor Siemens' design comments before the GMAEC has first verified Siemens' comments. Finally, it is up to the contractor to adjust their design to both GMAEC's and STT's GMAEC approved comments, and then the design can be submitted again. When the design is completely approved, then finally the contractor can be paid for the design.

Two routes are shown in the design procedures in Figure 9. The dark line with the official design review route through the GMAEC. The dashed line represents a secondary route of design review through STT. Note that STT reviews are based on three objectives: system and transit design requirements, operations and maintenance, and interface coordination. These three objectives are met with the three STT departments: Systems, Interface Coordination, and Operations and Maintenance. The dashed route ends back with the ASC and with the GMAEC's design reviewers who attaches (although not integrated) STT's comments to their comments. Then the STT comments follow the official route back to the ASC.

2.5.2.2 *Official Design Review Procedures*

The official design procedures were developed early and had extensive detailed flow charts (Appendix D, Early Protocols) that later developed into more extensive flow charts (seen flow chart Appendix E from a Manual of Procedures). The manual of procedures shows the decisions to be made at each step and is more complete than the early protocol. For example, the manual of procedures includes the requirement of the integration of STT comments with TUO comments while that the protocol did not. However, both have commonalities such as they have many iterations between personnel in Technical Services. This section will be based on the recent official procedures, the Manual of Procedures and compare them to the actual design review procedures as described by the actual participants in the process.

The official design review procedures have many discrepancies from the actual procedures. Common discrepancies occur as project participants take short cuts when they are under time pressure. For instance, one discrepancy is that TUO often does not integrate Siemens' design review comments with their own comments before giving both comments to the contractor. As can be seen in the actual procedures, GMAEC *does* receive STTs comments, but often STTs comments are not integrated with GMAEC's design review comments as was envisioned. Perhaps the lack of early emphasis on TUO integration with STTs enabled GMAECs design reviewer to avoid integrating with STT's comments without much opposition. The early protocols would give the indication that the tone of the project was set early on by PRHTA/GMAEC that STT's contribution was not very important in administrating the project since STT were not included in these protocols.

Also, the TUO design reviewers are under a lot of time pressure because there are many designs to be reviewed and each design only has 15 working to be completed. This leads to another discrepancy in the numerous iterations between parties in Technical Services in the GMAEC. These iterations can be very

time consuming and, thus, can cause bottlenecks in the approval processes. However, the long procedures are not always followed because reviews have tight time constraints, and, thus, shortcuts are taken in the actual procedures as shown in Figure 9.

A third difference between the design review procedures is that the Change Control System (CCS) and Document Control in the protocols have been intentionally omitted from Figure 9 for simplicity, but they can be seen in Appendix D, Early Project Procedure Protocols. CCS is a software program that was purchased by another heavy rail transit owner from Los Angeles. Software for document routing is generally required on federal projects and thus this software program is often just viewed by many project participants as a requirement rather than a benefit. Project participants are required to use this software to generate and route all standard forms. CCS documents and tracks the routing of documents. From the protocol in it is not clear whether parties other than the contract manager enters information into the Change Control System (CCS). Actually, Technical Services is the one that enters comments into the CCS, but there has been much resistance to use CCS as many other organizations encounter when introducing new software. People just prefer their own ways of tracking documents and have a tendency to only trust their own system of tracking. The fact that CCS is not very user friendly makes it even harder to convince employees to use the system.

The other item not shown in the actual procedures in Figure 9, but shown in the official procedures, is Document Control. Document Control is a physical storage place where all hard copy incoming originals, copies of all outgoing correspondence, and change control documents are filed in one central location. Individual employees also store documents in their offices for easy access, and, at times, the same document is stored in several offices. This procedure of self-filing takes additional time of employees and files occupy space in individual offices and creates confusion where documents are filed and confusion of which version of the document is the final and submitted version.

2.5.3 Schedule Review Process and Progress Payments

The detailed procedures within the TUO and STT organizations for schedule reviews and approvals can be seen in their manual of procedures. This section focuses more on the flows between organizations for the schedule review and approval and progress payments to the contractors.

The schedule and the progress payments to the contractors are linked. Each alignment section contractor schedules his/her own work and provides monthly progress reports including summary of work

done as well as a recovery schedule (if there has been any schedule changes) to the Contract Manager (see Figure 10). The CM, as a public employee, handles monthly payments to the contractors based on the schedule. Since the contracts are cost loaded, the payments are dependent on the construction progress and are measured in “percentage complete.” In order to monitor the correlation between payments and progress, the project control division of the TUO, mostly GMAEC, analyzes the schedules to avoid early payments for work not performed. The ASC also submits their schedule to Siemens who reviews the schedules for possible delays in the alignment contractors’ hand-off to Siemens. Siemens also monitors schedules for productivity, performance and possible delays, which are reported to the GMAEC. The contractor determines his/her work schedule, but the hand-off dates cannot be changed without both Siemens’ and TUO’s approval, as stated in Siemens’ contract with the PRHTA.

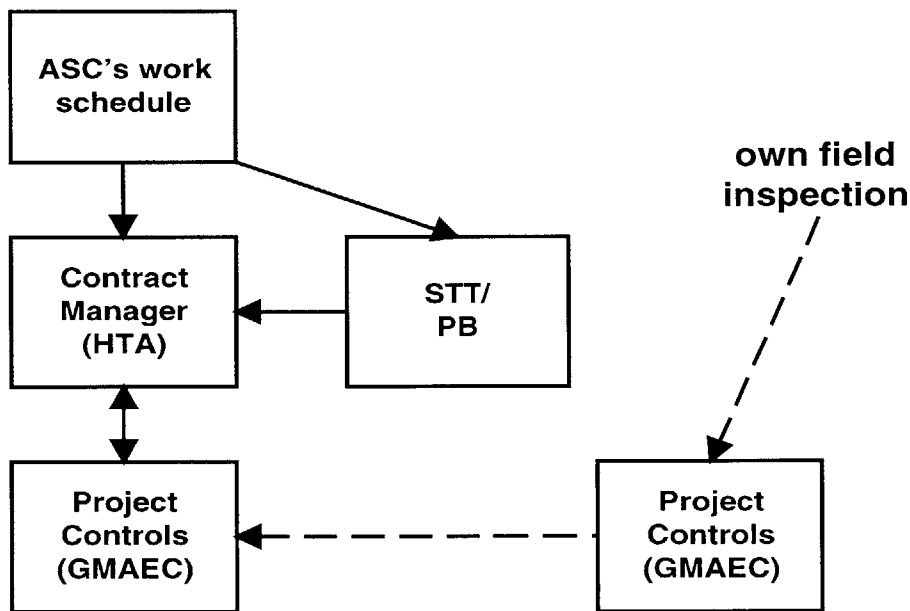


FIGURE 10: ASC'S SCHEDULE REVIEW PROCESS

The ASCs have not been submitting their schedules regularly, and, thus, the ASC have not been paid for several months. In one instance the contractor was not paid for six months because he did not submit a schedule; but the contractor convinced higher up PRHTA employees to pay him anyway and payment was issued despite no schedule was submitted. However, recently the policy has become stricter and no payments are made unless a schedule is submitted.

Even if the ASC’s schedule is submitted to the PRHTA/GMAEC, STT often does not receive the schedule from the ASCs. STT receives the schedule from the PRHTA/GMAEC instead. After STT has

received and analyzed the schedule, GMAEC's Project Control claims that STT rarely provides useful information to the Project Controls because Project Controls generally already have the ASC's schedule analyzed. For STT own purposes, STT reviews the ASC's schedule to determine if there is going to be a delay in the hand-over date. Even though many of the ASC are already very behind schedule, the PRHTA/GMAEC claims there will be no delay in the hand-over to STT. The PRHTA/GMAEC will maintain the position of no ASC delay as long as possible because a delay would mean locking in a new hand-over date and would constitute a change order with STT. Thus, until the PRHTA/GMAEC officially tells STT that there is a delay of the ASCs, STT will calculate the most likely hand-over date. The early delay calculation will allow STT to procure new personnel for systems testing for a more likely hand-over date.

In a response to the already delayed construction schedules and the lack of submitted schedules from the contractors, GMAEC's Project Controls are making their own ASC schedules from their field observations. This new schedule is compared to the one that is submitted by the ASC in order to identify problems which could have caused construction delays and which other parties are affected.

In summary, both STT/PB and PRHTA/GMAEC review the schedule submitted by the ASC. In addition, the GMAEC reviews the ASC schedule that is based on GMAEC observations. Thus, the task schedule review is duplicated several times.

2.5.4 Change Order Process

The actual change order process within TUO are fairly close to the actual procedures and will therefore be discussed together in this section. The change order processes is used to document, evaluate, negotiate, disposition and issue change orders in Tren Urbano. The complete change order process is composed of four major sub-processes – Initial Notice, Contractor Change Request, Authority Change Request, Change Directive, and Change Order - each of which is described and presented graphically in the Manual of Procedures and are not expanded upon in this section. For a Change Order to occur not all of the sub-processes listed may be needed. An example of a complete process that is initiated by the contractor is shown in Figure 11.

The Contractor Change Request process starts with the contractor submitting an Initial Notice (IN) to the PRHTA/GMAEC that a change order is due. Within 10 days of the IN, the contractor must submit a complete estimate and schedule of the change with documentation of merit in the form of a Contractor

Change Request (CCR). Usually the CRR is not filed within 10 days and an extension is filed by the contractor, which is usually approved by the PRHTA/GMAEC. Now the Contract Manager together with Technical Services, Project Controls, and the legal team from Palmer and Dodge determines whether the CCR has any merit. If the CCR has no merit, it is returned to the contractor; otherwise the CCR follows the Change Notice (CN) or Change Directive (CD) process. A CCR becomes a CD if it is determined that the contractor needs to start the work immediately and the cost, time and technical impact evaluations will be negotiated after the CD has been issued. This direction is avoided as the negotiation process later becomes more complicated and could be more costly for the PRHTA. After the CN or CD has been approved, a Change Order (CO) must be negotiated and the cost, time and technical issues must be approved.

The technical issues, cost, and time must negotiated for both the CN and CD between the PRHTA/GMAEC and the contractor. Usually the technical issues are quickly resolved. There is a policy in the PRHTA/GMAEC not to give the contractor schedule extensions if possible even it is means increasing payments to the contractor. The cost of the change is usually what lengthens the negotiation process. On the PRHTA/GMAEC side, the Contract Manager makes the final recommendation. Final approval occurs during the signature process.

The signature process referred to in Figure 11 is the procedure to obtain the signatures of a list of project participants who must review and approve the package. The order in which the signatures are received is not prescribed; however the list can be up to 10 people from the Contract Manager to the Secretary of Transportation. Initially the Executive Officer (Director of the PRHTA) had the final signature, however in early 1998, the Secretary of Transportation signature became required as well. As the Secretary has many other projects to oversee, to obtain his signature as well as the Executive Director's be a lengthy process. This adds time to the already lengthy process for gathering signatures, for example a CN often takes 2-6 months to be approved. There the signature process, as a sub-process of the change order process, can be a bottleneck. Now the contractors and PRHTA/GMAEC must work together to avoid delays while the change order is being processed.

All change orders are not negotiated in adequate time. For example, STT and PRHTA/GMAEC came to a stalemate over the price of a detention pond. Because of the long negotiation period, the pond was holding up the construction work. Hence, the PRHTA/GMAEC set up a force account in which STT constructed the detention pond on a time and material basis. STT had the option of not doing the work on the force account, but then PRHTA/GMAEC would get another contractor to do the work and subtract the amount of the other contractor from SST's contract. PRHTA/GMAEC believed that the force account

would be cheaper than SST's price for the work, but the force account also obligated the PRHTA/GMAEC to monitor the productivity, schedule, and actual labor hours spent on that specific task. This could have been avoided if the change order process and negotiations were easier achieved.

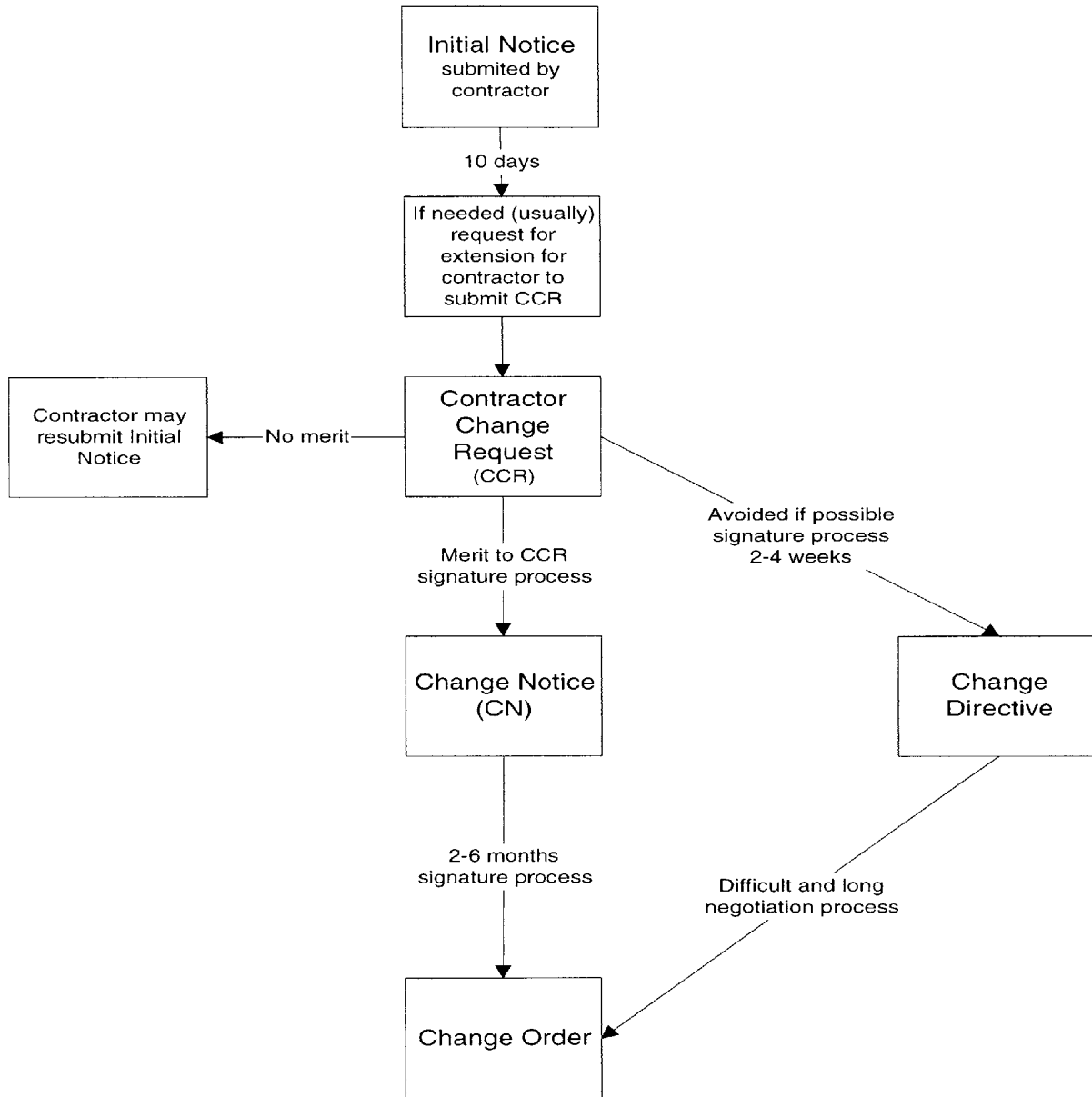


FIGURE 11: PROCESS FOR CONTRACTOR REQUEST FOR CHANGE (RFC)

The Contract Manager for Kiewit also views the change order process as slow, but is able to work the contractor schedule around the change orders to avoid delays due to pending change orders. STT also views the change order as slow, but fairly reliable for standard change orders between the contractor and the PRHTA/GMAEC.

Although most changes order are slow, they are viewed as reliable; however not all changes are adequately covered by the change order procedures. Currently the change procedures are initiated either by the contractor or the PRHTA/GMAEC but only between each contractor and the PRHTA/GMAEC. For example, STT has a new idea on how to improve the ASC's design of a roof on a station because STT realizes there could be a major wind tunnel effect. However there is a no mechanism for implementing this new idea and STT concerns may not be followed up upon. For new ideas, which STT feels, are crucial, informal methods such as making numerous phone-calls and numerous letters may be used. This creates more paperwork than a simple request for change form. The new idea may also not be addressed in a timely fashion as there are no time limits on informal procedures as there are in the change order process.

2.5.5 Contractor Request for Information (RFI) Process

A contractor in the Tren Urbano Project may request information from STT, in which case it is handled by STT, and there is a procedure outlined in the STT procedures manual. Information could also be requested from the owner by STT or any other contractor. Details of the procedure for the owner and its consultants (TUO) to handle RFIs can be seen in Appendix D. The chart shows the procedure of approvals and reviews required in order to give the contractor the information that he/she requested from the TUO. The main ideas from the RFI procedures is that the CM receives the RFI from the contractor first and then distributes the RFI to the appropriate department within the TUO. Finally the RFI is returned to the contractor via the CM. This procedure also illustrates again that STT and PRHTA/GMAEC have separate processes that may be duplicated and overlapped.

The ASCs are required to hire inspectors to monitor the quality of their work (see Figure 12). The inspectors are required to do such tests as slump tests. The PRHTA also has inspectors in the field to ensure that the ASC's inspectors are performing their work.

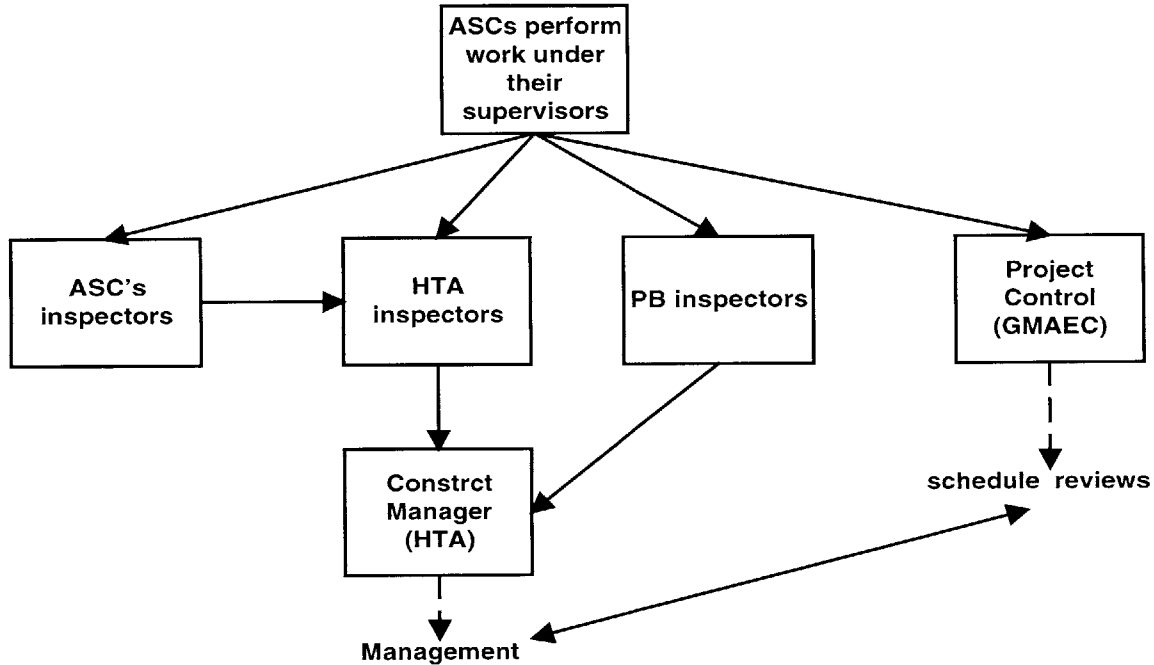


FIGURE 12: FIELD INSPECTION OF ALIGNMENT SECTION CONTRACTORS

The PRHTA employees are the owner and can also provide directives to the ASCs. PB also has inspectors in the fields who monitor for interface with systems, transit issues, and quality for operations and maintenance. PB also provides the expertise in transit construction since neither the PRHTA nor the ASC (except ICA and Kiewit) have any transit construction experience. Note, however, that not all field information from PB reaches top management, as the contract managers will filter the information first. Note also that for much of the time, the ASC has four entities inspecting their work. This is a duplication of effort that could lead to conflicting observations and comments to the ASC.

2.5.7 Lessons Learned Process

There are no official process or protocol for lessons learned in the Tren Urbano Project. Some projects have official processes; for TU to implement this, it would require additional staff and time to document lessons learned and to ensure the lessons are being applied throughout the project. Most projects, which do not have official processes for lessons learned, usually have some informal processes.

Informal lessons learned processes require high cooperation between project participants. In TU, the contract managers would especially benefit from lessons learned from other contract managers, however, the PRHTA contract managers who have no transit experience are not learning from the two consultant contract managers with high experience. There needs to be more cooperation for lessons to be learned- good and bad lessons.

As one contractor is constructing many of the alignment sections, it would seem highly probable for that contractor to share experiences from one section to another section. However, the contractor often has made the same mistakes twice on the same alignment segment. For example, a retaining wall was constructed and one section was not flush. The contractor did not learn from this mistake, the next section was not flush either! The contractor has different people on each section, so it seems that it does not have an adequate lessons learned process. In conclusion, there needs to be better cooperation in the project to allow for more lessons learned processes.

2.5.8 Process for Notifying One Party of Another Party's Changes

One party, for example one ASC, may not know changes being negotiated between another ASC and the PRHTA/GMAEC. There may be lessons learned from a change, as discussed above, which could be valuable to the first ASC, or the changes may directly affect another ASC. As much of the information of other parties' changes is often not relevant to all other parties, there are no formal procedures in place. Informally, however, project participants may relay other parties' changes.

The information relayed between ASCs and CMs are usually in the form of interface meetings with PB. PB must ensure the physical structures line up and that the ASCs are working together to make the interface between the sections constructed in a logical manner. Changes between one ASC and the PRHTA are not discussed with the other ASCs unless PRHTA/GMAEC/STT/PB believes that it would

affect the interface between the ASCs. Generally there is a lack of knowledge about what other parties are doing. This confusion is also present in the TUO; first due to confusing lines of responsibility, project participants do not know what other peoples' general and overall responsibilities are. Second, there is not enough communication between people of their specific actions within those responsibilities.

STT reviews the designs of the ASC and thus has more knowledge of the other contractors than the ASCs do. However, often changes between the ASC and PRHTA/GMAEC are made without STT knowledge. Informally, however, the CM for STT provides STT with information of the other ASC's changes. If these channels of informal information were formalized, then better efficiency could be achieved in the overall management of the project.

2.6 CONFLICTING SITUATIONS

Based on the delivery method, the organization, the cultures involved, and the information flows identified above, several potential conflicts may be identified between the parties involved in the Tren Urbano Project. Such conflicts can be classified as either mostly organizational rooted conflicts or mostly informational flows caused conflicts. Most conflicts, however, are interlaced between the organizational structures and the information and communication that occurs between the parties involved and many other factors such as language differences.

To identify conflicts between parties involved, it is useful to identify how each party perceives their role. Party's perceptions of own role as seen Figure 13 may not always be aligned with the objectives of the delivery method, nor are they aligned with the other party's self-perceptions. There are often overlap in control and responsibilities or, worse, gaps. Also, there is often a difference in perception of role in the project, and that can lead to conflicts as will discussed in this section.

As seen in Figure 13, the Secretary of Transportation, the management of PRHTA, the PRHTA in TU, and the GMAEC see themselves in charge of the project. As the reporting lines and duties are confusing, each party may try to take over in order to put order in the project. This can cause potential conflicts as parties fight for control of the project. Ultimately the Secretary of Transportation will gain the control of the project. With control comes the need to manage the project, and, thus, the project has a tendency to be micro-managed by top management. As evident by the current management practices and lack of delegation, the project is already micro-managed. Micro-management limits efficiency, and inefficiencies lead to more confusion. As participants see confusion, they tend to take short cuts in the

organization. For example, they may go directly to the PRHTA management and bypass GMAEC and STT/PB. As long as the PRHTA management will listen to the ASCs, the ASCs will take advantage of this short cut. This will cause other parties to feel more out of control and fight for more control.

The objective of the project was Siemens/PB to perform some management role which requires a partnership and Siemens/PB and PRHTA/GMAEC. However, as the fight for control increases among other parties, Siemens/PB role in the project management is greatly reduced. PB, as part of Siemens Transit Team, must aid in coordinating the ASC and has experience to provide quality control. However, with lack of control, it is difficult for PB to implement any management schemes.

PARTY	PERCEPTION OF OWN ROLE
Secretary of Transportation	Has ultimate responsibility for the success or failure of the Tren Urbano project in the public eye, thus the project becomes a political pawn.
PRHTA Top Management	Manages other PRHTA Project strongly, thus, TU must be managed firmly likewise
PRHTA in TU Project	Owners of the TU Project which have supporting staff such as the GMAEC and others
GMAEC	Main brain of the project
Alignment Section Contractors	A contractor with similar role as in other projects
Siemens	Provider of systems, vehicles and O&M
Parsons Brinkerhoff	Consultant in a lump sum environment. Lacks power needed to effectively execute interface coordination and quality control/assurance

FIGURE 13: PERCEPTION OF EACH PARTIES' OWN ROLE IN TREN URBANO

The differences in perception of each party's own role, lead to conflicts because overlap in the responsibilities, control, and authority due other parties perceiving a party's role differently than the party perceives itself. The potential conflicts between parties due to overlapping perception of authority and control are summarized in Table 2.

There are numerous potential conflicts in the Tren Urbano Project due to confusion in organization and perceptions of each party's role. The potential conflicts in the relationships described in this section are some of the more critical in terms of the implications of the potential conflicts.

TABLE 2: RELATIONSHIP MATRIX BETWEEN PARTIES AT TREN URBANO

	PRHTA-Mgt.	PRHTA-TU	GMAEC	ASC	Siemens	PB
Secretary	Secretary Controls PRHTA	Secretary Controls PRHTA	Secretary looks for GMAEC for technical advice	Little interaction	Little interaction	Little interaction
PRHTA-Mgt.		Direct Reporting line used frequently	PRHTA sees GMAEC to obey	Established & Old relationship	Little interaction	Little interaction
PRHTA-TU			Struggle for Control	Established & Old relationship	Need to integrate	Needs more interaction, goes through Siemens
GMAEC				Information passes through PRHTA	Needs more interaction, goes through PRHTA	Need some interaction. Competing for similar work.
ASC					Unclear management line. Goes through PRHTA	Unclear management line. Goes through PRHTA and Siemens
Siemens						PB subcontractor of Siemens

The relationships among the parties in the Tren Urbano Project can be generalized in several categories, as can be seen in Table 2 as bold boxes or areas. The first type of interaction is shown in the area in the left upper corner. These parties have little interaction, as they should, because the top upper management should not be involved with parties that other parties down the chain of command can deal with. Other squares closer to the diagonal have little interaction, but should have more. For example,

Siemens and the GMAEC need more interaction but is limited by the PRHTA. These relationships which should have more interaction are boxed in a bold box. And will be discussed further as a group below. Another bold box has the theme of struggle for control as occurs between the GMAEC and PRHTA at times. Other themes in bold boxes include an established and old relationship, and no managing line. Thus, the relationships between the various parties will be discussed in themes and will be described in more detail in the following sections.

2.6.1 Struggle for Control

There is a potential conflict between the owner (PRHTA) and its consultants (GMAEC) *as they struggle for control*. As discussed in Section 2.4, the organizational structure is perceived differently by different entities. This may stem from that the PRHTA are the owners and the GMAEC has the transit experience, thus, both parties perceive that they need to be involved in top management. Also, the PRHTA have reporting lines dating back from many other previous PRHTA project, and these are hard to break and insert GMAEC personnel in the direct reporting line. For example, the CM's are no higher than the Project Manager on all the official organizational charts, but the CMs tend to report to the executive Director according to their legal hired status. This bypasses the Project Director and the Project Manger (GMAEC). This could lead to confusion and inaccurate management of the project. Old reporting lines should be disregarded and an integration in top management is necessary.

2.6.2 Old Established Relationships

Another potential conflict is between the owner (PRHTA) and the alignment section contractors (ASC). There is an *old established relationship* between the PRHTA and some contractor with habits of dealing with each other. For example, working relationship on one project may affect the relationship in another project. This could also occur in the Tren Urbano project. If a contractor is entitled to extra payments in one section, the PRHTA could waive the extra payment for a time extension in other sections. A contractor has typically increased their payments through many change orders and the PRHTA have been lenient with giving a contractor schedule extensions. However, Tren Urbano is Design/Build, thus, the contractor should be more independent to make more design decisions. Less change orders should occur due to design changes and the PRHTA would have less control over the

design. Old habits are hard to break and the PRHTA is still very much in control of the design and a contractor may be still submitting and receiving many change orders.

Other problems occur due to prior perceptions of how the project should be managed. The PRHTA's and ASC's relationship has traditionally only covered construction. However, as the Tren Urbano is Design/Build, design reviews needs to be incorporated in the issues between the PRHTA and the ASCs. As the PRHTA and ASC are typically construction managers and typically emphasize the schedule, they both agree that time design reviews should be decreased. One way to reduce the design review time is for the PRHTA/GMAEC's technical services to limit the design reviews to one round of comments and only one round for checking that the comments were executed for each submittal. This conflicts with the high quality that the project aims for. Therefore, in order to reach such goals as high quality that designer typically have, the new set of contracts and the implications of design/build need to be clarified to contractors and the PRHTA.

2.6.3 Need for Integration

The Tren Urbano Organization, which includes the owner (PRHTA) and its consultants (GMAEC), *need to integrate* with the turnkey contractor, Siemens and Parsons Brinkerhoff (PB) in managing the schedule, design, and the alignment section contractors (ASC's). There are separate schedule reviews and design reviews (see Section 2.3.1) by the ASC's, PB, and the GMAEC. Not only is this a duplication of effort, but also does not allocate ultimate responsibility on one entity/department. One party may assume the other party is doing the reviews, and when it is not done adequately, everybody will blame everybody else. Siemens and PB's role as project managers needs to be better integrated. One way is to have flag reports from PB to top TUO management, which identifies major issues for the week. Another solution could be to have PB attend more top managerial meetings in the TUO. In the beginning of 1998, PB started to attend meetings with the TUO's Project Director and the contract managers, but this only one step towards full integration.

2.6.4 Unclear Management Line

Problems could also occur between the turnkey contractor (STT) and the ASCs. Siemens and PB are overseeing the ASCs to ensure quality and to make the designs fit with a transit mindset. PB inspects

the ASCs, but does not have the power to direct the ASC because all changes *must go through the PRHTA*. However *STT should manage ASCs directly* according to their turnkey contract. Conflicts may occur, for instance, if the ASCs finish behind schedule, Siemens is held behind in their schedule. Siemens will probably require additional payments from the PRHTA to cover their additional time with the Tren Urbano project. The turnkey contract, however, says that Siemens must deal with the ASCs directly for the transfer of the site. Also, Siemens is using a civil contractor to do their civil work who happens to be a prime contractor in another section. If Siemens has an issue with this contractor as their subcontractor, the contractor can go to the PRHTA as a role of a prime from the other sections. Siemens must deal with the contractor as both a subcontractor and a prime contractor.

As STT is responsible for maintaining the civil work during operations, STT is avoiding risk of poor workmanship by writing letters to the TUO about any potential poor quality work. This may provide a door for STT to sue TUO if a problem should occur during operations.

2.7 SUMMARY OF CHAPTER

The Tren Urbano Project is a \$1.5 billion heavy rail project in San Juan, Puerto Rico. It has been procured to meet its objectives using an innovative procurement method using a hybrid of turnkey, multiple primes, and construction management. In part due to the procurement method and the need for outside expertise in train technology in Puerto Rico, there are numerous cultures involved in the project. These cultures include different ethnic cultures, but also more importantly, different professional and corporate cultures. The project is also in multiple phases: planning for future alignments, design and construction of the first alignment, and planning for operations and maintenance. Within this organization many types of processes, or information flows, occur such as design review, schedule review, and change order processes. In the processes and organization there may be various conflicts that occur due to overlapping perception in responsibilities and control. The potential conflicts may also tie to the confusion in the organization and layout of the information flows. An analysis of how these conflicting situations form and can be prevented, based on the source issues in the organization and processes, will be laid out in Chapters 6 and 7.

CHAPTER 3

PROJECT MANAGEMENT REQUIREMENTS

Low cost, an on-time schedule and high quality are usually the goals of a construction project. To accomplish these goals, the project management must be efficient and effective. The management structure needs to be organized in such a way that issues arising can be solved efficiently and effectively so that results are achieved. The organization should be the backbone for which efficient information flows occur. Effective and efficient information flows will lead to reduction in management cost (compared in inefficient operations) and issues will be resolved quicker and with better solutions. This will reduce the number of potential conflicts. But even there, conflicts will occur, and for those, more effective and efficient solutions should be reached.

Project management of large scale engineering projects has numerous requirements. This chapter will primarily focus on special requirements for innovatively procured, multi-cultural, multi-phase projects like Tren Urbano. The following requirements are needed by the management structure in such projects to improve efficiency and effectiveness of the project management.

3.1 UNITED MANAGEMENT TEAM

In projects where more than one organization is performing management tasks, there is a tendency for each management party to work separately, if there is no effort to combine the management efforts. This fragmentation may lead to several scenarios: First, lack of a united management team can cause confusion

by the parties being managed as a contractor may get conflicting directions from different management parties. Lack of clear direction to the contractors will reduce standardization and enforcement in the project. Second, the management parties may perform overlapping tasks, or there may be gaps between the management perspectives that each party assumes the other party is performing. Thus, not all management tasks may be performed fully. Last, each of the several managers may not be on a level field; there may be subcontractors performing some of the management functions for another management party. For the subcontractor management party to be effective, its prime must work closely with the other contractors/owner. Therefore, a united management team is needed to reduce confusion, improve standardization and enforcement, perform all management tasks completely, and enable all management parties to be effective.

3.1.1 Enforcement of Project Policies & Procedures and of the Contract(s)

The contracts in a project must be enforced to what they were intended for. Lack of enforcement in one area may lead to lack of enforcement in another area. As contractors discover that the rules of the project are formed as the project is progressing, the contractor will naturally try to perform less, and get paid more than the contract specifies. This will actually lead to the contractors fighting harder than if they knew where the line is drawn by the contract. Also, the owner will receive less.

Likewise, lack of enforcement of policies and procedures will lead to more party participants trying to take shortcuts. This will lead to confusion, and the quality will often suffer, as all necessary checks are not being performed.

3.1.2 Standardization

For projects that are divided into relatively equal sections, each section of the project must be run with standard policies toward each contractors. Contractors will take lowest ceiling for quality under varying standards. High quality standards must be set by top management and be aimed for by all. Standards must be consistent through all contracts and all contracts must be enforced strictly to this standard.

Likewise, standardization must also be present for employees performing similar tasks, such a group of managers, each managing a contractor for a section of the project. Based on interviews with project participants, if the performance of the employees start to fall, it is natural for the management to set more realistic, but also lower, standards. Lower standards will in turn lead to lower performance. Therefore, during periods of lower performances it is important for management to keep the standards high, even when the gap between standards and performance is high. (See Figure 14). If standards are keep high, than pressure from top management can help raise performance to the standards. If standards are lowed, then performance will unlikely surpass the standards. If the gap between performance and standards is constant then an increase in standards will also increase performance as shown with dashed line in Figure 10. This assumes the gap is constantly being applied pressure from upper management (TU Interviews, 1997-8).

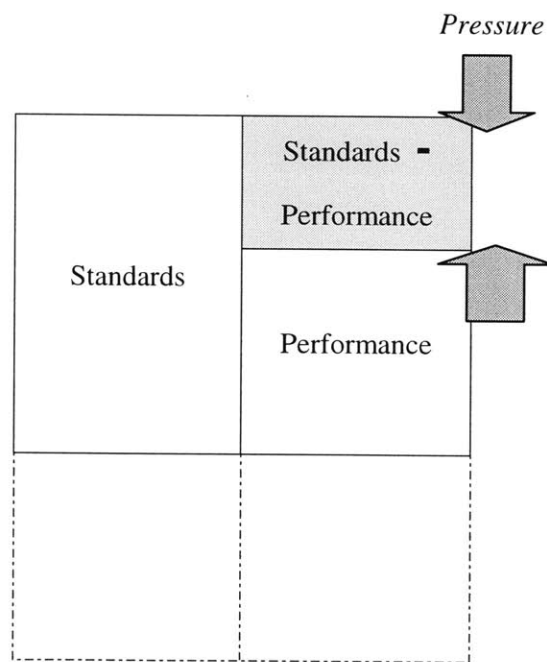


FIGURE 14: PERFORMANCE AND STANDARDS

The standard levels set by management must also have clear objectives that are communicated clearly. If objectives stay at top management they will have no effect on the organization. Thus, consistent standards by upper management can keep performance from falling and pressure to increase standards by clear objectives can improve performance.

3.1.3 No Adversarial Relationships between Parties Performing Overlapping Tasks

Management parties that perform overlapping tasks may easily form adversarial relationships as they are competing with other parties for recognition. One way of competing may be to minimize the other party's efforts. This could result in a downward spiral as more effort would be spent fighting the other parties than actually performing the tasks. Another result could be that the overlapping tasks might be performed fully by each party instead of partially by each party. This would be a more productive outcome than spending resources fighting the other parties, but it would also waste resources.

3.1.4 Enable All Management Parties to be Effective

Some of the management responsibilities may be contracted or subcontracted to other parties and organizations. This procurement method may make it difficult for the (sub)contractor to work directly with other management parties without always directly involving the owner. Also, the (sub)contractor cannot manage other parties with authority and control without a close working relationship with the owner. Therefore, a strong relationship and highly interactive relationship between all parties is required to make a procurement of management parties effective.

3.2 CHAMPIONS FOR OBJECTIVES

A project must have clear objectives and have champions for each of the objectives: quality, budget & schedule, and long-term operations and maintenance. There should be a champion for each of the objectives with supporting departments where issues arise. The champions will in turn report issues to top management. This will avoid the phenomenon that occurs when everybody is responsible for all objectives, and, thus, nobody takes responsibility and champions any one objective. People will assume that other people are championing the objectives and will, thus, not do so themselves. Instead, the objectives should be clearly allocated to appropriate managers.

3.2.1 Little Confusion to Who is Responsible for Which Tasks

Champions can also avoid confusion in organization. In an evolving project, new types of tasks may continuously appear which need to be performed by somebody. It may be challenging to figure out who does what and thus waste a lot of time. By making particular positions in the projects clearly responsible for particular objectives, it may be clearer who should perform a task or resolve a particular issue.

3.2.2 Focused on Project Objectives

A project should stay focused on its priorities and objectives. In order to implement the objectives, there need to be some party participants who champion each objective. Clear objectives are needed to set the policies of the project.

As a project evolves, the objectives need to be continuously reevaluated. The project may have lost track of the original objectives and needs to be put back on track, or the original objectives may be obsolete or may just need further refinement. By keeping objectives updated and integrated in the organization, there will more focus to the organization.

3.2.3 Reduction in Repetitive Errors

In large projects, errors may occur far from each other and by various project participants. Innovatively procured, multi-cultural project have more challenges, and, therefore, errors tend to occur more easily. Errors are a waste of time and resources. Therefore, the project management must make special efforts in reducing repetitive errors by setting policies and procedures such as a lessons learned process.

3.3 DELEGATION OF AUTHORITY

In innovatively procured, multi-cultural projects there tends to be more uncertainties and more management tasks to deal with. Hence, responsibility and authority needs to be delegated to appropriate levels on hierarchy in order for all management tasks to be performed. The project must avoid too much responsibility and authority at the top management level because this leads to micro-management (management style which top management is attending to all the details of the project). Micro-management leads lack of efficiency and bottlenecks in the information flows that lead to delays. Also, as the top management to perform more tasks than they can effectively do, not all tasks get proper attention and the project may suffer.

3.3.1 Proactive, Not Reactive

By delegating responsibilities and smaller tasks, the top management will be more effective and have more time to perform their responsibilities, setting policies and procedures, in a proactive mode. In a project with uncertainties such as an innovatively procured, multi-cultural, multi-phase project, there often are more issues to resolve and take time away for other tasks. Resolving the issues should be delegated because there really needs a strong focus to set policies and procedures. This focus is needed because the standard policies and procedures used in typical projects may not be useful as is and would often need major changes and fine-tuning before the project starts and throughout the project in order to be effective.

3.3.2 Only Relevant, But All Important Information to Top Management

For the project management to set these policies and procedures, the top management must receive information in a timely fashion, but only relevant and important information. Right information to the top management can aid better decision-making. Good decisions aid the project and would tend to reduce to number of issues. To accomplish getting relevant and important information to top management, there needs to be reporting mechanism in which the important issues are brought to the top management's attention. A good mechanism should ensure that there would be no need to take shortcuts in the procedures to get top management with issues. Taking shortcuts just cause more confusion and

often if shortcuts are allowed, too much information would tend to get to top management. This in turn would lead to micro-management.

3.3.3 Little Confusion in Reporting

Tasks must be delegated in an organized fashion to avoid confusion in reporting. Confusion in reporting will lead to issues being resolved in various ways and there will be not standard issue resolution method. This will cause fewer issues to be resolved as some personnel may be overloaded with problems and some have no issues at hand.

Also, confusion in reporting can cause some employees to get guidance from some manages and some from other managers for similar tasks. This causes employees to work in different directions and this would cause further confusion in the project. Also, if an issue is at hand, then employees may not even know who to take the issue to or may even take it to an unfitting manager. Then, a manager who does not have the correct control aligned with responsibility would try resolve an issue when another manager could resolve the issue much more effectively and efficiently.

3.3.4 Responsibility Aligned with Control

In projects, which are innovatively procured and multi-cultural, multi-phase organizations may be not immediately obvious and may often take time to streamline. Therefore, the project management must pay special attention to organizing the objectives and responsibilities of the organization. Responsibilities, which are aligned with the objectives, should be delegated to employees to champion. For employees to be effective in their responsibilities, they must have control over their responsibilities. For example, a person can not be responsible for the design quality if he/she does not have any control over the design department. Thus, responsibility must be aligned with control.

3.4 CONFLICT MANAGEMENT

Conflicts can occur for many reasons. In innovatively procured, multi-cultural, multi-phase project, conflicts may also occur due to uncertainties of how the procurement strategy will lead to project

coordination and development, or conflicts may occur due to misunderstanding resulted from differences in perceptions of the different professional cultures in the project. The project management must be arranged in such a way that potential conflicts can be minimized and the conflicts that do occur can be resolved quickly. Conflicts should be resolved before they damage the collaborative relationship and cause full-blown conflicts and claims that have severe financial and schedule impacts.

3.4.1 Reduction in Misunderstandings and Conflicts Due to Cultural Differences

A project with several cultures, whether they are ethnic, professional, or corporate, is prone to conflicts and misunderstandings between project participants. Each culture has its own set of different objectives, priorities, positions, interests and way of conducting business and these may often be in conflict among groups or there may be perceived conflicts in interests due to misunderstandings. To reduce the number of potential conflicts due to misunderstandings, the project management needs to foster a better understanding between groups of each other's objectives. Misunderstandings need to be clarified and as this may not happen immediately, there is increased time spent on each issue. This produces more stress on individuals and on the project. The project management should foster an environment where misunderstandings are minimized.

3.4.2 Reduction in Claims

In many construction projects, claims can cause high legal fees at the end of the project. This may significantly increase the cost of the project. Issues must be resolved throughout the project before they become claims and the issues must not be left until the end of the project. Then resources are wasted to recreate the project and a settlement is often reached which both parties could have agreed to during the project construction.

To avoid a lengthy litigation at the end of the project, management must ensure that all claims are dealt with in a timely manner. This means calling the contractor and requesting him/her to officially withdraw claims that may have already been informally disregarded by both parties. This will minimize the likelihood that claims are left at the end of the project.

In innovatively procured projects, numerous claims are even more likely to occur as there are more unknowns and uncertainties of the contractual arrangements. In arrangements, which have not been tried before, each party may interpret the contract differently. Also, if numerous cultures are involved, each culture may be used to different interpretations. For example, designers may not ever have worked in conjunction with construction and operations clauses in their contract, or a Spanish contractor may be used to contractual interpretations used more commonly in Spain. Therefore, especially in innovatively procured, multi-cultural, multi-phase projects, the management must be organized to resolve conflicts quickly before they become conflicts, and if the conflicts become claims, the project management must handle each claim effectively and quickly.

3.4.3 Smooth Transfer of Site between Contractors

In projects where a site will be handed over from one contractor to another contractor, delays can be especially critical. In the event that the first contractor is late, the second contractor will most likely be late or would have to work double shifts because he/she did not get access to the site on time. Then, they would want to be compensated for compressed schedule. Accountability for any delays need to be allocated and negotiated well in advance of a hand-over. The hand should be as smooth as possible to avoid any claims typically against the owner. Although another contractor may be responsible for the hand-over, often only the owner can enforce actions and thus should oversee that the planning for the hand-over is timely and done cooperatively.

3.5 HIGH MORALE

Morale is difficult to install in an organization as high employee morale is often the *result* of a well functioning organization. In return, a high employee morale can lead to a better functioning organization and, thus, better quality, schedule and budget in the project.

The project management, can however, influence the morale by setting effective procedures and processes and projecting enthusiasm about the project. The project management should understand that an innovatively procured, multi-cultural, multi-phase project is often more challenging, and, therefore,

employees will have more difficulties to overcome. Management should affirm employees in their work as they may become discouraged with the difficulties of the project. The project management should spread enthusiasm about working in such an innovative project.

3.8 SUMMARY OF CHAPTER

The project management requirements discussed in this section can ensure a more efficiency and effectiveness and, hence, reduce the number of potential conflicts which increase costs and schedule. The requirements for the project management in this section are requirements that should be especially watched out for in innovatively procured, multi-cultural, multi-phase projects. The first requirement for innovatively procured multi-cultural projects is an untied management because in innovatively procured projects, the management tasks are often divided among different parties. Next, there must be champions for objectives because objective more often tend to sidelined when there are many other issues to resolve that arise from the multi-culturalism and new allocation of responsibilities due to the delivery method. Next, authority needs to be delegated to positions of responsibility and to other organizations that are responsible for specific tasks. Delegating important managerial tasks may be especially difficult as management sees confusion in the organization. The managers would have less confidence that tasks will be executed effectively if the tasks are delegated in a confusing organization and are hence less likely to delegate authority. Last requirement, innovatively procured, multi-cultural, multi-phase projects have great potential for conflicts, and, thus, conflict management and issue resolution methods must be implemented to reduce the financial and reduced collaborative relationship impact of full blown conflicts and claims. In summary, the key requirements for innovatively procured, multi-cultural, multi-phase projects include a united management team, champions for objectives, delegation of authority and conflict management. A well functioning organization will lead to higher employee morale which also benefits effectiveness of the project management.

CHAPTER 4

RESEARCH BACKGROUND

To meet the requirements of the project management, two tools will be used in this thesis: partnering and the system dynamics modeling technique. Partnering is a team-building effort used in projects to improve the schedule, cost and quality of construction projects. The system dynamics modeling technique is used to demonstrate behaviors of a system such as a project. Partnering provides team-building relationships for a collaborative project, whereas, system dynamics provides the tool to model these relationships. These tools will be used for analysis of the Tren Urbano Project in Chapters 6 and 7.

4.1 PARTNERING

Partnering is a way of conducting business where project participants build a cooperative team relationship to develop a project. “Partnering value to the (construction) industry lies in its ability to utilize the inherent strengths of all partners for the common and individual good, to speed project completion while observing high standards of safety and integrity” (Altoonian et. al., 1996). To gain a cooperative environment, the participants need to gain understanding of each other’s project objectives, priorities and expectations, and then develop common aims to establish a non-adversarial process for resolving issues. As partnering is not a legal entity, but a proactive management process for all parties to mutually benefit, it requires genuine commitment from all parties.

4.1.1 What Is Partnering?

Partnering is “a proactive management process to integrate and optimize the services of each partner to best achieve their business objectives” (Altoonian et. al., 1996) and relies purely on good faith agreements, not on legally bound contracts. “This requires changing the traditional relationships to a shared culture without regard to organizational boundaries” (Daigle et. al., 1998). Partnering can be between two or more parties or in long-term relationships or be project specific. Partnering in projects, which this thesis will focus on, is usually initiated with meetings at which parties get together and share objectives. “The participants, assisted by an independent facilitator, become acquainted with and understand each other’s project objectives and expectations, recognize aims, initiate open communication, and establish non-adversarial processes for resolving problems” (Groton, 1997).

Each party voluntarily agrees to follow the terms of the partnering contract, although not legally. Generally, the contract obliges parties to work in good faith and deal fairly with honesty and integrity in implementing partnering. The specific terms may include that parties will assist and avoid hindering other’s performance. All parties will fulfill its obligations diligently in accordance to laws and statutes. Also, all parties must cooperate in the common venture of the contract. If these terms are reached with genuine effort, then there are great chances for successful partnering.

4.1.2 History

Partnering was started in an effort to curb the increasing costs of change orders, claims, and legal fees resulting from increasingly adversarial relationships within the construction industry. The first use of partnering in the private construction industry was a large chemical manufacture and its contractor in the middle 1980’s (Daigle et. al., 1998). The first public agency to use parting was the Army Corps of Engineers (COE) in cooperation with Mobil and the Alabama District in 1988 (Daigle et. al., 1998). The new process of conducting business was agreed on by the COE and the contractor, and since then, this framework has been used for many public sector partnerships (Daigle et. al., 1998). Due to early successes and the apparent need for partnering, partnering has become widespread in United States and has also spread around the world to become a global concept (Daigle et. al., 1998).

TABLE 3: PARTNERING VS. TRADITIONAL CONSTRUCTION

Category	Result Area	Results
Cost	Total Project Cost (TPC)	10% reduction
	Construction Administration	24% reduction
	Marketing	50% reduction
	Engineering	\$10 per hour reduction
	Value Engineering	337% increase
	Claims (% of TPC)	87% reduction
	Profitability	25% increase
Schedule	Overall Project	20% reduction
	Schedule Changes	48% reduction
	Schedule Compliance	Increased from 85% to 100%
Safety	Hours without lost time accidents	3 million vs. 48,000 industry standard
	Lost work days	4 vs. 6.8 industry standard
	No. of medical doctor cases	74% reduction
	Safety ratings	5% of national average
Quality	Rework	50% reduction
	Change Orders	80% reduction
	Direct work rate	42% reduction
Claims	Number of Claims	83% reduction
	Projects with claims	68% reduction
Other	Job satisfaction	30% improvement

Widespread studies have shown (Altoonian et. al., 1996) that partnering on average can reduce project costs by 10% and schedule by 20%. Also, claims alone have shown to be reduced over 80% in terms of cost and number of claims due to partnering. More details of the average benefits of partnering versus un-partnered projects can be seen in Table 3 (Altoonian et. al., 1996).

This data presents very high incentives to use partnering in projects, so many projects have attempted to use it. However, partnering requires a lot of work and preparation; the mutual benefits can only be realized if all parties put genuine effort into building a cooperative relationship.

4.1.4 Objectives during Implementation Phases

The Construction Industry Institute (Thompson et. al., 1996) has broken partnering into five implementation phases, owner's internal alignment, partner selection, partnering relationship alignment, project alignment, and work process alignment. During each of these phases specific objectives should be aimed toward that define that phase.

Owner's internal alignment:

- Identify business drives
- Evaluate partnering and establish it as strategy
- Prepare and align the organization

Partner selection:

- Select optimum partner

Partnering relationship alignment:

- Develop aligned objectives
- Develop measures
- Develop reward system

Project alignment:

- Develop win-win project objectives and success criteria
- Establish intra-project goals

Work process alignment:

- Established project team processes

These objectives define the aims of the partnering process from different angles. To achieve these aims in all the five perspectives, meetings must be held to convey and coordinate mechanisms for developing a partnering relationship. Meetings should occur initially in initial meetings and throughout the project in follow-up meetings to ensure that the drive to achieve the objectives stay strong until the end of the project. Guidelines for implementing partnering is discussed further in Section 4.1.7.

The next sections will use these phases, but condensed into three phases. The partner selection phase is omitted because often partners are selected based on the lowest bid on public projects, such as the Tren Urbano Project. Thus, as the partner selection has limited influence, it is not used for this thesis (for details on partner selection see Thompson et. al., 1996). Next, the partnering relationship and project alignment phases are combined to a relationship phase, as they often overlap in the sense that a relationship is built over the objectives of a specific project. Thus, the summarized categories are now: owner's internal alignment, relationship alignment, and work process alignment.

4.1.5 Barriers for Partnering

Although the benefits of partnering are generally desired by all, barriers can prevent partnering from being effective, and, thus, the benefits are not reached. Barriers can make partnering more difficult and can hinder the ability for partnering to truly work. These barriers are important to recognize and avoid.

Barriers were defined by the Construction Industry Institute (Thompson et. al., 1996). In this thesis these barriers are broken into three categories, owner's preparation, relationship and process barriers to effective partnering. The initial owner preparation is the base of decisions that will have significant impact on the remaining phases of partnering. The relationship barrier may occur when the owner partners with the contractors. It is essential that this step works because this is the essence of partnering.

The third category is the processes for which partnering is implemented and these processes directly correlate with the results/benefits. As partnering is heavily dependent on personalities and processes (Thompson, et. al. 1996), it will be difficult to realize successful partnering if teamwork is lacking and processes are heavy.

Initial Owner Preparation Barriers:

- Forcing partnering in a non-partnering culture
- Flippant decision to use partnering
- Loss of champion for partnering

Relationship Barriers:

- Not investing time and resources
- Withholding pertinent information
- Management personnel changes
- Misidentification or nonalignment of objectives
- Lack of flexibility
- Unethical conduct
- Incompetence
- Lack of, or Poorly developed, communication channels
- Failure to resolve disputes at lowest possible level (micro-management)
- Company based mentality (rather than integrated team)

Processes Barriers:

- Personality conflicts
- Lack of formal dispute resolution
- Lack of necessary training
- Lack of champions at lower levels
- Lack of recognition and feedback

Recognizing these barriers can help identifying them if they occur in the partnering process in a project and can help to avoid these pitfalls. Then, the project can focus more factors which can make partnering successful.

4.1.6 Key Success Factors of Partnering

Barriers should be watched out for and avoided. Instead, success factors should be strived for. Again the Construction Industry Institute has listed many success factors, and in this thesis, these are broken into the same three categories: owner's preparation, relationship, and process factors.

Owner's Preparation:

- Identify business drivers and strategic plan
- Identify core competencies
- Partnering concept evaluated
- Clear decision to proceed with partnering
- Owner organization aligned
- Internal partnering *first*

Relationship Factors:

- Develop trusting relationship
- Process for continuous building of trusting relationship established
- Partnering charter built
- Create separate, empowered organization
- Optimize team strengths
- Partnering relationship integrated into strategic plans
- Alliance objectives, measures and reward system
- Open and effective communication processes established

- Staffing plan developed with selecting appropriate personnel that can work in a team
- Conflict resolution process developed to be at lowest level possible
- Employee training plan developed
- Social activities to nature trust and teamwork

Process Factors:

- Communication of project objectives
- Analyze work processes
- Allocation of resources
- Implementation of innovative ideas and processes
- Empower down to discipline level

Overall, there are key ingredients, which make partnering successful. Foremost, parties must trust each other. Trust takes time to develop and should be continuously fostered by actions that are team oriented. Second, there must be clear and open communication processes for which ideas can be expressed for innovative solutions for issues. Solving problems should be done in a cooperative manner where solutions are found by input from many parties. These solutions to problems should be sought that can be agreed by all and maximizes the total benefit of all parties (i.e., win-win approach).

Another important aspect to achieve successful partnering is clearly identifying common goals, yet there will be some differences in values and interests, which should be respected. Parties can support each other reaching the commons goals and be willing to change to accommodate other parties' goals that may slightly differ.

Finally, upper management must support partnering and there should a champion for partnering appointed and supported by upper management.

The Construction Industry Institute has listed many guidelines for effective partnering (Altoonian et. al., 1996, Thompson et. al., 1996). Their guidelines were divided into five categories that were aligned with the objectives for partnering, as was discussed in Section 4.1.4. To implement all these categories of objectives, partnering meetings need to be held between all the parties in the project. The partnering meetings occur in three stages, preplanning, starting the partnering relationship, and partnering throughout the project. The first two stages of partnering meetings occur initially in the project and set the stage for partnering for the remainder of the project. The third type, partnering throughout the project, is the follow-up partnering meetings (Keil, 1998), which ensure that the partnering spirit continues to strive. The three stages of partnering meetings is listed below with key ingredients for objectives and factors for success.

1. Pre-planning at Initial Meetings

- Owner assesses its objectives and competencies clearly.
- Leadership is set, and a champion for partnering must be selected.
- Decision to use partnering, as a strategy must be embraced by all.
- A partnering strategy is defined. The organization should be aligned to meet this strategy.

2. Starting the Partnering Relationship at Initial Meetings

- A pre-construction/design conference is held with all contractors, subcontractors, suppliers as well as all-applicable government agencies and utilities. It should be held in a neutral location facilitated by a third party.
- Align all parties' objectives towards a common aim.
- There must be a willingness and belief in the process of a win-win approach.
- A continuous plan for developing trust and teamwork is established.
- Open and effective communication process established.
- Develop benchmark measures and a reward system.
- Dispute resolution process is developed.

3. Partnering throughout the Project at *Follow-up Meetings*

- Partnering strategy is implemented with a showing of good faith and fair dealings in performance
- Benchmarks formed during the initial partnering meetings are continuously assessed
- Frequent follow-up meetings as needed determined by evaluations
- Neutral facilitator available for a few hours pre-meeting for discussion with any project participant and to determine agenda for meeting
- Project principals (only) can attend follow-up meetings if partnering is on track, if not all project participants should attend

Following these guidelines will improve partnering for any project. Now, how can one determine if partnering truly has been successful? This question can be answered by continuous evaluation and following the benchmarks presented in the following section.

4.1.8 Evaluation of Partnering

In order to measure the performance of partnering adequately, it should be measured in terms of qualitative benchmarks (i.e., soft measures) such as project participants subjective evaluations and quantitative (i.e., hard measures) such as cost, schedule, quality, and safety.

Research by the Construction Industry Institute (Altoonian et. al., 1996) recommends using results, process and relationship measures to ensure sufficient information is available in a timely manner. The result measures are quantitative (i.e., hard) and are also called outcome measures. They consist of traditional performance measures such as cost, schedule, safety and quality and are based on performance relative to quantifiable standards. They can be measured both at the very end of the project (i.e., end point measures) or at intermediate project points (i.e., in-process measures). The end-point measures are most useful for historical comparison purposes and cannot be used to improve partnering effectively in a project because the project is complete by the time these benchmarks are assessed. To benefit the project, the in-process measures can be used for continuous evaluation. The assessment can give an indication to upper management that partnering may need further improvement in certain areas. The in-process result measures are also more specific than end-point result measures. For example, for an end-point measure of cost, the in-process measures would be engineering, equipment, construction, and start-up.

The next type of measures is the process measures. The process measures evaluate the performance of the work process between parties. The work processes are the driving forces to achieve the result measures.

Behind the process measures are the relationship measures. The relationship measures are the most qualitative of the types of measures and are largely based on perceptions and subjective opinions of the project participants. These measures are important because they can give an early warning of any deterioration of partnering. The relationship measures tend to be most focused on participants' satisfaction with the arrangements.

In summary, good relationships lead to good working processes between the parties involved in a project. Good processes in turn lead to good results. Therefore, partnering should be evaluated in three forms, *relationship*, *processes* and final (and immediate) *results*. The relationship measures can give an "early warning system" since the other two derive from the cooperation of the relationships.

4.1.8.1 *Variables to Measure*

This section will actually list many of the variables that can be used to measure partnering. These benchmarks are now divided into soft and hard variables. The soft variables are more relationship based and usually occur early on when partnering is being formed. The hard, easily converted to number, variables are easier measured at the end of the project.

Hard Variables

Hard variables are more common because hard numbers are easier to measure and understand. The hard benchmarks can be measured at intermediate points during the project and at the end. The hard variables in Table 4, developed by The Construction Industry Institute (Thompson et. al., 1996), include some typical end-measures and some in-process measures.

TABLE 4: HARD BENCHMARKS FOR AN IMPROVED PROJECT

End-Point	In-Process Measures
Cost	Engineering Equipment Construction Start-up
Schedule	Conceptual Definition Design Procurement Construction Start-up
Quality	Rework Field Changes Operability Maintainability Post-start-up
Safety	Lost-Time Injury Rate Recordable Injuries Subcontractor Performance

The end-point measures assess the total project performance at competition whereas the in-process measures assess the performance at intermediate project points. The end-point are more important for historical performance comparison and assessing the overall project and is a summary of the in-process measures. The in-process measures can be used to discipline the project team to ensure goals, which were set by the objectives, will be reached at the end-point.

The in-progress partnering benchmarks are often more useful because they can be measured early in the project when there is still time to improve upon the partnering process. These benchmarks can be hard as discussed above, but they are more often measured with opinion surveys where project participants are asked to rank items such as satisfaction on a scale from 1-10. Attitudes and opinions can be good measurement for the present performance but also for future performance as attitude tend to be “self-fulfilling prophecies”. Some indicators include (Thompson et. al., 1996):

- Internal communication
- External communication
- Meeting effectiveness
- Employee morale
- Internal trust/candor
- External trust/candor
- Internal leadership
- External leadership
- Accomplishment of objectives
- Utilization of resources
- Problem solving
- Creativity and synergy
- Timely evaluation, and appropriate response
- Definition and adherence to roles and responsibilities
- Continuous improvement
- Teamwork

Other indicators were developed by the author of this thesis, which can be used to survey the project participants. These indicators to measure soft variables include:

- Conflict resolution process, i.e., what level are disputes resolved or number of unresolved disputes
- Personal interaction – positive or negative
- Trust between parties

- Better working environment
- Communication clarity and completeness
- Delegation of authority
- Time spent waiting for approval from management
- Number of claims elevated to each level
- Total time spent working to accomplish a task
- Amount of duplication of effort in information processes
- Delay in receiving needed information
- Response time for new ideas

These benchmarks can be used for assessing the health of the partnering relationship, or at least the project participants perception of it. Unlike the hard variables, these measurements give an early warning for any deterioration of the partnering relationship. Early detection will make it easier to bring the partnering relationship back on track towards the partnering goals and objectives. Also, if specific problems are found, solutions to these problems can be found before negative impacts are seen (Thompson et. al., 1996).

4.1.9 Summary of Partnering

Partnering is a method of parties working together in a project in a cooperative manner. Benefits of working together have been shown to improve cost, schedule, quality and safety. These goals can be achieved by aiming towards common objectives and sharing information. Open communication can also improve problem solving towards more innovative and wider benefits to more parties. Thus, by working towards maximizing the total benefits and not just each own's benefits, the project improves overall and hence, each party benefits.

System Dynamics is a tool that can be used to demonstrate behavior of specific variables. The model must have boundaries to be practical because theoretically there could be almost infinite variables. Thus, it is most effective if used to address a specific problem (Sterman, 1998.)

4.2.1 Behavior of Variables in Loops

System dynamics is a tool that can demonstrate behavior over time. It can show how actions may affect other actions, which may in turn affect itself, and thus a circular behavior is formed. System Dynamics consists of reinforcing and balancing loops. Reinforcing loops occur when the variables in the loop increase and increase. For example, increased motivation leads to increased productivity, which in turn lead to increased motivation. Thus, productivity and motivation continuously increase exponentially in a virtuous loop. This loop-like behavior can work in either direction, for example, as motivation decreases, productivity decreases, which in turn in decreases motivation. Thus, in this case both motivation and productivity decrease continuously in a vicious loop. This reinforcing system and its dynamics can be illustrated in diagrams as seen in Figure 15.

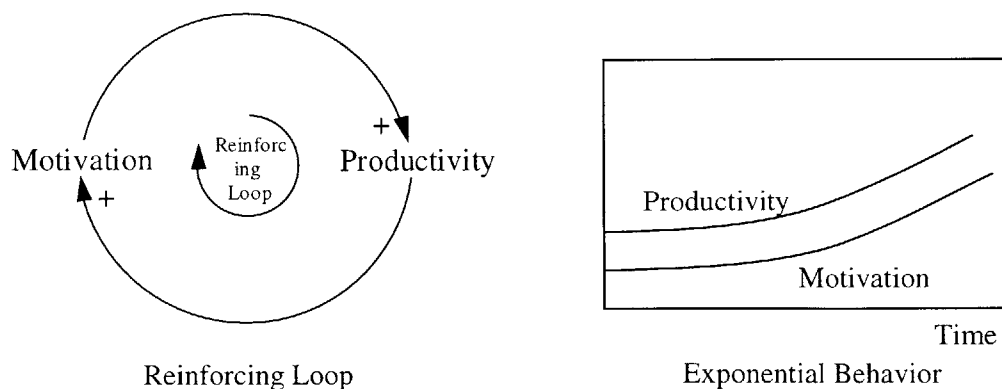


FIGURE 15: REINFORCING LOOP AND ITS BEHAVIOR

The other type of loop is the balancing loop. In this type of loop is self-correcting and counteracting of change. For example, increased productivity leads to increased fatigue. Increased fatigue, in turn, leads

to less productivity, which decreases fatigue. Eventually an equilibrium is reached between productivity and fatigue. This system has goal seeking behavior that can be seen in Figure 16.

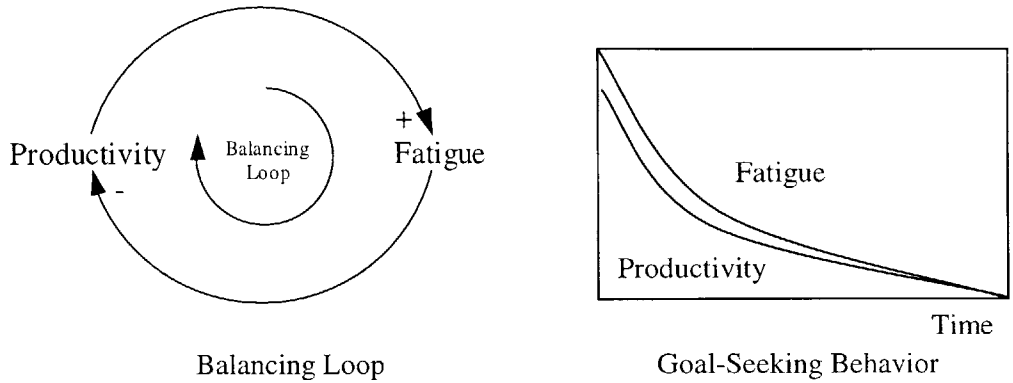


FIGURE 16: BALANCING LOOP AND ITS BEHAVIOR

Several loops can also be interrelated and form complex behaviors. The reinforcing and balancing loops from Figure 15 and Figure 16 are now used in a multiple loop system as shown in Figure 17. No matter how large or complex a system becomes, the system still consists of reinforcing and balancing loops that interact with each other. In this example the behaviors of the two loops interact to form S-shaped behavior. However, as systems become more complex, the behaviors become even more complex.

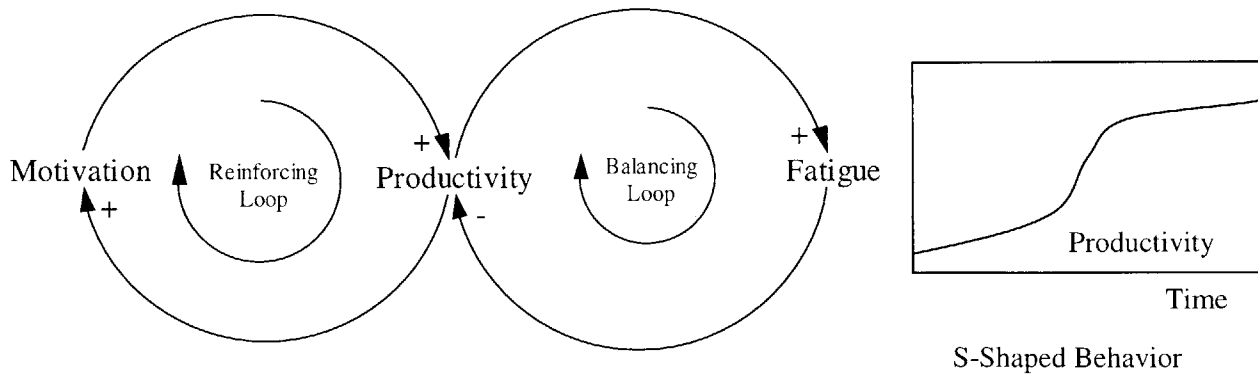


FIGURE 17: MULTIPLE LOOP SYSTEM

Because these systems of loops can get very complex, it becomes very difficult to understand the behavior with one's own mental model, i. e., one's intuition. Therefore, to help determine the behavior of a system, system dynamics software is used to model the behaviors.

System Dynamics is typically used in conjunction with one of many possible software packages. This greatly enhances the use of system dynamics as values can be assigned to each variable being assessed and then when the model is run, the behavior of the variable can be measured. The thesis uses the software package Vensim[®].

Vensim[®] uses three types of variables: stocks, flows, and auxiliary. The stock variables are variable which can accumulate and are denoted with a box. The flow variables determine the flow in and out of the stocks, and are denoted with double line straight arrows. Finally, the auxiliary variables affect the flows and each other. Auxiliary variables are written out without any special notation. The initial auxiliary variables can be recognized by the fact that no arrows point into them. The stocks can also affect the auxiliary variables.

The effect of one variable to another is shown in Vensim[®] with arrows. These relationships can either be positive or negative. Positive means that if the first variable improves then the other will too. Or, if one variable worsens, the other variable will worsen too. A negative relationship means that if the first variable improves the second will get worse. Or, if the first variable worsens, the other will improve. In other words, in a positive relationship, variables move in the same direction, and in a negative relationship, variables move in opposite direction.

The variables' effect on each other is dependant of the equations the model is built on and the initial values. Initial values are given to the initial auxiliary variables and the stocks. The values given to the initial auxiliary variables stay the same throughout the model, however, the values of the stocks change. The value of a stock starts with its initial value, and is then increased/decreased when the model is run by the amount that flows into or out of the stock. The stocks increase by accumulation. For example, if the stock has a value of 100 and 10 points flow into it, then it has a value of 110.

The flow and auxiliary variables (except initial) are defined by equations. All the variables pointing into the auxiliary or flow variable must be used in the equation for that variable. For example, if A and B point to C, then $C = f(A,B)$. Standard functions such as absolute value or if-then-else statements can also be used in equations. System dynamics also has other specialized functions such a delay in data. The equations are very important the behavior of the model.

A system dynamics model is a tool to simplify the real world. In reality there are endless variables that affect what is being modeled. The modeler must, therefore, cut off the model at what she/he deems relevant. The modeler must also limit his/her number of variables and choose relevant variables which can help explain a specific issue. Therefore, it can always be argued that a model is incomplete. In a sense it is always true that a model is incomplete because a complete model would be the real world itself.

A system dynamics model can be useful because it can simplify the real world. It can take a piece of the real world and demonstrate how factor affect each other to produce various, perhaps unexpected outcomes. The usefulness of a model will of course be limited to the quality of the model, but despite the quality, the model can useful for a modeler to illustrate his/her mental model of the real world.

4.3 SUMMARY OF CHAPTER

This chapter describes two tools that will be used for the analysis of the Tren Urbano Project in this thesis, Partnering and Systems Dynamics. The analysis of the Tren Urbano Project will then be expanded beyond these general barrier or success factors to specific success or barrier factors for any innovatively procured, multi-cultural, multi-phase projects like Tren Urbano and use system dynamics to illustrate how partnering affects many other factors in the project.

Partnering is a team-building method of parties working together in a project in a cooperative manner. Cooperation in a project has been shown improve the total cost, schedule, quality and safety. Partnering has been attempted globally in many projects to reach these benefits. These benefits can be achieved by aiming towards common objectives and sharing information and *only if* all parties put genuine effort and belief into the partnering effort. Open communication can also improve problem solving towards more innovative and wider benefits to more parties. To share objectives and to establish open communication processes, initial and follow-up meetings with evaluations should be held. Thus, partnering achieves its benefits by the parties working towards maximizing the total benefits and not just each own's benefits. The overall project will then improve, and, hence, each party benefits.

The other tool, System Dynamics, can demonstrate behavior over time using a software package such as Vensim[®]. It can show how variables may affect other variables, which may in turn affect themselves

and form a circular, loop like behavior. The loops can be reinforcing, which creates continuously increasing values for the variables, or the loops can be balancing that lead to steady state values for the variables. The loops interact to form complex behaviors which are challenging to understand without the model. These behaviors can be used to form strategic recommendations regarding which variables to increase or decrease and the timing of the variables.

CHAPTER 5

PARTNERING IN TREN URBANO

Partnering has proven beneficial in many projects some more than others in terms of improving cost, schedule, and quality. This may be due to how effectively partnering was implemented, or how much improvement needed to be done, i.e., the parties may already have established good working relationships from prior projects. Some project may need partnering more than other projects based on their delivery system.

This chapter will first describe the strong need for partnering in the Tren Urbano Project due to the many uncertainties of the project. Then, the implementation of partnering in Tren Urbano to date will be described. This will provide the base for the analysis in the next two chapters, Chapters 6 and 7, for which the tools, partnering, and system dynamics will be used.

5.1 WHY PARTNERING IS ESPECIALLY NEEDED IN TREN URBANO

Effective partnering in Tren Urbano could tremendously improve the project by making its innovative delivery method even more effective. On the other hand, lack of effective partnering could prove more devastating in Tren Urbano than in a conventionally procured. Thus, it is more important in Tren Urbano to provide very effective partnering than in other conventional procured projects. This section describes the reasons why partnering is especially important in Tren Urbano.

5.1.1 Enhance the Pros of Duplication

The management of Tren Urbano consists of several parties each with their own objectives and priorities. The management parties also perform functions from different perspectives that may at times overlap. This provides checks and balances that can be superior to a traditionally delivered project as the parties of different perspectives and aims can complete the task more thoroughly. But poor partnering may, on the other hand, prove the innovate project to be worse as the management would be inconsistent and competitive.

If a team building effort is initiated, overall duplication of effort could be minimized, as more information would tend to get shared. Duplication, however, is not necessarily something to be avoided. The pros and the cons must be evaluated based on the circumstances to meet the project objectives and partnering could elicit these situations. See Table 5 for the pros and cons of duplication of tasks.

TABLE 5: PROS AND CONS OF DUPLICATION

Pros	Cons
<ul style="list-style-type: none"> • Better quality check 	<ul style="list-style-type: none"> • Extra cost and potentially extra time
<ul style="list-style-type: none"> • More parties involved, better end product (double check) 	<ul style="list-style-type: none"> • “All responsible, no one is”
<ul style="list-style-type: none"> • Competition creates motivation 	<ul style="list-style-type: none"> • Competition can create an adversarial relationship

The Tren Urbano project aims at very high quality and thus choose to have some tasks overlap to ensure the highest quality at what is perceived as a small price. It is assumed that effective partnering will overcome the obstacles of the cons (see Table 5) such as competitive adversarial relationships and the phenomenon that often happens when too many entities are responsible for one task: One party assumes others will be performing the task, the others assume the first party is doing it, so therefore no one is. Hence, Tren Urbano relies on partnering in accomplishing its objectives, and effective partnering becomes especially important.

An example of duplication is that Parsons Brinkerhoff (PB) performs much of the management role in terms of interface between systems to fixed facilities and interface between fixed facilities. The owner's consultants, the GMAEC, also perform schedule and design reviews of the ASCs' work. Poor partnering may cause inconsistent comments from the management team to the ASCs, but with good effective partnering a more complete review can be provided than if only one party was involved in the review process. Thus, the integration and collaboration between GMAEC and PB will provide for a superior project.

5.1.2 Help Form a Partnering Bridge to Form a Unified Management Team

In order for GMAEC and PB to partner effectively, it is required that PRHTA and STT form a partnering bridge where PB and GMAEC can pass through as seen in Figure 18. From this partnering bridge, cross-organizational partnerships can form and a unified management that will improve the organization.

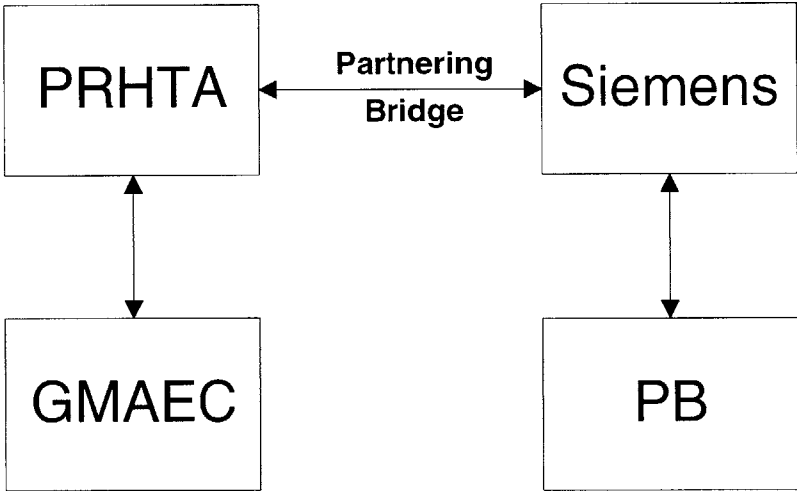


FIGURE 18: PARTNERING BRIDGE IN TREN URBANO

A unified management team is necessary in order to form a common management strategy and implementation. This is especially necessary in Tren Urbano because of the numerous parties involved in various contractual relationships that must work together on tasks that often overlap. Lack of an unified management team can cause such things as conflicting directions and further uncertainty in the project as

parties would have less knowledge of other parties who are not directly in the management chain of command.

5.1.3 STTT Contractor Would Act More as a Part-Owner Than a Pure Contractor

For a more effective partnership between the owner and STT, STT should be perceived by all parties as part of the owner’s management team. This can be accomplished by strengthening part-owner objectives and priorities as defined in the STTT contract.

The STTT contract characterizes the objectives and priorities for the STTT contractor in line with two contrasting viewpoints, as owner partner and as pure contractor. This occurs because the responsibilities of the STTT contractor includes both contractual obligations as well as aligning objectives and interests with the owner (see Table 6).

TABLE 6: TWO PERCEPTIONS OF TURNKEY CONTRACTOR, STT

As Owner Partner	As Contractor
⇒ Operations and Maintenance for 5-10 years gives incentives to reduce lifecycle costs	⇒ Design and construction of systems and vehicles (Major cost component of the STTT contract)
⇒ Oversees the ASCs interface with each other & interface with systems	⇒ Design and Construction of one fixed alignment section
⇒ Reviews ASCs’ design & schedule	
⇒ Partnering with PRHTA/GMAEC	

For example, the owner’s procurement strategy’s aim was that by giving 5-10 years of operations and maintenance to the STTT contractor, the STTT contractor would have an incentive to act in the *owner’s interest* to reduce lifecycle costs (Dieterich, 1998). For STT to make decisions in the design and construction of the fixed facilities to reduce lifecycle costs, it needs a strong partnership with the owner. On the other hand the STTT contractor is being paid to perform these functions according to the STTT contract and hence also becomes a contractor. It may be questionable whether this dual role is possible or

if the perception of STT tends to lean one way or the other. The aim of the procurement strategy was for STT to act on the owner's interest, and, hence, it needs to be perceived as part owner by themselves and the other members of the Tren Urbano Project. However, STT may actually be perceived more like a contractor. One reason that perception of STT may be leaning more towards to contractor side is that STT does not have a binding mechanism for overseeing the ASCs. If STT had a direct input and binding mechanism on the work performed by the ASCs, STT may be pulled more in the part-owner direction.

It is important for STT to act more like an owner than a contractor in order for the objectives and incentives to be aligned for effective partnering. Good partnering will give the STTT contractor more authority to perform its management functions effectively. Hence, the benefits of the turnkey contract can be gained as envisioned by the federal turnkey demonstration project.

5.1.4 Aid Non-Contractual Relationships between the Turnkey Contractor and the Multiple Primes

Aside from the important role of the owner and STTT contractor partnering, partnering is also especially important in Tren Urbano with the ASCs. ASCs partnering with the owner can improve costs and schedule. Also, ASC partnering with STT is especially important because there is no contract between them. If partnering breaks down, the owner would stand between the various contractors, and the advantages of the turnkey delivery method would deteriorate.

5.1.5 Improve Communication and Understanding between the Multi-Cultures

As discussed in the previous section, Section 2.4: "Multi-Cultural Environment", Tren Urbano has numerous cultures. It has many ethnic, corporate, and professional cultures in a multi-phase project. This makes communication and understanding of other participants' objectives and priorities even more challenging. Effective partnering can improve communication and understanding needed for a smooth project.

5.2 IMPLEMENTATION OF PARTNERING IN TREN URBANO

Partnering has been officially established in Tren Urbano through initial partnering meetings (Grafals, 1997). Initial meetings include conferences with each contractor separately, all designers together and a conference with all principles at a Quality Summit (TU, 1997). Partnering follow-up monthly meetings have also been held. This section describes these initial and follow-up meetings and discusses how well they fit the general partnering criteria.

5.2.1 Initial Meetings

Partnering started out very promising with a series of initial meetings. They were held in a neutral location for 2-3 days for each contract with the owner. An outsider to Tren Urbano, the American Arbitration Association (Grafals, 1997), facilitated these meetings. Risks, concerns, goals, objectives were discussed in small mixed groups. These meetings fit the criteria for typical good-partnered projects. However, the benefits of partnering will only hold true if the harder to measure, “soft”, criteria of partnering are also met. The soft criteria include genuine effort of all parties to developing trusting relationships. Then, over time can the effectiveness of these initial meetings be measured.

A quality summit was also held in a neutral location (i.e., a hotel) for the purpose of all parties meeting each other and presenting how they planned to approach the Tren Urbano Project in terms of quality design, construction and management (TU, 1997). The meeting was run by the Tren Urbano Office, not a neutral facilitator. This partnering meeting pointed out different issues in the Tren Urbano Project. For example, the different parties mingled minimally between English-speaking and Spanish-speaking participants. This could be an indicator that further work needed to be done in cross-cultural relationships.

The quality summit also pointed out areas that needed more effort, for example, the drive and belief in partnering of some of the alignment section contractors. This meeting also pointed out that some human infrastructure was still needed. Design/build/operate projects like Tren Urbano do not have the time to develop personnel infrastructure like a design-bid-build then operate project because all personnel is needed in a more compressed time. This becomes an issue as partnering concurrently with personnel being continuously added.

Although this conference was successful in delivering the message that quality was important to the owner, and how parties intended to approach the project, it did not focus on partnering issues very well. Thus, this meeting only had some factors of a partnering meeting: a neutral location, and some emphasis on how each organization would approach the project. To be an effective partnering meeting, the Quality Summit should have been facilitated by a third party and it should focus on working together in small groups instead of numerous presentations. There needed to be more interaction between parties.

5.2.2 Follow-up Meetings

Monthly “partnering” meetings have also been held with all the project principals. There was a good initiative, but instead of working on the partnering relationship, these meetings served as a way for the contractors to take a short cut to the regular issue resolution process bringing their issues to the top management directly without thorough analysis. The owner’s top management typically ran these meetings and other parties presented their status reports. Issues were resolved at these meetings, but at a micro-management level. Therefore, in an effort to improve these meetings and keep up the partnering spirit, the meetings are now being reduced to quarterly meetings. By keeping the meetings several months apart, project participants could not wait until the next meeting to resolve their issue as if the meetings were monthly. Thus, project participants pursued other channels to resolve their issues and the partnering follow-up meetings then could focus more on partnering relationship issues. Tren Urbano could further improve these meetings by working on installing good communication processes throughout the project and increasing the commitment to the partnering process.

All these partnering meetings and initiatives were good initial steps to implement an effective partnering program. However, as expected, more has to be undertaken to achieve the greater level of effectiveness because of the additional challenges of the project in terms of innovative procurement, multi-culture and multi-phase that creates an environment where continual revision and improvement needs to occur.

Partnering can be especially important in innovatively procured projects. Innovatively procured projects may reap many benefits, as they are able to specifically address the needs and objectives of the project than a traditional delivery method could not. However, the procurement may be more risky as it has not been tried before and this creates more uncertainties. Often partnering is assumed to heal the uncertainties and gaps in the project. Therefore, a lack of partnering can be especially devastating.

Partnering in the Tren Urbano Project is important for several reasons. First, it needs to meet the project management requirements of a unified management team since there are many parties that perform management tasks. Another reason is that there are also many parties that perform overlapping tasks. To ensure that the pros of this duplication gets enhanced – better quality, double check, and motivation due to competition- effective partnering is needed. The flip side that occurs with ineffective partnering is extra time coordinating the multiple tasks, gaps in the tasks’ performance and adversarial relationships. Another reason for partnering in project like Tren Urbano is to generally improve communication between the multi-cultures. Also, partnering can aid non-contractual relationships between parties that must coordinate their work.

Partnering has been implemented in the Tren Urbano Project in terms of initial meetings with the owner and each prime contractor and between all designers. A quality summit was also held with all parties. Subsequently, follow-up partnering meetings have been held with the principles of all parties involved in the Tren Urbano Project. In the two next chapters, Chapter 6 and 7, the partnering in the Tren Urbano Project will be evaluated.

CHAPTER 6

EVALUATION AND ANALYSIS OF INDIVIDUAL COMPONENTS

Several lessons from partnering in Tren Urbano can be applied to other projects that have multi-cultures and have an innovative delivery method. The lessons from Tren Urbano will be analyzed in this chapter and generalized for any innovatively procured, multi-cultural, multi-phase project. This chapter will also explain how various factors can effect each other.

This chapter will first present what could have been done to improve the project factors. The project factors occur initially, at the outset, of the project (See column one on Table 7 for a list of these factors). These factors have already occurred in Tren Urbano as has been described in previous sections. This section will now evaluate these factors.

The project factors affect the operational factors, which are also continuously changing throughout the project. Thus, lessons are learned from what could have been done up until now and what should be done for the remainder of the project. Next, the operational factors affect the resulting factors. The resulting factors are difficult to improve upon in isolation. Thus, improved operational factors are prerequisite to improve the resulting factors.

The factors can also be considered at different levels. In this thesis issues are divided into the levels of direct partnering issues and issues related to how the parties interact in the organization. The issues are shown in two horizontal levels in Table 7 corresponding to partnering and organizational issues. Partnering issues are shown as a layer on top of organizational issues which affect the organizational

issues in each column, i.e., operational partnering issues affect operational organizational issues and resulting partnering factors affect resulting organizational factors.

The project and operational factors eventually lead to the resulting factors to reduce conflicts and, hence, improve costs, schedule, and quality. It is assumed that reduction in conflicts and a smoother and more effective and efficient project will improve cost, schedule and quality.

These factors cannot be viewed independently, but must be viewed as a whole. At the end of this section a system dynamics model will be presented to show how the above factors are related and how they affect each other to produce various outcomes. This will tie the factors together and demonstrate various behaviors caused by using or not using partnering effectively.

TABLE 7: SUMMARY OF FACTORS AND ISSUES

	Project (Initial) Factors	Operational Factors	Resulting Factors
Partnering Issues	Partnering Commitment Education Initial Meeting	Follow-up Meetings Evaluations Knowledge Transfer	Claim Management
Organizational Issues	<i>Uncertainties:</i> Hybrid Delivery Method <ul style="list-style-type: none"> • Turnkey • D/B/O • Multiple D/B • Construction Management Numerous Cultures <ul style="list-style-type: none"> • Multi-Phase • Multi-Professional • Multi-Ethnic • Multi-Corporate 	Turnkey Contractor Acting as Part Owner Effectiveness of Champions Confusion in Organization Benefits of Duplication	Micro-Management Site Transfer Conflicts

Several lessons from partnering in Tren Urbano can be applied to other projects that have multi-cultures and have an innovative delivery method. The lessons will be analyzed in this chapter from Tren Urbano and generalized for any innovatively procured, multi-cultural, multi-phase project. It will also explain how various factors can affect each other.

6.1 PROJECT FACTORS

The project factors are the variables that occur initially and in a sense define a project. The Tren Urbano project factors have been described in previous chapters in terms of organization, delivery method, numerous cultures, and partnering implementation effort. This section will analyze the factors and show that some improvement could have been done in the following areas.

6.1.1 Initial Meeting

Tren Urbano's initial meeting was carried out as many other typical meetings for starting a good partnering relationships. However, extraordinary effort may have been needed to implement the partnering program because of the many challenges of this innovatively procured, multi-cultural and multi-phase project.

As the belief in partnering is often the key to partnering's success, there should have been made an extraordinary effort to ensure that there was a common belief in partnering at the initial partnering meeting. A common belief in partnering may have been more difficult to achieve in Tren Urbano because partnering has not been done before in a project like Tren Urbano in terms of procurement strategy and mix of professional cultures. Therefore, a larger than typical partnering push-off to generate excitement about partnering should have been done. It could consist of numerous meetings, small group exercises and a retreat. These meetings should have had high interaction between parties to develop the trust that is essential for partnering. And of course, all party participants should have attended.

This big push-off could have generated more initial enthusiasm for partnering. Because parties from other cultures may not be familiar with partnering or with the other business cultures involved in the project, they may have some initial disbelief in the process. Once skepticism for partnering is established, it is very difficult to reverse, so there should be no room for doubt from the beginning of the project.

To develop trust at the initial meeting, it is important that it is held in a neutral place facilitated by a neutral party. Tren Urbano did find a third party to facilitate the initial meetings in neutral locations. However, as Tren Urbano has the challenge of being in a multi-cultural environment, any qualified third party may not suffice. The third party was North American and, thus, related better to the North American Tren Urbano participants than the other mostly Spanish-speaking participants. The initial meetings may have benefited from having a culturally neutral facilitator. A multi-lingual who was very familiar with Puerto Rico and the Latin culture may have opened trust better for all the Spanish speaking parties in Tren Urbano.

The first initial meeting, between the owner, its consultants and the turnkey contractor (i.e., Siemens), is the most important meeting and should develop trust between the parties involved in management to form a unified management team with common objectives. Next, at partnering meetings with each contractor, the owner, its consultants and the turnkey contractor should be acting as one unified management team with common goals.

In addition to recognizing other parties' goals, objectives, expectations and risks, the format of the workshops should also have been facilitated in such a way that different personalities, professions, cultures should be recognized for their individual strengths. The workshop should also include actual problem solving in smaller groups of problems unrelated to Tren Urbano. This will show that although problems will occur in a project with high uncertainties, the problems can be worked out with good communication.

6.1.2 Education

As not all the parties in the Tren Urbano Project may be familiar with the process and possible benefits of partnering, education on partnering during the initial meetings may also have been necessary. Examples of projects where partnering was effective despite uncertainties in the project should have been illustrated and the reasons why partnering was effective should have been outlined and discussed in detail. As subcontractors and other parties join the Tren Urbano Project at later dates, this education should be a continuous process. Education about partnering may also help decrease some skepticism for partnering in any project.

6.1.3 Cultural Barriers

Cultural barriers require additional effort for a partnering relationship and should also be specifically considered. In the initial partnering meeting, cultural differences and the process for conducting business could have been explained more clearly. A separate meeting may even have been necessary in order not to cut out any actions of the first meeting partnering agenda. In this second partnering meeting, emphasis should have been placed on work processes. For example, the differences in culture for meeting times and feedback could be explained. This could potentially ease the initial tensions about each others' work cultures that could have been difficult to overcome. Several workgroups could be formed in informal settings in order to gain better understanding of other parties in a more relaxed atmosphere.

When any project has several cultures, whether ethnic, corporate, or professional, or all, special effort have to be put forth for participants to meet in small group settings to discuss objectives and priorities in the project. This can help alleviate some of the initial strains that may develop and be detrimental to the initial period where trust is developed.

Some strains may arise due to the different primary languages spoken by the project participants. Most of the PRHTA and ASCs, except Kiewit, speak Spanish as their first language. The GMAEC and PB mostly speak English as their first language, and many of Siemens' team speak German as their first language. As meetings and decisions are made verbally, as they tend to be in the construction industry, there is a strong potential for misunderstandings. It is therefore important to have written as well as verbal communications.

6.1.4 Partnering in a New Role

An innovative delivery method can provide additional benefits, but also provides some additional challenges for partnering. Parties typically have a difficult time at the beginning of the project to change their mindset to a partnering mindset. The reason may be that some parties may never have used partnering before or because parties are set in their habits of working with other parties in the same type of non-partnering working relationships.

A new delivery method can change the traditional owner versus contractor relationships into a more complex set of relationships. Then, as all parties may be working on the project in a newly defined role, this can be an opportunity to include partnering as an integral part the new role. For example, the design-build and turnkey nature of the Tren Urbano project could have been an opportunity for the owner to redefine its role in managing its contractors. As many of the old habits of doing business in a particular way are changed, it is at this moment that the old ways should be changed to a partnering mode. Therefore, the new delivery method can be used to uproot old relationship habits, and start with a partnering habit.

6.2 OPERATIONAL FACTORS

Once a project has been started (usually by the first 6 months to a year), the project factors are already set. Throughout the remainder of the project the operational factors can be worked on. Below are some lessons already learned from Tren Urbano up until now. These lessons can still be applied to the remainder of the Tren Urbano Project.

The lessons can be divided up into two categories, partnering and organizational issues, which are interrelated. The factors within the operational factors of the organizational issues category are also related to each other as shown in Figure 19. Each of the organizational issues in Figure 19 is affected by all the project factors and the operational partnering issues. As the project factors are already set, the operational partnering issues can be worked on.

This section will first discuss the partnering issues: follow-up meetings, evaluations and knowledge transfer. Then, the organizational issues will be discussed.

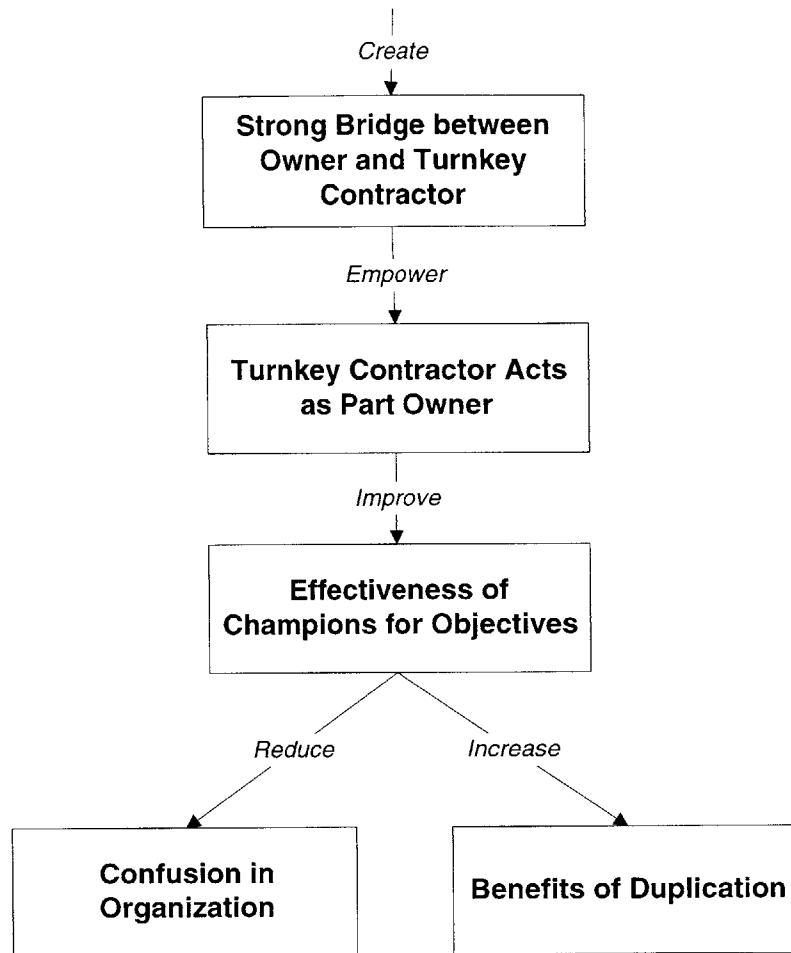


FIGURE 19: ORGANIZATIONAL OPERATIONAL ISSUES

6.2.1 Follow-up Meetings

The follow-up partnering meetings can maintain the partnering relationship that is set from the initial partnering meeting(s) and/or the follow-up meetings can be used to improve more upon the partnering relationship. These follow-up meetings should use the same ideas from the initial meeting(s): aims, objectives, risks and priorities of the various organizations, and work on developing good communication and trusting relationships. Generally, these meetings should also be held in a neutral place facilitated by the same third party.

Good follow-up meetings can continuously improve the partnering relationship. Tren Urbano does facilitate follow-up partnering meetings, but these meetings could be improved further if they were more focused on building a partnering relationship than on actual project issues. The project should only be discussed in larger terms such as importance of schedule versus costs. Specific project issues should be avoided at these meetings as they may give rise to hostility. These meetings are also important for evaluations as discussed in the next section.

6.2.2 Evaluation throughout the Project

During a project with a complex set of relationships, it can be more difficult to evaluate the partnering process especially since hard numbers on cost and schedule savings cannot be evaluated until project completion. Hence, additional effort should be used in the evaluation of 'soft' measurements such as trust, communication and problem solving. As measurements and evaluation of the partnering process are being performed, special attention should be given to ensure that there is a belief by all in a win/win approach as this can be the key ingredient for successful partnering. These relationship evaluations, although vague, become very important because they can determine if partnering deteriorates in early stages. The more time that elapses after partnering starts to deteriorate, the harder it is to regain trust in one's partners. Thus, when the final evaluation of the 'hard' measurements near the end of the project, it may be too late to restore partnering because the project is already finished.

The partnering relationship in Tren Urbano has shown signs of weakening. Letters are constantly being written with sole purpose of preparing for court battles. Good faith negotiations have often failed and in one instance the owner had to use a force account for a contractor change order because no agreement could be made. Contractors have numerous claims and the rate of new claims is increasing. These are some signs that partnering is losing effectiveness and returning to a trusting relationship is a challenge that must be undertaken very seriously.

Earlier evaluations in Tren Urbano could have shown the initial signs of partnering deterioration at time when partnering could have been restored easier. Earlier evaluations may also have shown that the trusting partnering relationship was initially not very strong. If partnering was not shown to be effective after the first partnering conference, more conferences, workshops and meetings should have been held, and more incentives should have been established to form some initial partnering results to strengthen the

belief in partnering. At least all the methods explained above to restore partnering should have been used, as partnering is crucial in the Tren Urbano project and for any project similar to Tren Urbano in its procurement strategy and numerous parties and cultures.

Another lesson that could have been formed from continuous evaluations is that common objectives were more challenging to define as this project had more unknown factors and uncertainties involving the delivery method and the numerous parties involved from different countries, professions and companies. Therefore, in addition to the initial preparation of owner objectives and common partnership objectives and aims, follow-up evaluations should have been initiated to reevaluate and perhaps refine objectives. For example, the fast track nature of this project could have been reemphasized or STT's role as part owner rather than pure contractor could have been more focused. This would require more frequent follow-up meetings than usually required for most projects. Hence, from the Tren Urbano Project, it can be generalized that more frequent follow-up meetings, formally and informally, is needed in any project where partnering is crucial.

6.2.3 Knowledge Transfer and Lessons Learned

Tren Urbano's top management places high emphasis on the transfer of knowledge to Puerto Rico. This can be accomplished in many ways such as working in mixed groups, MIT-UPR technology transfer (MIT, 1997), training the local skilled work force in heavy rail technology, or by lessons learned processes from the different construction contracts. Lessons learned processes entails learning from each other's mistakes or accomplishments, and if done effectively, it can prevent repetitive errors in the project and future projects.

Lessons learned can have long-term benefits for Puerto Rico, but only immediate for the project participants. When lessons learned are utilized, more time can be spent proactive tasks. Increased time spent on proactive tasks will reduce the number of immediate conflicts. The reduction in immediate conflicts will, in turn, reduce the time that needs to be spent on reactive tasks. This will free more time for proactive tasks such as developing further the lessons learned.

For effective lesson learned knowledge transfer, there needs to be an atmosphere in which parties cooperate and share information. This occurs when people are willing to share their experiences, and also, people, who could learn, must be open to learning from others and admit that they have things to learn from others' experiences. There should be an atmosphere where people are not afraid to admit when they

made a mistake or were wrong, and they should be learning from their experiences and share their lessons learned. Partnering can help foster this type of cooperative atmosphere. Partnering could be seen as an opportunity for the Puerto Ricans with no transit experience to participate in knowledge transfer activities in a trusting relationship. The transfer of technology to Puerto Rico should have been used to further strengthening the partnering relationship. A good partnering relationship could lead the future transit oriented discussion and interchange.

Currently there are no formal lessons learned processes and the informal lessons learned network is relatively weak. Formal processes should have been formed as a framework in which further informal exchange of knowledge and information could occur. Then, project participants could learn from each other as the project progresses instead of waiting until the final project evaluation. More formalized procedures, such documenting all experiences storing them on a database accessible to all parties, would be necessary for the process of lessons learned, and this could become very costly to input all the information and upkeep the database. However, the benefits would outweigh the costs if done correctly and parties embrace the concept.

In any project where some parties have more experience than others, lessons learned can be beneficial. Often informal lessons learned procedures can be just as valuable as formal procedures, but the informal procedures take time to develop because relationships between parties need to be formed first, and may not ever take place if the project is not partnered effectively. A formal lessons learned framework in an effective partnering environment can lead to strong informal ties. Informal information exchanges may be perceived as less threatening, and thus be more effective.

The last three sections discussed issues of follow-up meetings, evaluations, objectives and knowledge transfer. These issues are the operational partnering issues that can be improved upon throughout the operations of the project (see middle upper box in Table 7). These operational partnering issues affect the operational organizational issues (see middle lower box in Table 7). The operational organizational issues will be discussed in the remainder of Section 6.2.

6.2.4 Turnkey Contractor to Act Like Part Owner

Partnering should occur at all levels in the delivery system from subcontractors to suppliers, but, also, in the Tren Urbano Project a special relationship was needed between PRHTA and STT as shown in Figure 18: Partnering Bridge in Tren Urbano and discussed in Section 5.1 “Why Partnering is Especially

Needed in Tren Urbano”. As discussed, a partnering bridge is necessary to form a united management team. The relationship between PRHTA and STT should have been the initial bridge from which other relationships should have developed. This would give a sense to the other contractors and parties that STT is acting as the owners’ partner and reinforce the turnkey concept. From there, GMAEC and PB could enhance their partnership, and a unified management team could be formed.

Initially STT was in the same office building as PRHTA and GMAEC, however, the need for personnel increased and space was limited, STT moved out into another office building. Being separated, STT distanced itself from the other management parties. In the mean time, PRHTA and GMAEC merged into one Tren Urbano organization despite the challenges of multi-cultures. Working physically close to others creates familiarity and invites for a partnering relationship. Physical proximity allows for natural connection while separation will require a lot of effort in order to achieve the same result. Thus, if STT was integrated physically in the same office as well, partnering between the management entities would become easier. This would also help diminish STT’s image as just a contractor, and hence STT would be working more of an owner partner.

It can be learned from Tren Urbano that the management team must be united in order for other parties to partner cross organizational. Also, it can be learned that if one wants a contractor to partner better with the owner and the contractor has many of the owner’s interests to act as part owner, physical integration may aid the integration of the organizations. Otherwise, a special effort needs to be made for such integration to occur effectively.

In the event that successful partnering occurs between PRHTA and STT, this will be the first step to have PB and GMAEC work together. However, there may be other challenges. For example, it may not always be very practical to have Siemens personnel present every time PB has management issues to discuss. Likewise, it may not be very practical to have PRHTA employees present every time when the GMAEC shares information with Siemens because this would require large meetings even for small information exchanges. Also, currently all information between the PRHTA/GMAEC and Siemens/PB is through the contract managers for PRHTA/GMAEC and the Project Director for Siemens/PB. This may not always be very efficient because it creates bottlenecks for information flows. Also it does not encourage communications between GMAEC and PB as they do not pass information between them in the information flows.

For best communications and cooperation between all parties there should be integrated into one structure with PRHTA and Siemens in the upper management and the GMAEC and PB working together

in various departments. For example, the schedule reviewers for the GMAEC and PB should work closely together or even physically sit in the same section. The champions for design quality, schedule, budget and operations should still be present in this integrated organization.

Partnering itself should be strongly supported by top management. Partnering should occur at all levels, however, it should be led by only few individuals who actually “champion” partnering. If these individuals are lost, partnering tends to fall apart. Thus, partnering must come from the top. Some means of developing trust and partnering include:

- Work in close proximity such as the same office/building
- Create an environment or mechanism for integration when close proximity is not possible
- Instill philosophies of openness, flexibility and fairness
- Provide employee incentives
- Operate with open book policy
- Sharing business drivers and information

If these guidelines are followed, this will further enable the management to work as one team. Then, if the partnering bridge is complete, this provides a highway for which information can pass more freely in the information flows. The information flows will be more effective and, hence, reduce management costs. Some unwanted duplication may even be avoided. Below some information flows are discussed and recommendations are made on how to reduce some duplication, but, again, for these recommendations to be effective, a partnering bridge between PRHTA and STT must be solid first.

6.2.4.1 Schedule Review of Multiple Contractor's Schedules

Both Siemens/PB and PRHTA/GMAEC are reviewing the schedules submitted by the ASCs. Often STT is not receiving the schedules from the ASCs in a timely manner. (This serves as an example in which the PRHTA needs to increase enforcement of processes of the ASCs). As the GMAEC does not receive STT's schedule analysis before they complete their schedule analysis, the GMAEC does not use STT's comments. Project Controls also make their own ASC schedules based on their own field observations. PRHTA/GMAEC need to enforce the ASCs to submit schedule which are reliable enough so the GMAEC does not have to do the inspection twice.

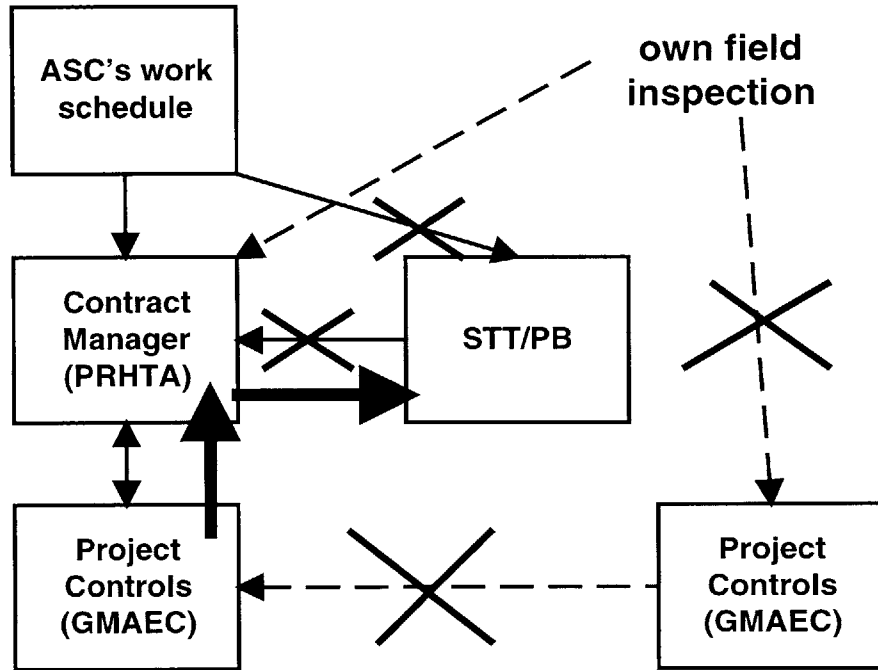


FIGURE 20: RECOMMENDED CHANGES TO ASC SCHEDULE REVIEW PROCESS

It is recommended (a summary can be seen in Figure 20) that the PRHTA should enforce the ASCs to submit good progress schedules, thus, the GMAEC's own field inspection effort should be made more effective on supervising instead of re-creating. Second, as Siemens/PB does not contribute much to the GMAEC's schedule analysis, Siemens/PB should stop analyzing the ASC's schedule themselves. Analysis the ASC's schedule by a third parties such STT/PB will not help the contractor speed up their work because their schedule is already weak and could use much self-improvement in terms of using the schedule beyond just a contract requirement. As Siemens/PB needs information from the ASC's schedules such as hand-off dates, the GMAEC should provide this information to Siemens/PB.

Following these recommendations can ensure less wasted effort by STT/PB, less work for GMAEC field inspection, yet by a good relationship between STT/PB and PRHTA/GMAEC, STT will still get the information it needs. Overall duplication could be eliminated if desired. This will be discussed further in Section 6.2.7, "Duplication".

Similarly as the schedule reviews, due to lack of time in the design review process, the GMAEC does not use Siemens/PB's design review comments on transit and interface very much to aid their own design reviews of contractual obligations of the contractor and/or numerical correctness of the design. GMAEC does not integrate PB/Siemens' comments with their comments before giving the ASC their own design review comments because of lack of time in the design review cycle. STT/PB comments are important and needed immediately to the contractor, and, therefore, are these comments given to the ASC immediately and separately from the GMAEC comments. This could lead to the contractor possibly receiving confusing or even contradicting design comments although the comments come from different angles. It is therefore important to integrate comments. Currently, technical services in the GMAEC officially has the responsibility to integrate the design comments, however, if STT does not get involved in the integration process, their comments could be lost.

The integration of STT with GMAEC design review comments is a time consuming process which is omitted due to time constraints under the current procedures. Thus, the solution is not simply to just integrate paperwork and continue with the current procedures. Instead the core issues of the procedures needs to be changed. Through good partnering and bringing the PRHTA/GMAEC and STT organizations together under one roof as discussed in Section 6.2.4, the design review section of STT/PB and PRHTA/GMAEC would work as one unit. More resources and information would be shared and reviews could even possibly be done quicker. Then the resultant design review comments would already be integrated because they would come from an integrated organization.

The integrated design review unit in one location would serve as one centralized stop for the alignment section contractors to discuss issues rather than a three-way discussion. Another benefit would be that STT/PB, as the operator, would have more influence on the design; and the potential for an adversarial relationship between PRHTA/GMAEC and STT/PB could be reduced.

As many other large projects, Tren Urbano must partner with many different entities. The pure number of parties and the number of different types of relationships between them may make it more difficult for the project participants to know who is responsible for each task. For example, it may easily become vague who sets the standardization across multiple contractors with similar tasks. Also, as many entities' responsibilities overlap with others, it may become difficult for one entity to fully champion for one cause.

Tren Urbano also has the challenge of being in several phases at the same time. Design and construction is occurring simultaneously and operations and maintenance is being planned. Feasibility studies are also being performed for future line extension. In this multi-phased, multi-party environment, project participants have often experienced difficulty knowing who performs what and when.

Tren Urbano very quickly added personnel as it moved from just a simple feasibility phase to the current multi-phase. During organizational expansion, duties and responsibilities were assigned to individuals in the current organization who was the most capable at that time. The current result is an organization where people are the basic units. The Tren Urbano organization is very confusing as is evident by the different perceived organization charts from different party participants. What should be done is for people to fill positions defined by responsibilities. Then, if a person should leave, a new person can be hired into a defined position and the organizational chart would not need to be reshuffled.

This responsibility-defined organization should be an integrated organization between PRHTA, GMAEC, STT, PB and others. Within the organization there should be champions for quality, cost and schedule for the phase I, a champion for operation and maintenance, a champion for the new phases (e.g. line extensions), and a champion for partnering itself. This will ensure a smoother run and more effective organization. For these champions to be truly effective, partnering must create an integrated environment between parties.

The champion for partnering and his/her mixed organizational team should be responsible for continuous evaluation of action plans and the partnering relationship. The Champion should call follow-up meetings as necessary (at least twice a year) and address new issues as they appear. As new project participants enter the project, they need to be incorporated and briefed on the partnering method.

In summary, organizations, which undergo an explosion in personnel and new tasks due to entering several project phases at once, may easily form a confusing organization with lacking champions. With effective partnering, these champions can be delegated to champion aims such as design quality. This can be championed across several organizations that may have an overlapping duty in the same task, and an integrated management can be formed.

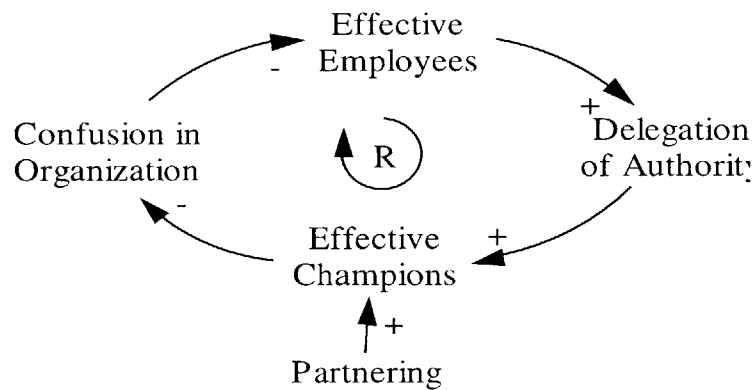


FIGURE 21: CHAMPION REINFORCING LOOP

The idea of champions can also be viewed as a circular pattern. Champions reduce confusion in the organization. This will make employees more effective, and, hence, the top management will be more likely to delegate responsibility. The champions will get the responsibility and authority to be more effective, and, hence, reduce confusion in the organization further.

This loop, as seen in Figure 21, can work in a positive direction, but can also work in a downward spiral. For example, if partnering is not effective, the champions are not as effective. This can cause confusion in the organization, less effective employees and hence less authority would tend to be delegated to the champions. Now, the champions are even less effective than before. Thus, starting with champions in a partnering environment can help ensuring that the loop will work in beneficial direction.

This loop is one part of the system dynamics model presented in Chapter 7. The full model will tie the factors together from this chapter in build upon the smaller model shown here. As a simple example of expanding a model, the model in Figure 21 can be expanded upon with another loop as seen in bold on in Figure 22.

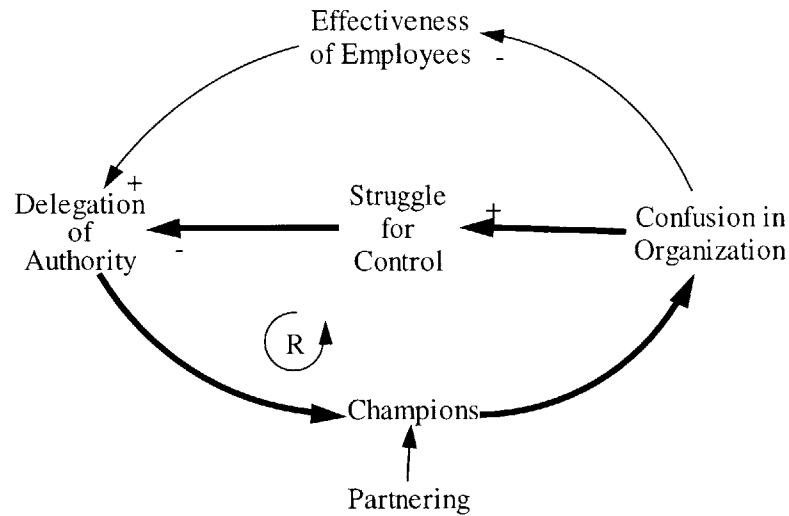


FIGURE 22: SECOND REINFORCING LOOP FOR CHAMPIONS

This feedback loop in Figure 22 may start with high confusion in the organization due to numerous parties involved and the lack of clear role definitions. This confusion will lead to parties perceiving that there is a need for leadership in the organization. As several parties try to gain the perceived need of leadership, they struggle to gain this control. As many parties are struggling for control, inevitable the top managers will gain power and there will less delegation of power. Then, the champions will have less authority and be less effective and there will be more confusion in the organization.

To implement champions in the Tren Urbano Project, the organizational structure may need to be modified. The organizational structure of TUO has already changed many times, but the inherent problems, such as lack of responsibility allocation and champions for objectives, have not changed with the changes in organization. A project organization structure is recommended which reflects the objectives of the project: quality, budget & schedule, and long-term planning and operations and maintenance. This proposed organization does not only moves the boxes around, instead it reflects the changes needed to run the project smoothly. The proposed organization is presented in a hierarchy and matrix format for comparison of the current organization hierarchy and matrix discussed in Section 2.3.

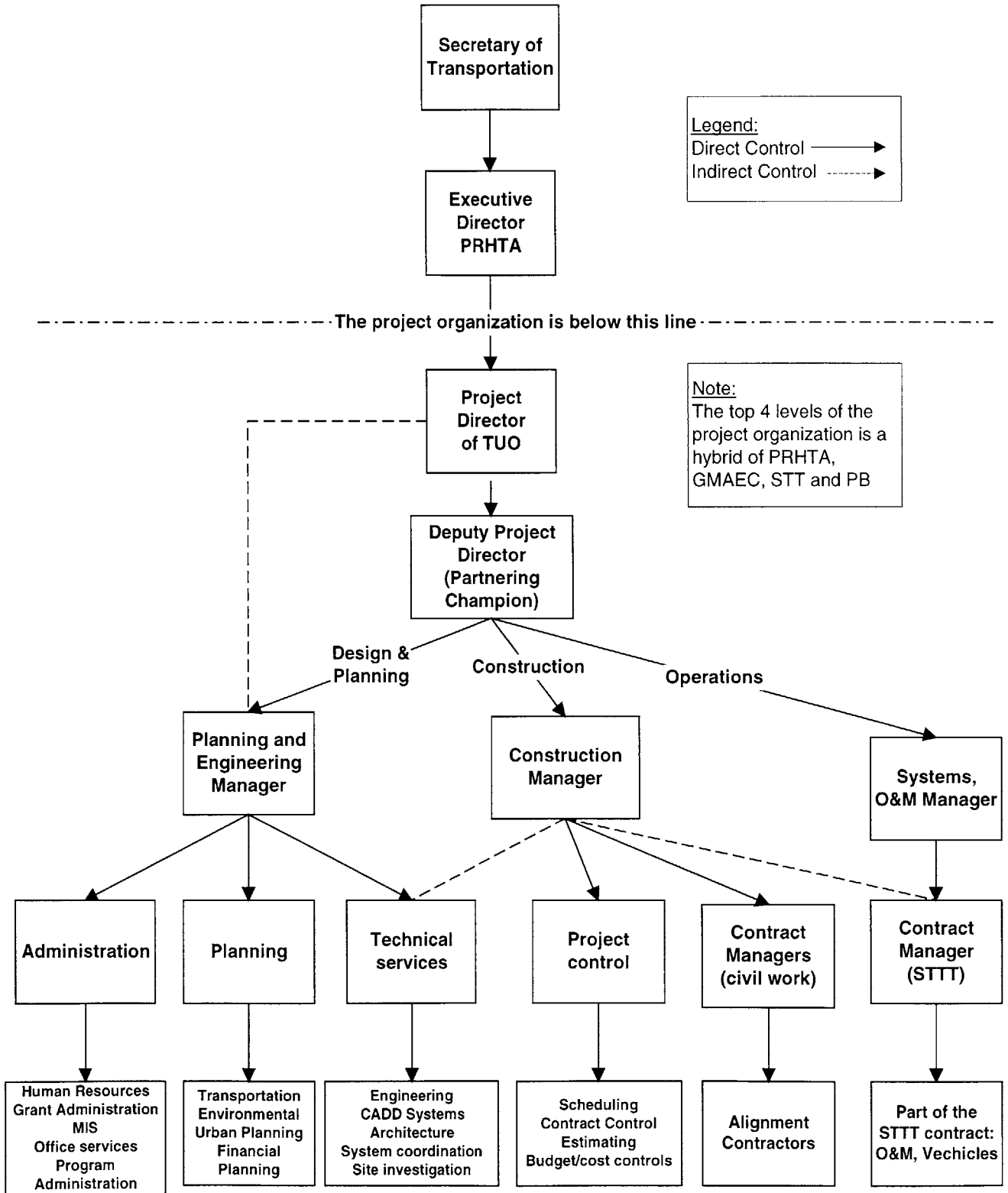


FIGURE 23: PROPOSED PROJECT ORGANIZATION CHART

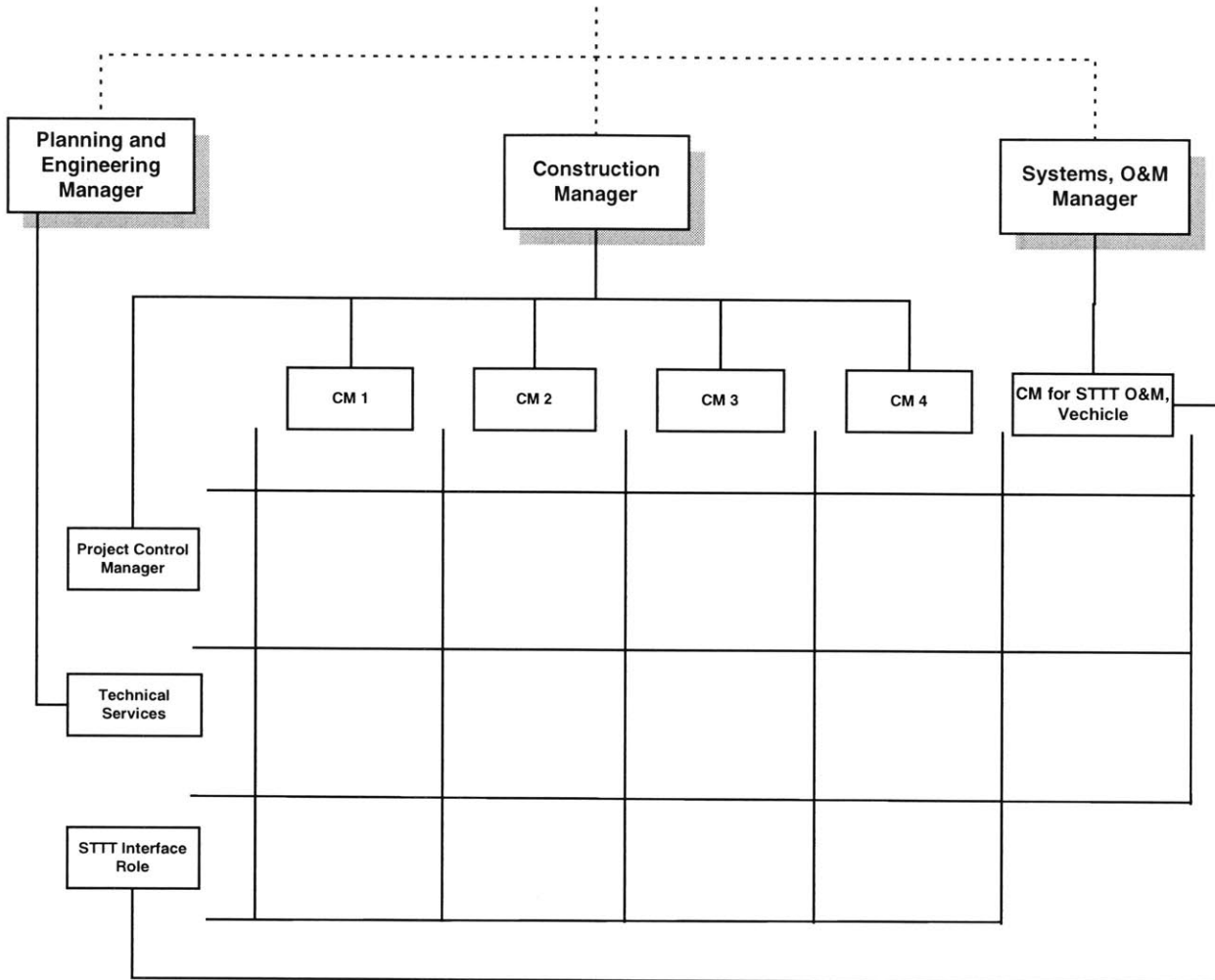


FIGURE 24: PROPOSED MATRIX ORGANIZATION

The proposed organization of the Tren Urbano Project shown in Figure 23 and 24 clarifies the working relationships, streamlines approvals, and avoids excess paper flow, which will provide a more efficient framework for faster workflow. The matrix organization and hierarchical organization show the same reporting structure and reflection of objectives, but the matrix organization shows that the responsibilities of the managers overlap. This overlap is a major reason why Parsons Brinkerhoff and Siemens need to integrate with PRHTA and GMAEC. Thus, the organization chart is an organization, which includes STT, PB, GMAEC, and PRHTA employees. Further discussion of overlapping functions is given in Section 6.2.7. Below is a description of the roles and responsibilities for the parties involved in this proposed (hybrid corporate) organization, starting at the top of the project organization.

The project organization starts with the Project Director who should be focusing on the external issues and should be managing the planning for future extensions. This may include issues such as project financing and public relations. The Deputy Project Director, who reports to the Project Director, is responsible for internal issues and the implementation of the project. Under the Deputy Project Director are three divisions - planning, construction, and systems/O&M – each with a division manager.

The construction division incorporates the contract managers and the project control group. The project control group should monitor all schedules for possible changes in the combined project schedule, and should have an integrated picture of the entire project progress. If the combined schedule changes, that is, the contracted hand-off dates change, Siemens/PB needs to work with the GMAEC for possible contract renegotiations or exploring other alternatives. The individual section schedules should be monitored by the contract managers (CM) with the help of project control, and, hence, the CMs will be responsible for the schedules and progress payments.

The Construction Manager with the aid of the project control department and the CMs, should have the means to take responsibility for a timely project progress and budget. This will require good communication and continuous interaction between the CMs and the project control group.

The CMs should also work closely with the Technical Services group and Siemens/PB in order to coordinate the project design reviews. The Technical Services group should review designs for all aspects except for reviews of the systems, alignment integration, and operations and maintenance, which will be performed by Siemens/PB. Defining distinct responsibilities for design reviews can avoid duplication of design reviews. The final integration of designs should be the responsibility of the Planning and Engineering Manager.

The Technical Services group should also be working closely with the planning group by doing the initial design for the new extensions. This combined effort, managed by the Planning and Engineering Manager, should aid the Project Director in future planning. As operations and maintenance has not begun yet, the Project Director should also be aided by the Systems/O&M Manager for long-term planning for O&M.

The Systems/O&M Manager should supervise the Contract Manager for the STTT contract, especially the systems and O&M part of the contract. For the alignment work i.e., the Test Track, the STTT Contract Manager needs to coordinate work with the Technical Services group and the Project Controls group. The Construction Manager should supervise the overall construction of all sections.

As the Construction and Engineering Managers oversee the details of design and construction, the Deputy Project Director integrates the two processes together and makes the required policy and managerial decisions.

Weekly meetings of the senior management can facilitate informed policy and managerial decisions. These meetings should have a core consistency, which include the Project Director, Deputy Project Director, Planning/Engineering Manager, Systems/O&M Manager, and the Construction Manager. The issues discussed at these meetings should be addressed and clarified by the individual departments prior to the senior management meetings. By getting issues resolved or aired for solution at the departmental level, the number of issues to be resolved by the senior management can be minimized and a bottleneck in the decision making can be avoided.

Overall, the purpose of this project organization is to allocate responsibility to several levels. The engineering managers should have responsibility for design, the Contract Managers should have responsibility for his/her contract, the Construction Manager should have responsibility for project construction, and the Deputy Director should be responsible for the integrated project.

In addition to allocating responsibilities, this project organization also intends to allocate the project priorities to different champions. These priorities are not subsumed by reporting mechanism of the organization. Instead each division, under the Deputy Director, champions separate priorities. The planning and Engineering Manager champions the design quality. The Construction Manager champions timely project completion and budgeting. Finally, the Systems Manager champions the Operations/Maintenance and integration. These priorities should be distinct in view that contracts are design/build or design/build/operate; and, hence, one issue arising in one area should not be more important than issues in other areas.

6.2.6 Confusion in Organization

Typically organizations are confusing if personalities instead of roles and responsibilities define the organization, as discussed in Section 2.3, “Tren Urbano Organization”. An organization can be even more confusing when there is a lack of champions and when several teams perform management tasks separately. This can lead to inefficiencies and ineffectiveness of employees. Confusion in the organization can also lead to a struggle for control. This happens as several individuals tries to take control in order to overcome the confusion. This will eventually lead the top management gaining control which encourages

micro-management as discussed in Section 6.3, “Resulting Issues”. In summary, the confusion in the organization can be an indicator of several factors. Often a new organization chart will be presented in attempt to organize the organization, but unless core issues such as champions, truly effective partnering, and an united management team, are dealt with first, the organization will still have some inherent flaws.

6.2.7 Duplication

Duplication in a project can cause adversarial relationships or it could benefit the overall quality of the project. This is summarized in the previous Section 5.1, “Why Partnering is Especially Needed in Tren Urbano.”

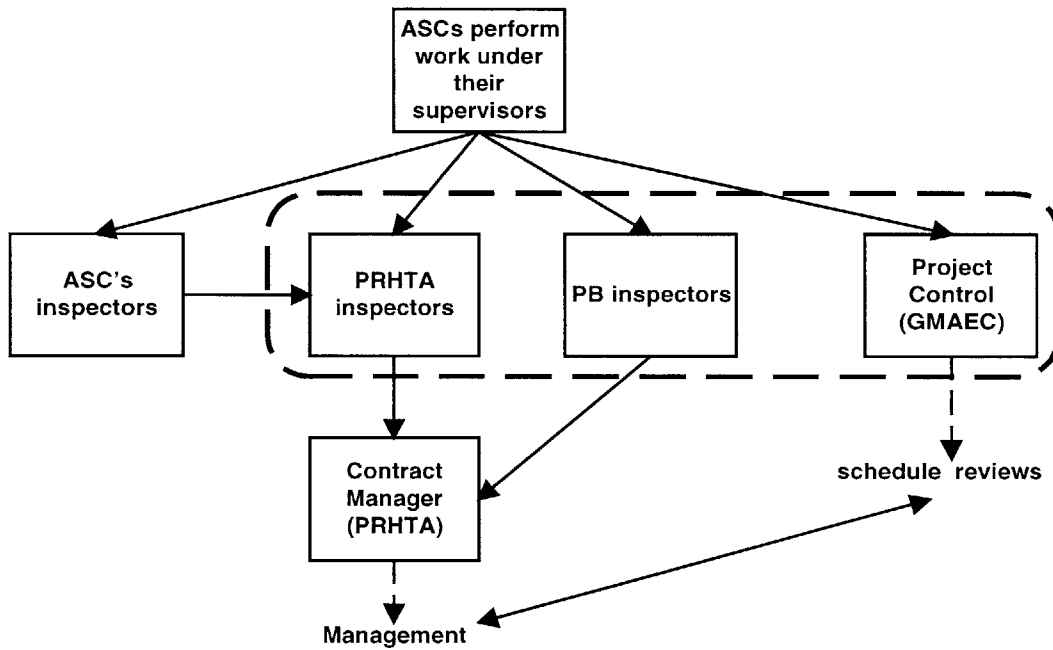


FIGURE 25: INSPECTION TEAM

Partnering should occur fully from the top management down to the field level. In Tren Urbano, many separate parties perform the field inspection. On site, there are representatives from GMAEC, PRHTA, PB and the contractor’s own hired inspectors as can be seen in the middle layer in Figure 25. At times the inspectors’ work may overlap or, worse, there could be gaps where one inspector is assuming the other inspector is reviewing that task and vice versa. As many other tasks in Tren Urbano, there may be some overlap and duplication, but as discussed previously, this was chosen as a procurement strategy

in order to achieve the best quality. In order to get the benefits of duplication, the representatives on site should form a team, as has already been done in one of the ASC's sites, to ensure full inspection and to avoid conflicting statements between inspectors that can occur with duplication and overlap. Inspectors must be willing to share information and each inspector may inspect one certain area and then inform the other inspectors. This ensures that all areas are inspected and few resources are duplicated.

Duplication can occur in many forms. For example, if several multiple primes perform similar tasks, but at different physical locations, the owner and management team are managing the same tasks for each contractor.

As many of the multiple prime contractors perform very similar tasks in roughly the same time period in Tren Urbano, it becomes very easy for the contractors to compete to be the best ASC. But on the other hand, it also becomes easy for one contractor to justify low standards if another contractor was able to use lower standards. For example, if low quality concrete was permitted for one ASC, then another would expect to be able to use the same low quality concrete as well. Another example, the contract language for the six ASCs is almost identical. The interpretation of the contract can be done in many fashions. Many interpretations will lead to the lowest common denominator, which may lead to lower quality and often higher costs for the owner. Hence, it is very important to work similarly towards all ASCs and to enforce those standards. In Tren Urbano, work tends to be divided up into contracts. For example, design reviewers tend to focus on one contract, contract managers focus on one or two contracts, inspectors focus on one contract and so forth. Thus, middle and upper management must ensure standardization and enforcement.

6.3 RESULTING FACTORS

Resulting factors are typically formed from operational factors. They can occur throughout the project, but tend to be more pronounced towards the end of the project.

They are typically very difficult to change independently. However, they often tend to be the most important factors as conflicts break out at this stage. Hence cost, schedule and quality is easily tied to these factors.

Cooperation for partnering can become very difficult when one party tries to take complete control. When control lies with the top management, the project becomes micro-managed. In Tren Urbano, a lot of control lies within the top management. Few tasks are delegated fully within the TU organization and to STT. One reason is that the project has many uncertainties such as its innovative delivery method, multi-phases, and the mix of cultures. As people tend to delegate what they already know and what is routine, they hold on to and control what is uncertain.

As the owner of Tren Urbano tries to do the difficult task of controlling the uncertainties, its consultants are given more tasks. For example, the more control the owner has, the more information is needed to make decisions and this information is generally needed quickly. Then, if the owner requests a full presentation showing the current schedule status for all the contracts the next day, the TUO employees would need to work double to get it done. It would not matter if it were a strategic good decision to shift all the resources at that time or whether the benefits of the analysis outweigh the costs. If the decision making was delegated better, each decision maker would have less information to keep up with, and the efforts to provide the owner with numerous reports could be reduced. The top management would then also be able to focus on larger issues of planning and policy setting.

A partnering environment should be formed in which trust can be developed and less uncertainty exists for other parties. People are more willing to delegate responsibilities to people that one trusts and knows well, and, hence, micro-management would be reduced.

Micro-management can also be illustrated in another aspect by using system dynamics. System dynamics is a tool that can demonstrate behavior over time as discussed in Section 4.2. This section will present a model for micro-management that will later will be integrated all other partnering and organizational issues into a full model.

The micro-management model in Figure 26 shows how top management could be caught in a vicious loop of increasing micro management. There are many ways in which management can get caught in this loop. For example, if due to a confusing organization structure and lack of employee experience, employees are not effective, management in response will not give these employees any authority; this happens as management does not perceive the employees to be competent to make good decisions. As authority is concentrated at the top of the organization, top management will decide upon most decisions,

even small ones. The result is micro management. Micro management will then limit efficiency of the management and employees will be even less effective than before. If there is a lot of struggle for control within the organization, authority may end up with the strongest party, which is usually the top management. Thus, the more struggle for control exists within the organization, the less authority tends to be delegated, and, hence, the reinforcing loop of micro management becomes stronger.

How does management break out of this loop? The obvious answer is to just stop micro managing. This will work if the only cause for ineffectiveness and inefficiencies is micro management itself. However, in most cases micro management is a response to other problems within the organization, for example, there may be few experienced people within the organization which starts the micro management reinforcing loop. The solution may be to hire more experienced people whom top management can trust to be effective and make good management decisions. Hence, more authority can be delegated to the employees and the organization will become more effective and efficient as micro management is reduced.

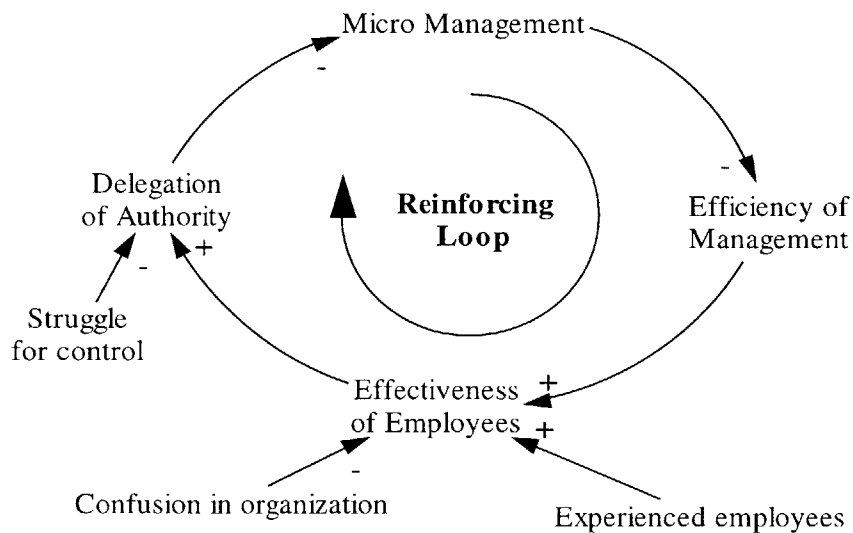


FIGURE 26: REINFORCING LOOP OF MICRO-MANAGEMENT

Likewise, a reduction in ‘organization confusion’ and a reduction in the ‘struggle for control between the various parties’ will break the vicious cycle. A confusing organization can give a sense of increased uncertainties in which top management may need to control, and also, the employees may not be able to do their jobs as they are constantly trying to find out who is responsible for what. This ties back to the idea of champions. If clear champions are present in the organization, the idea/concept

which is championed gets more attention and employees know who is doing it, so they will not need to do it themselves again.

In the Tren Urbano Project, micro management is caused by several factors. First, there is need for more experienced employees on the project. Especially, some of the PRHTA construction personnel have a lot experience in highway construction, but have little experience in rapid transit train design and construction. Second, the organizational structure of the Tren Urbano Project can be confusing due to the numerous parties and contractual relationships, and, thus the employees are less effective as they spend a lot of energy in coping with the organization. Last, many parties in the project struggle to control the Tren Urbano Project in the light of many uncertainties. This leads to authority lying with the highest authority. In order for the Tren Urbano Project to break out of the micro management loop, all factors which contribute to the loop needs to be tackled:

1. Ensure employees are experienced
2. Create a less confusing organization
3. Reduce the struggle for control by clearly defining each party's responsibilities and bounds
4. Delegate authority with accountability

These steps can reduce the need for micro-management. Thus, the reinforcing loop would turn in an advantageous way to increase efficiency and effectiveness in the project management. For example, one way to start to break out of the loop of micro-management is to delegate some authority at many levels and in many aspects. One item, the amount authorized to approve change orders should be ranked. For example, a Contract Manager may be able to approve change orders up to \$25,000, the Construction Manager would be able to approve change orders up to \$100,000, the Deputy Project Director up to \$250,00, and the Project Director should be able to approve any change orders above \$250,000 with the concurrence of the PRHTA. The top management above the project organization should not sign change orders, as this would create bottlenecks. If this is implemented, some bottlenecks would be reduced, the top management becomes more efficient and the managers become more effective in reviewing and approving the change orders. As the top management sees that the employees are effective, authority may stay with the employees and create an effective delegation of authority.

There exists many other cycles from micro managing besides the cycle described above, however, controlling even a few of the factors which lead to some of the micro-management cycles can have a great

effect. One other important cycle for micro-management is that uncertainty and lack of trust can lead to micro-management, and micro-management can lead to further hostility and more micro-management. To break this cycle, good effective partnering should be initiated from the start. Each party should show by its actions that they are indeed willing to partner, and over time more trust will build. But as Tren Urbano has been in the design and construction phase for two years already, partnering, which is not as strong as it could be, is a challenge to continue to strengthen. A new start for partnering is needed. This can serve as a lesson to other projects: partnering must be strong from the beginning and continue to be strengthened because it is very difficult to repair trust once it is broken.

6.3.1.1 *Spending Too Much Time to Generate Information for Top Micro-Management*

The GMAEC in their role as an owner representative represents a portion of the cost of the project. Thus, as the project scope and cost escalates in the project, the GMAEC costs of managing the project may escalate with it. The management cost escalation occurs as micro-management in the Tren Urbano Project increases, and more and more work is given to the GMAEC. The GMAEC adds a lot of value to the Tren Urbano Project as discussed in Chapter 2, but there needs to be better control over GMAEC time spent on numerous reports. More time needs to be spent on monitoring the contractors and trying to reduce project costs. Currently, much of GMAEC's time is spent on generating reports for higher management to support the micro-management. For example, the project controls group spends about 50% percent of its time generating reports and presentations for higher management. As management feels more out of control due to confusing reporting lines, the time spent on generating reports seems to be escalating. Management is asking for more and more reports with more and more detailed information. Then, management has even more details to sort through and less time to focus on larger issues such as setting policies. The increase on the issues that reach higher management is also a resultant of the management not delegating authority. Only information that has an impact on management decisions or cannot be resolved at lower levels need to be reported to higher management. Thus, by reducing micro-management, there would be less time spent by the GMAEC on generating reports.

In order to reduce the number and length of the reports generated by the GMAEC, guidelines need to be set for the reports to ensure management is receiving adequate and complete information. Management must be sure that the details are sorted such that all crucial issues are reported. Without such assurance, management will continue to ask for more and more information to ensure that they are informed of crucial issues.

To reduce the time spent on each report, the contractors need to provide more information to the GMAEC. For example, schedulers generate reports based on their own field observations and analyzes because often the contractors are not providing this information. The PRHTA/GMAEC need to enforce the contractor to provide status reports that the GMAEC can easily combine into one project wide report. With better information from the contractors and a reduced need to serve micro-management, there could be savings in the GMAEC and the GMAEC could spend more time on proactive tasks.

6.3.1.2 *Change Order Process*

Micro-management can also create bottlenecks. For example, the owner's top senior management must sign all change orders. As they are involved in many other projects besides Tren Urbano, obtaining these signatures is often a lengthy process. This can easily delay the project and create further hostility. So although the change order process works well, there are some bottlenecks that can be avoided for an even quicker change order approval by the owner.

PRHTA Director and the Secretary of Transportation currently sign all change orders, which increases the time for change orders to get approval because they both oversee many other projects and issues besides Tren Urbano. Often the construction schedule can be worked around anticipated change orders, however, at other times the project may be delayed. Therefore, the bottlenecks must be removed and authority must be delegated.

Another bottleneck, which should be reduced in the change order process, is the negotiation process. Parties need to adhere by the partnering philosophies and be fair and upfront, for example, the contractor should come forward with his/her actual costs that PRHTA/GMAEC would see as reasonable. This could considerably cut down the change order process especially since most of the process is taken up by the negotiations over costs.

The technical and cost review and negotiations for Change Directives can take place during or after construction. Using more change directives and less change notices could also cut down on the time of the change order process. This, however, requires very good relationships between all parties and a mutual trust which must slowly be built through good partnering.

The change order procedures should generally not be changed much, however, the procedures should be expanded. The procedures should include a mechanism in which STT could suggest changes to the

ASC for maintenance and other purposes. This procedure should ensure that STT/Alternate Concepts concerns are dealt with in a timely manner.

6.3.2 Site Transfer Conflicts

Partnering is important as a conflict prevention mechanism. Conflicts can occur due to delays in the information flows such as the review time. However, the true effect of partnering is often not seen until major flagstones in the project such as site transfers are reached. The conflicts, which occur at site transfers, are most often a resultant of poor partnering in combination with other operational factors such as effectiveness of champions and the turnkey contractor acting as part owner.

In Tren Urbano, there are many important site transfers. The six ASCs build the fixed facilities on site including earth movement, guideways and tunneling. Then, the Turnkey contractor takes over each of the sites to install systems such as electrical work, tracks, and control systems. Many problems could occur if the transfer issues is not properly dealt with prior to the hand-over.

The site hand-over date is set contractually between the owner and the ASCs, and the owner and STT. Hence, if the ASCs and STT do not partner with the owner and each other, the owner could very likely be in the middle of the ASCs and STT. The advantages of the turnkey delivery method would deteriorate as the Turnkey contractor would only deliver their section and the owner would have to manage all other contractors and the interaction between them.

Problems could become especially severe if there is any schedule delay of the fixed facilities. Systems, such as tracks, are laid upon the fixed facilities of all sections, so if only one alignment civil section is delayed then the systems installation would be delayed. A delay in the start of the systems work will cause Siemens to stay with the project longer which translates into additional money needed. Siemens will need more money to stay longer with the project and the management staff of TUO and the GMAEC needs to work longer on the project. There are also penalties involved that the ASCs must pay for delays. Currently, the major cause of conflicts has not been technical issues but “who pays” issues. Using this as an indication, it would indicate that money issues associated with delays would cause major conflicts, i.e., the fault of delays to STT should be figured out early, before an impact to the total project can be seen. Some of the ASC current schedules are already predicted to be late based on current

productivity levels and amount completed. Thus, a fixed facilities schedule delay should be anticipated and planned for.

As STT needs to plan and hire personnel for system installation, PB, as representative in this issue for STT, is performing its own analysis of the ASC schedules. This is a duplication of owner's consultant's work. Sharing of information between PB and the owner's consultants through partnering needs to be done over the PRHTA-STT bridge as described previously. This can only be done if a partnering trust is developed first. Through partnering, then, the delay can be discussed without getting into issues of change orders.

A hand-over plan should be made to include who is accountable for delays and any other known issues. Also, if any change orders are needed, these should be negotiated in good faith prior to the hand-over in order not to delay the project any further. It would be very easy for a contractor at the time of the hand-over to ask for unreasonable compensation because he/she knows that the project is at a critical point. Good faith negotiations would hence become more difficult at the time of the hand-over. Thus, an action plan for the hand-over should be done by all parties in the partnering spirit as early as possible.

The site transfer issues in Tren Urbano can be generalized to any project for which contractors are responsible for transferring the site. First partnering is very important as a first step. Second, the owner must ensure that contractors work out a transfer action plan and if not, the owner must do it. Also, any possible claims due to delays should be negotiated in good faith as early as possible to avoid the time pressure of the transfer date.

6.3.3 Claim Management

Partnering has typically been emphasized until the end of construction, however, the partnering process should be extended until all disputes are settled to minimize legal fees and settlements. When all claims are settled, then the partnering process can finally be evaluated completely.

Each project sets benchmarks to evaluate and measure the effectiveness of partnering in the form of result measures, process measures and relationship measures. Relationship measures tend to be more "soft" and are more difficult to measure, but this is where partnering really starts. These measures should

be monitored throughout the project. Thus, as Tren Urbano is still under construction, the 'soft' relationship measures are the best indicators of the effectiveness of partnering. The "hard" measurements such as cost, schedule, safety, quality, and claims are easier to measure but usually happen after the fact. Thus, when Phase I of Tren Urbano is complete, including all claim settlements, the cost, schedule and other 'hard' measures can be evaluated. Since claims are the last performance benchmark to linger after the project is constructed, it should be the last piece of the partnering process.

Claims is the benchmark category found to typically have the greatest reductions in partnering projects, i.e. over 80% in number and cost (Altoonian et. al., 1996), and it is an indicator of level of assistance of others performance. The cost and number of claims can be used as benchmark for both the effectiveness of the federal turnkey demonstration project as a procurement method and the effectiveness of the partnering process in the Tren Urbano project.

At the end of a well-partnered project few claims should exist, however if some claims should exist, the partnering process should be used to resolve these conflicts as soon as possible. If claims are dealt with even in a short period after the project construction is complete, the project participants have dispersed. Piles of claims typically lead to large court settlements and legal fees, so early good-faith negotiations should be used in the partnering spirit until the last dispute is settled. When all disputes are settled a final evaluation of the partnering process can be performed as an indicator of the success of partnering and can be used as a springboard for a positive attitude to partnering for the next project.

Many lessons can be learned from Tren Urbano project to date during the design and construction phase. As the project nears completion more lessons could be learned and a final evaluation can be done.

6.4 SUMMARY OF CHAPTER

This chapter focuses on the analysis of individual factors that affect the success of partnering in a innovatively procured, multi-cultural project like Tren Urbano and subsequently affects the impact of the conflicts in the project. These factors are in addition to the partnering success factors discussed in Section 4.1.6, "Key Success Factors for Partnering".

The factors in this chapter is divided into three stages, initial, operational and resulting. The factors in the initial stage define the project and its uncertainties that must be dealt with throughout the remainder of the project. The initial factors include partnering early in the project and the delivery method and number

of cultures in the project. The initial factors directly affect the operational factors, which occur throughout the project. These factors also include partnering issues because partnering must be implemented throughout the project to be very effective. The operational factors that affect the organization include that the turnkey contractor should act as an owner because their objectives are similar in some aspects such as quality construction to minimize operations and maintenance costs. Also, there should be champions for objectives and a clear plan to transfer sites between contractors.

The initial and operational factors, mentioned above, lead to the resulting factors. The resulting factors can begin to build-up as the initial and operational factors take place, but they are more pronounced toward the end of the project. The resulting factors are very difficult to improve upon independently, and therefore the success or failure often depends on the preceding factors, the initial and operational factors. However, small “Band-Aids” can be applied to these factors. For instance, an action plan for site transfer between contractors can reduce potential conflicts. Also, delegating some tasks to reduce micro-management despite uncertainties can help. Another resulting factor, claims, can be improved upon by continuing the partnering effort until all claims are settled.

CHAPTER 7

INTEGRATED ANALYSIS USING A SYSTEM DYNAMICS PARTNERING MODEL

The systems dynamics modeling technique can be used to analyze any system as explained in Chapter 4. This chapter will, however, focus on modeling partnering in an innovatively procured, multi-cultural, multi-phase project. The system dynamics partnering model presented in this chapter will demonstrate how relationships between the factors in Chapter 6 can lead to various behaviors over time. It is important to show the relationships between variables because few of the factors can be improved upon independently effectively. Customarily, most of the variables must be improved upon together to improve a project. The initial partnering factors are, however, independent, i.e., the initial partnering efforts can be improved upon independent of other factors. The initial organization factors, such as the delivery method and the number of cultures, are also independent and are defined at the beginning of the project and will not change as the project progresses. The model will show that these factors will have a great effect on the operational and resulting stages of the project.

7.1 MODEL OBJECTIVE

The model presented in this chapter will support and build on conclusions drawn in the previous Micro-management, Champions, Claim Management, and Site Transfer Conflicts Sections in Chapter 6.

In Chapter 6 simple system dynamic models for some variables were presented with supporting conclusions. A sample conclusion from one factor is that micro-management causes more micro-management. Also, micro-management is often caused by other factors such as uncertainties, lack of experienced personnel, and confusion in the organization. This chapter, however, will integrate the individual system dynamic models with each other and with the other factors presented in Chapter 6. It will also aid the understanding of how the resulting factors are truly affected by other initial and operational factors, and how the operational and resulting factors are difficult to improve upon independently. The model will focus on effective partnering and it will demonstrate how effective partnering can:

- Increase Effectiveness of Champions
- Decrease Micro-Management
- Reduce the Number of Conflicts at Site Transfer
- Improve Claim Management

The model will also show that an action plan for site transfer and claim management can be helpful, but partnering is necessary for best results.

7.2 METHOD

The method for building the model will be based on direct observations of the Tren Urbano Project. Also, numerous interviews with project participants in 1997 and 1998 will support these observations.

Neither the relationships between the variables nor the model will be verified and calibrated with actual data from the project. The data from interviews and direct observations were used to build the model, but not no data from the project has been used to test the model. The model can, however, be used to show how changing one variable affects other variables which again affects others variables. The units and magnitude are not relevant in this model as it is done in dimensionless units, however, the direction of the movement of the variables and their relative movement can be observed. A description of the variables and their relationships can be seen in Appendix F. Here the equations for the relationships can also be seen.

From this model, different behaviors in project management can be illustrated over time and the variables, which are important for better project management, can be identified. Finally, this will lead to a better strategy to improve the overall effectiveness and efficiency of the project.

7.3 MODEL DESCRIPTION

The system dynamics partnering model in Figure 27 consists of many variables, which are all explained in Appendix F. The most important variables in this model are the five stocks framed in boxes. These are the variables that accumulate or decrease over time, and their behavior will be shown in graphs in Sections 7.4 and 7.5. The stocks have flows, shown with double arrows, increasing and decreasing the stocks. The flows depend on the variables that points into them with curved arrows. Those variables, in turn, are dependent on the variables pointing into them and so forth. Only the values of the initial auxiliary variables, which are defined by the user of the model and have no arrows pointing into them, are constant throughout the timeframe of the model.

The equations that define the values for all the variables, except for initial auxiliary variables, are in this model a multiplication of all the variables pointing into the variable. For example, “Delegation of Authority” is equal to “ Effectiveness of Employees” times “Lack of Struggle for Control” times “Certainties in the Project”. When the arrow is bold, then the relationship is stronger than the other variables feeding into a variable. In terms of the equation, this means that the variable is multiplied twice. Thus, as the variables increase, then the variables that they feed into also increases.

This simplification of the equations was made possible by having all the variables moving the same direction (denoted with “+”) and having some variables be shown as “lack of”. For example, “Confusion in the Organization” actually *decreases* the “Effectiveness of Employees”, indicating a negative relationship. Thus, to make it a positive relationship, the “Confusion in the Organization” was changed to “*Lack of Confusion in the Organization*” and this will *increase* the “Effectiveness of Employees.”

The model was run with various initial auxiliary variables that were inputted by the user of the model; these are mostly shown on the right in the model and feed either into uncertainties or partnering. Partnering in this model, thus, consists of the effectiveness of initial and follow-up meetings with evaluations; uncertainties, thus, is the combination of multi-cultures, experience with the delivery method (i.e., innovative procurement) and project technical difficulty. The model was, hence, run with weak or strong uncertainties and partnering, in different combinations depending on the values of the initial

auxiliary variables. Another initial auxiliary variable, with which the model was run for, is the action plan. The action plan has been discussed in Section 6.3 as a necessary support and aid to “Site Transfer Conflicts” and “Claim Management”. The action plan is also shown as an auxiliary variable in the model and can also be changed by the user to generate various behaviors in the same way that as uncertainties and partnering do. In summary, combinations of partnering, certainties and action plans were used for various runs of the model to produce various outcomes shown in Section 7.4 and 7.5.

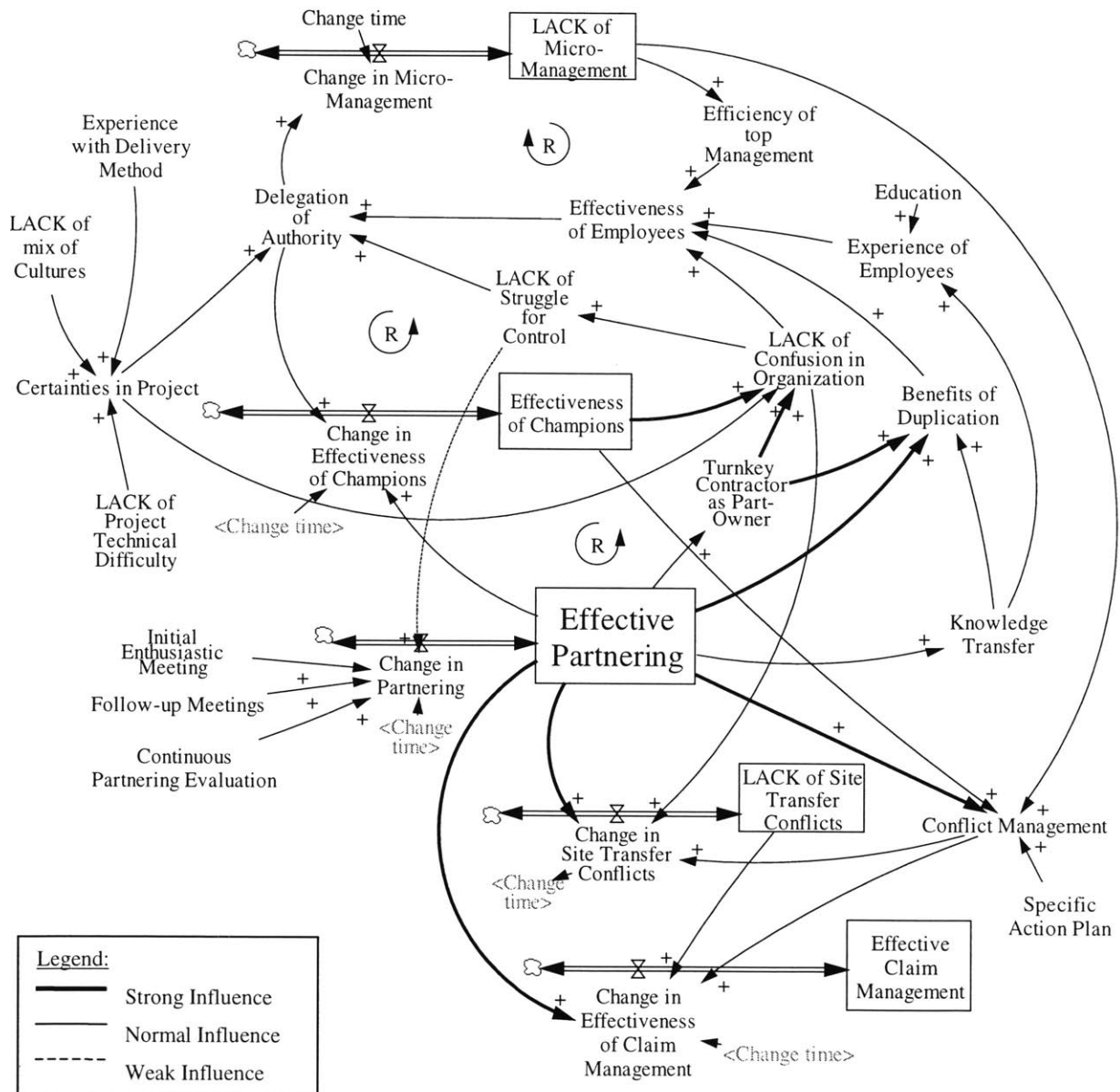


FIGURE 27: SYSTEM DYNAMICS PARTNERING MODEL

The remainder of this section will explain the relationships in the model. Since the system dynamics model generates behaviors of all variables, all variables change through time when the model is run. This forms a complex network of relationships that a computer can simulate. To simplify the explanation of the model, it will be explained in five sections based on the stocks shown in the model, micro-management, champions, partnering, site transfer conflicts and claim management. These stocks were chosen because they are the backbone of an effective project.

7.3.1 Micro-Management

As discussed in the previous micro-management section, Section 6.3.1, micro-management can be caught in a vicious or virtuous loop. A vicious loop may start with a new delivery method, numerous cultures and a technical difficult project that lead to uncertainties. Less authority is delegated in an uncertain environment, which in turn, leads to micro-management. When there is micro-management, the top management is not as efficient because they have too many issues to resolve in too little time and this creates a bottleneck for resolving issues. Also, top management under micro-management will tend to “put out fires” instead of focusing on preventive actions such as setting policies and procedures, and, hence, be less effective in managing the project. A less efficient top management leads to less effective employees as employees are not getting adequate directions, policies, and procedures. The effectiveness of employees can also be decreased by decreasing the experience of the employees and confusion in the organization. Then, as employees are not as efficient, the top management will be less likely to delegate authority to the employees. This in turn leads to more micro-management and hence a vicious cycle of micro-management occurs. The reinforcing loop can go in either direction, if it starts out good, it will continue to be better, if it start out poor, it will get worse. The cycle can be broken by changing the factors of: uncertainties, experience of employees and decreasing the confusion in the organization. These factors can be changed by effective partnering as described in the “Effective Partnering” loop below in Section 7.3.3.

7.3.2 Champions

The effectiveness of champions can also feed upon itself in an either vicious or virtuous loop. The champion loop may start with little authority delegated due to few certainties in the project and a vicious

micro-management loop that causes fewer and fewer delegated responsibilities, authority and control. As the champions will not have the authority to champion their objectives because upper management will be making all decisions, the champions will not be as effective. Lack of effective champions causes confusion in the organization because no one will know who is responsible for what. Confusion in the organization will do two things: employees will be less effective and there will be a struggle for control. The struggle will occur because all parties will try to do what needs to be done, and to do that, they need to control all aspects of the project. When there is a struggle for control, the control and authority will naturally move to the top management, which leads to less delegation of authority. Confusion in the organization will also lead to less effective employees because they will spend much of their time figuring out what is going on. The employees are now perceived by upper management as incapable because they are ineffective, and the top management will give the employees less authority. Together, the struggle for control and ineffective employees will lead to less delegation of authority, which, in turn, decreases the effectiveness of the champions and restarts the vicious circle.

As the micro-management loop, this loop can be vicious, but it can also be virtuous. A virtuous loop can start with effective partnering. Partnering enables the champions to champion objectives across organizations and that increases the effectiveness of the champions. More effective champions reduce the confusion in the organization, which decreases the struggle for control, which increases the delegation of authority. This in turn increases the effectiveness of the champions and the virtuous loop is started.

7.3.3 Effective Partnering

The value of the effectiveness of partnering is set by the initial variables: an initial enthusiastic partnering meeting, continuous partnering evaluations and follow-up meetings. As these variables are input by the user, partnering can be defined by the user as effective or ineffective. Partnering is also affected by the struggle for control in the organization. Partnering, in turn, affects many other factors: Partnering creates open communication for ideas to flow freely in the transfer of knowledge between party participants. Partnering also enables the turnkey contractor to act like a part owner because the turnkey contractor will feel more part of the management team. Third, partnering increases the benefits of duplication because there will be less adversarial relationships due to competition; also, parties will know what other parties are doing in a partnering relationship, thus, “all is responsible, no one is” can be avoided and quality can improve. Increased partnering eases the site transfer conflicts and claim management. This occurs because during a well-partnered project, less conflicts tend to build up to major

event such a site transfer or until the end when claims are often settled in court for hefty fees. In well-partnered project the conflicts can be resolved early and not explode at site transfers or at the end of the project.

There is a loop around the partnering stock that can be either vicious or beneficial. For example, great partnering will increase the turnkey contractor as acting more like an owner. This will decrease the confusion in the organization as the management is now more unified. This will decrease the struggle for control, which will help improve the partnering attitude. Although this loop is not as influential as the initial auxiliary variables to the effectiveness of partnering, this loop is important because it interacts with the champion loop, which in turn interacts with the micro-management loop.

In summary, partnering is mostly affected by the initial variables, but ineffectiveness of the champions and micro-management, caused by many uncertainties, can decrease partnering by way of the struggle for control. Partnering is a central part of the model as it affects many other variables in the model.

7.3.4 Site Transfer Conflicts

Major conflicts at site transfers are typically the result of the partnering throughout the project. Effectively partnered projects tend to have fewer conflicts at site transfers because open communication and early issue resolution procedures will ensure parties will try their best to work with other parties at transfer in a cooperative manner. Lack of confusion in the organization caused, by partnering and effective champions, will also decrease the potential for conflicts because project participants will know who is responsible for what and when at site transfer. An action plan for site transfer as discussed in section 6.3.2, "Site Transfer Conflicts" can also decrease the number of conflicts. These factors, partnering, confusion in the organization, and quality of an action plan will affect the potential for conflicts at site transfer. However, partnering is the most influential as it can prevent potential conflicts and is shown in the model in bold.

Conflicts at site transfer, in turn, affects claim management, but this does not constitute a complete loop. Site transfer conflicts are, however, instrumental in the model as it does reinforce the link between partnering and effective claim management. It also serves as another resultant factors, besides claims management, at which the success of the project can be measured at the end.

As a resulting factor, claim management mostly results from other factors and is difficult to improve upon independently. It is affected by the effectiveness of partnering throughout the project because partnering can install procedures to resolve issues easily and quickly and hence prevent claims from forming in the first place. Partnering can also aid the claim resolution as parties work together to resolved issues at win-win level instead of taking one's own interests in stake.

A plan for managing claims, as part of the conflict management program, can also aid the effectiveness of claim management. The plan can aid the owner in organizing of the issues and set procedure for resolving issues. However, partnering tends to be more effective in reducing cost of claims because partnering can *prevent* claims and therefore this relationship in shown in bold in the model.

Site transfer conflicts can also increase the number of claims and hence make claim management more difficult. As the site transfer near the end of the first contractor's job, the contractor may push harder for more money and time as this may be his/her last opportunity. As the contractor pushes harder, this makes claim management harder.

As a resulting factor, claim management hardly affects any other factor. Claim management does, however, weakly affects the "Benefits of Duplication." For example, if two parties, both working on schedule reviews, are involved in a claim, they would tend not to share information and not work together. Then, the benefits of duplication would decrease into an adversarial relationship. Mostly, however, claim management is mostly an end result. It is note worthy, however, because the big increases in cost and schedule often occur in claim settlements, or worse, in court disputes. The management of claims can be improved by partnering as a conflict preventive.

7.4 COMBINED BEHAVIORS

In order to demonstrate the model objectives in Section 7.1, the model was run with different initial auxiliary variables to produce various outcomes. It showed that partnering improved the effectiveness of champions, site transfers, claim management and decreased micro-management. However, in projects with more uncertainties, more partnering effort would be needed in order to achieve the same level of claim management, effective champions, and reduced number of site transfer conflicts. The model was

also run with and without a specific action plan for site transfers and for how to manage claims. The model showed that although an action plan can improve a site transfer and claim management, partnering is much more instrumental in improving claim management and reducing site transfer conflicts.

Running the model for various initial factors requires points to be allocated to the initial factors. The runs described in this section are the results for specific points given to the initial factors. Obviously there are many other possibilities for runs for other point combinations than used in this section, but the combinations in this section were chosen to demonstrate specific behaviors of the model related to the objectives. The points allocated to the initial variables are important because they are relative to the points of the resulting variables. For example, if on a scale of 0 to 2000, 100 points are given to the initial variable, “Follow-up Meetings”, and the model produces, let’s say, 500 points for the resulting variable “Effective Partnering”. Then the effective partnering benefits would be five times the effort put into the follow-up meetings. Thus, a small initial effort may lead to large payoffs later; and although the points may seem arbitrary, they can still show meaning by demonstrating relative benefits or lack of benefits compared to other variables.

7.4.1 Best and Worst Case Scenarios

The first graph generated for this thesis in Figure 28 shows the worst and best case scenarios for the effectiveness of the stocks: Champions, Partnering, Lack of Micro-Management and Claim Management. These stocks are shown on the same scale because their behavior is the same in the best and worst case scenarios. The lines on the graph for the best and worst case scenarios are the boundary lines for which all other case scenarios in the remainder of this chapter take place.

The behavior of the stocks over the lifetime of a project is set for 10 years in this model. To customize the lifetime to, for instance, five years, simply change the x-axis to a scale of 0-5 (divide all years by two) and keep the line on the graph the same. This customization can be done for all graphs in this chapter without running the model again.

Partnering/Champions/Micro-Management/Claim Management

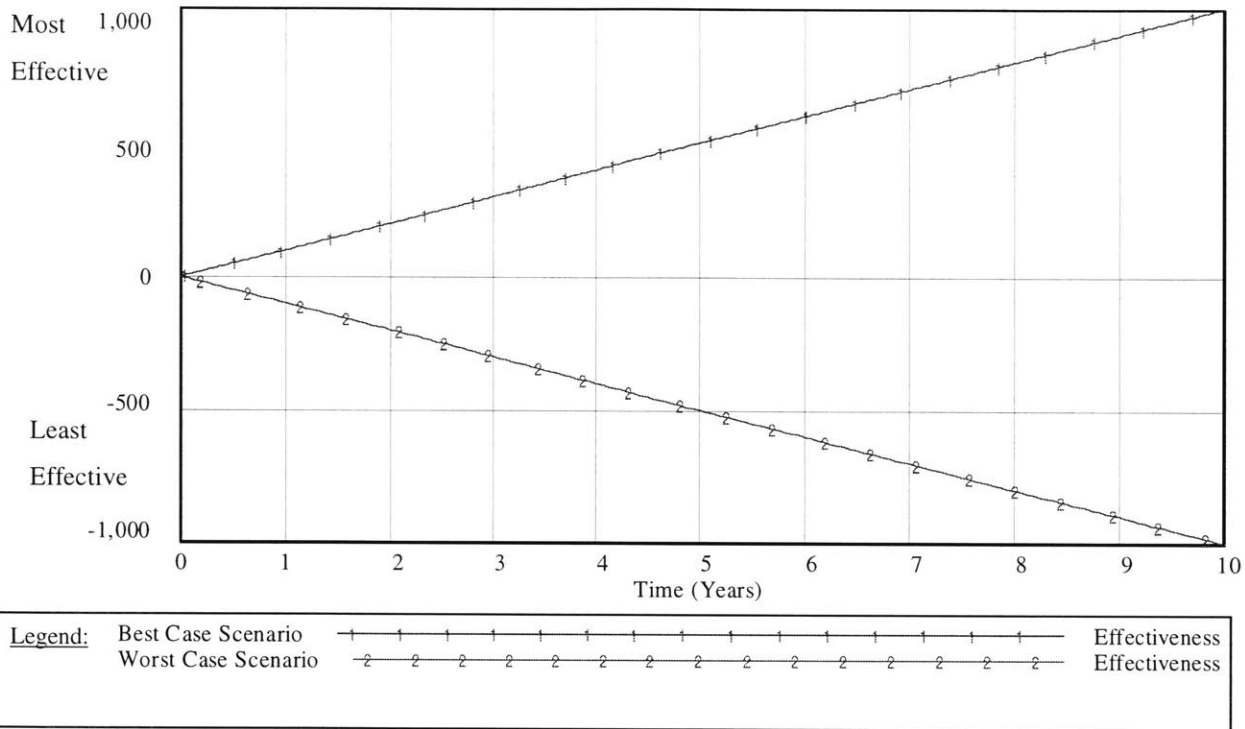


FIGURE 28: BEST AND WORST CASE SCENARIOS

The stock variables' behavior start at the beginning of the project at time zero with a null value, i.e., no change. The best case scenario improves the project to a maximum of 1000 points and the worst case makes the project get worse to a minimum of negative 1000 points in a straight line. The straight-line behavior occurs because the initial variables are held constant and because the model is simplified not to include any specific events in the project.

The last stock in the model, Site Transfer, has different behavior than the other stocks shown in Figure 28 because the site transfer does not happen until well into the project when the transfer takes place. This model uses the fourth year for all site transfers but this date can easily be changed by the user in the model equation (see Appendix F). The best and worst case scenario behaviors of the Site Transfer stock has the same behavior as the other stocks, but it just starts later. Likewise, the behaviors start at zero and have a best case of 1000 points and worst case of -1000 at the end of the project.

These behaviors are generated by allocating maximum points to the initial variables for the best case scenario and no points to the initial variables for the worst case scenario. The best case scenario has fully effective partnering from all meetings, i.e., given a total of 2000 points for all types of meetings and

evaluations. Certainties are given a total of 5 points for all types, i.e. multi-culture, procurement, and technical difficulty. Last the action plan for site transfer and claim management is given a maximum of 300 points.

These maximum points for initial variables are on a different scale than the stocks in Figure 28, which have a maximum of 1000 points. This difference occurs because the initial variables are input variables and the stocks are resulting variables and are therefore regarded differently in the model. The difference between the initial variables occurs due to the differences in their nature. For example, partnering has a numerous interactions and therefore the point scale is high, whereas uncertainties stem from such items of number of cultures and number of times a delivery method has been tried before and is, therefore, lower.

7.4.2 Initial Versus Follow-up Partnering Meetings

To achieve fully effective partnering as generated in the best case scenario, there should be initial and follow-up meetings and continuous partnering evaluations. Partnering evaluation can improve partnering any time throughout the project, but initial and follow-up meetings typically only occur in certain phases of the project life. This section will compare the importance of partnering early versus later in the project. It will show that establishing a good partnering relationship early in the project is crucial for truly effective partnering.

Five runs of the model were done with various points given to initial and follow-up meeting variables. In these runs the initial meetings are assumed to be completed by the first year and a half. The points given to the initial and follow-up meetings are shown in Table 8. Using these numbers, a graph was generated as shown in Figure 29. The rounded-off numerical end result, for the effectiveness of partnering at year 10 of the runs in Figure 29, is shown in the last column in Table 8.

The values are shown out of the maximum points that were used in the previous section, 7.4.1, “The Best and Worst Case Scenarios”, which has the best case partnering scenario with 2000 points for the initial and follow-up meetings. The next best case, as shown in Table 8, has both OK initial and follow-up meetings. The next worst case would be to have either initial or follow-up meetings without the other as seen in Table 8; in this case the initial meetings are more beneficial than follow-up meetings.

TABLE 8: POINTS GIVEN TO INITIAL AND FOLLOW-UP MEETINGS

Label on Run	Initial Meeting Points (Allocated/Max.)	Follow-up Meeting Points (Allocated/ Max.)	Partnering End Result (Allocated/ Max.)
Great Initial Meeting	2000/2000	0/2000	630/1000
OK Initial Meeting	1500/2000	0/2000	570/1000
OK Initial and OK Follow-up Meeting	1500/2000	1500/2000	900/1000
Great Follow-up Meeting	0/2000	2000/2000	500/1000
OK Follow-up Meeting	0/2000	1500/2000	200/1000

The initial meetings not only create a better end result, but also a better cumulative result. As seen in Figure 29, in the cases where there are only follow-up meetings, there is a sag in the middle of the project. The sag occurs because the partnering relationships would actually get worse with no initial meetings, but then slowly recover with follow-up meetings. Thus, the end resulting effectiveness of partnering in Table 8 is a useful comparison tool, but the cumulative behavior of partnering over time in Figure 29 gives a better overall picture. Thus, if partnering is poor throughout the project (follow-up meetings only) and only great partnering just at the end, then many conflicts still occur throughout the project, and, hence, the resulting number of conflicts would be high despite that the partnering relationship would be great at the end of the project.

Initial vs. Follow-up Meetings Effect on Partnering

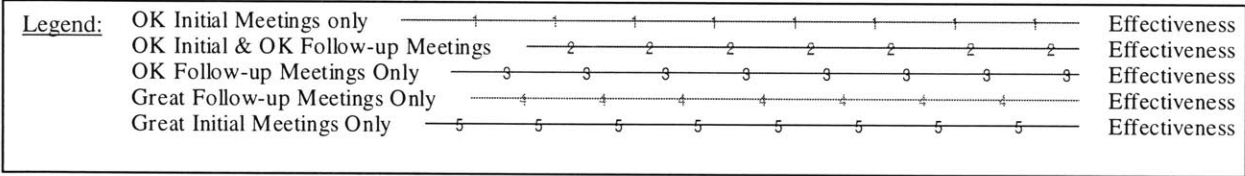
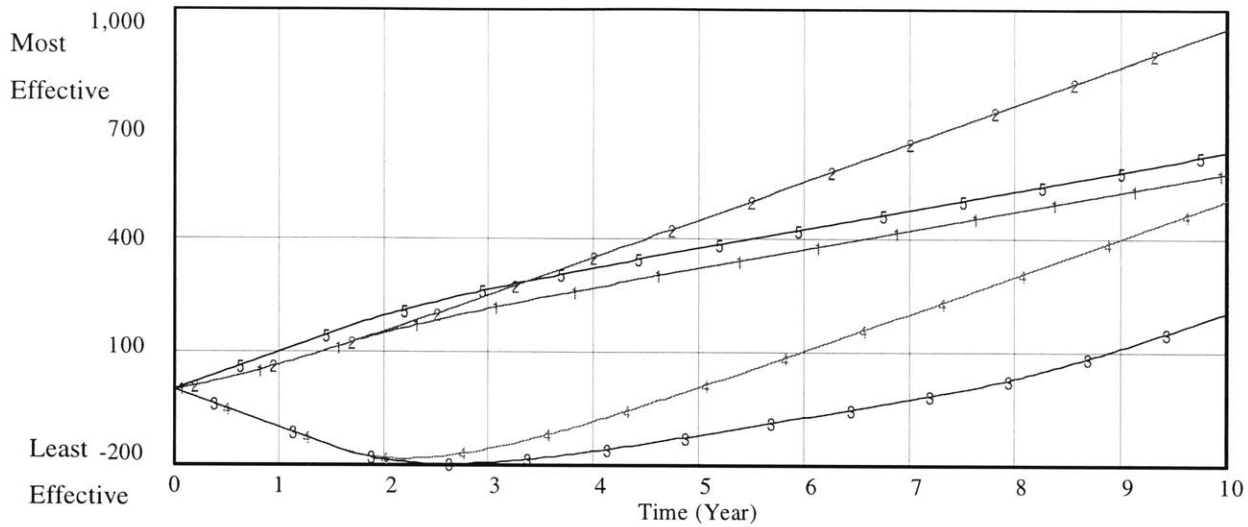


FIGURE 29: EFFECTIVE PARTNERING FOR DIFFERENT MEETING SCENARIOS

It can also be seen that for the same effort (same number of points), but shorter time period (only 1.5 years versus 8.5 years for the follow-up meetings), the initial meetings are much more effective than follow-up meetings alone. However, the best and second best case scenario both have both initial and follow-up meetings. Thus, it can be concluded that the initial meetings are important, but if they are not perfect, then follow-up meetings can significantly improve the project.

7.4.3 Partnering and Uncertainties Effect on Champions and Micro-Management

This section will show how the partnering and uncertainty in combination affect the effectiveness of the champions and the level of micro-management. It will show that more uncertainty requires more partnering effort for the same level result of micro-management and effectiveness of champions.

TABLE 9: POINTS GIVEN TO PARTNERING AND CERTAINTY

Label on Run	Level of Certainty (Allocated/Max.)	Level of Partnering (Allocated/Max.)	Champions/ Micro- Management End Result (Allocated/Max.)
OK Partnering, High Uncertainty	0/5	1000/2000	-1000/1000
Great Partnering, High Uncertainty	0/5	2000/2000	1000/1000
OK Partnering, More Certainty	5/5	1000/2000	-900/1000
Great Partnering, More Certainty	5/5	2000/2000	1000/1000
No Partnering, More Certainty	5/5	0/2000	-1000/1000

Points were allocated to partnering through the initial auxiliary variables pointing to partnering in the model, i.e., initial and follow-up meetings with evaluations; points were allocated to certainty in the project the auxiliary initial variables pointing to it, i.e., multi-cultures, delivery method and technical difficulty. The total values for certainty and partnering that were allocated can be seen in Table 9 in the two middle columns.

The results of the runs, as seen in the last column, shows that great partnering has the best results for the effectiveness of champions and least micro-management. Okay partnering and more certainty gave the second best results. No partnering and okay partnering with high uncertainty were the worst cases. Thus, it can be concluded that great partnering is needed for best results, especially with uncertainties. Also, with some certainty, less partnering is needed for the same results.

Partnering and Uncertainty for Champions and Micro-Management

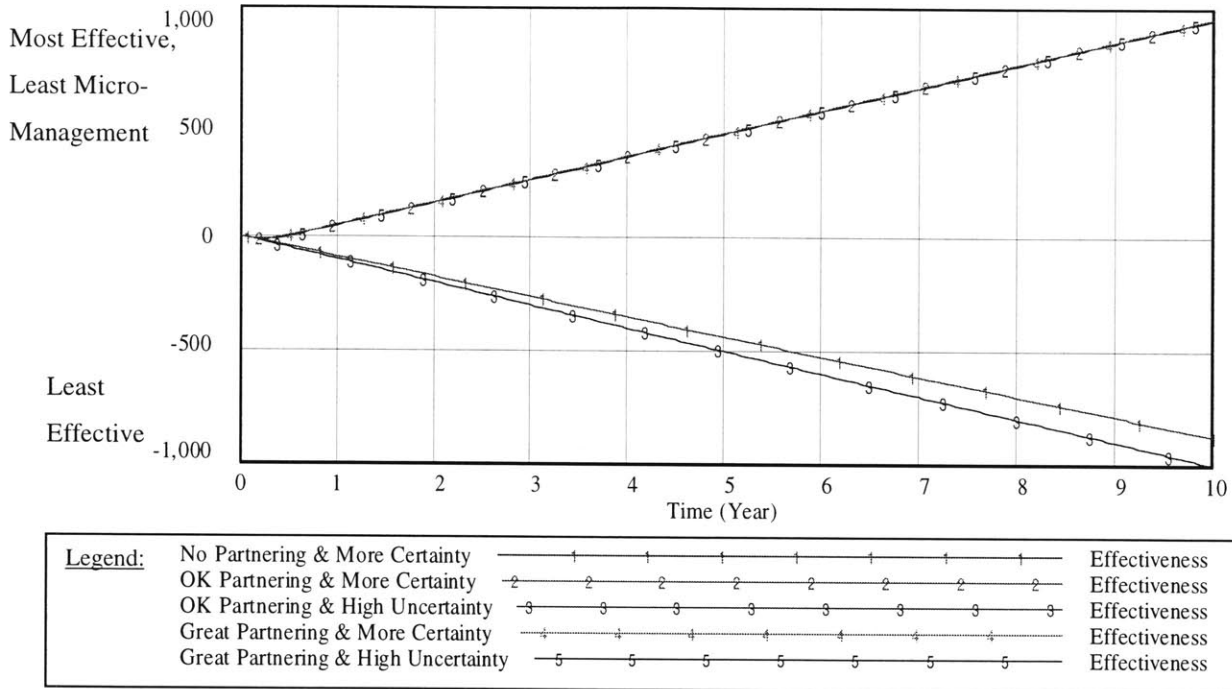


FIGURE 30: PARTNERING AND UNCERTAINTY FOR CHAMPIONS AND MICRO-MANAGEMENT

In Tren Urbano, the delivery method is very innovative and there are many types of cultures, thus, there are many uncertainties. Hence, the partnering effort must be increased to achieve the same results as partnering produces in traditionally procured projects. Project participants may be more or less responsive to partnering meetings in uncertain projects because there are so many other issues to deal with, but continuous partnering evaluations can monitor the effectiveness of the meetings, and the need for more meetings can be determined and then implemented.

7.4.4 Partnering and Uncertainty Effect on Site Transfer Conflicts and Claim Management

The relationship between partnering and uncertainties for site transfer conflicts and claim management is discussed in this section. The same values are used for partnering and certainty as shown in Table 9, and the results are similar to Champions and Micro-management in Section 7.4.3. Partnering and low uncertainties are needed for the best results for conflicts at site transfers and for most effective claim

management. However, often projects have uncertainties due to its delivery method and numerous cultures, and, then, more partnering effort is needed for the same level of results.

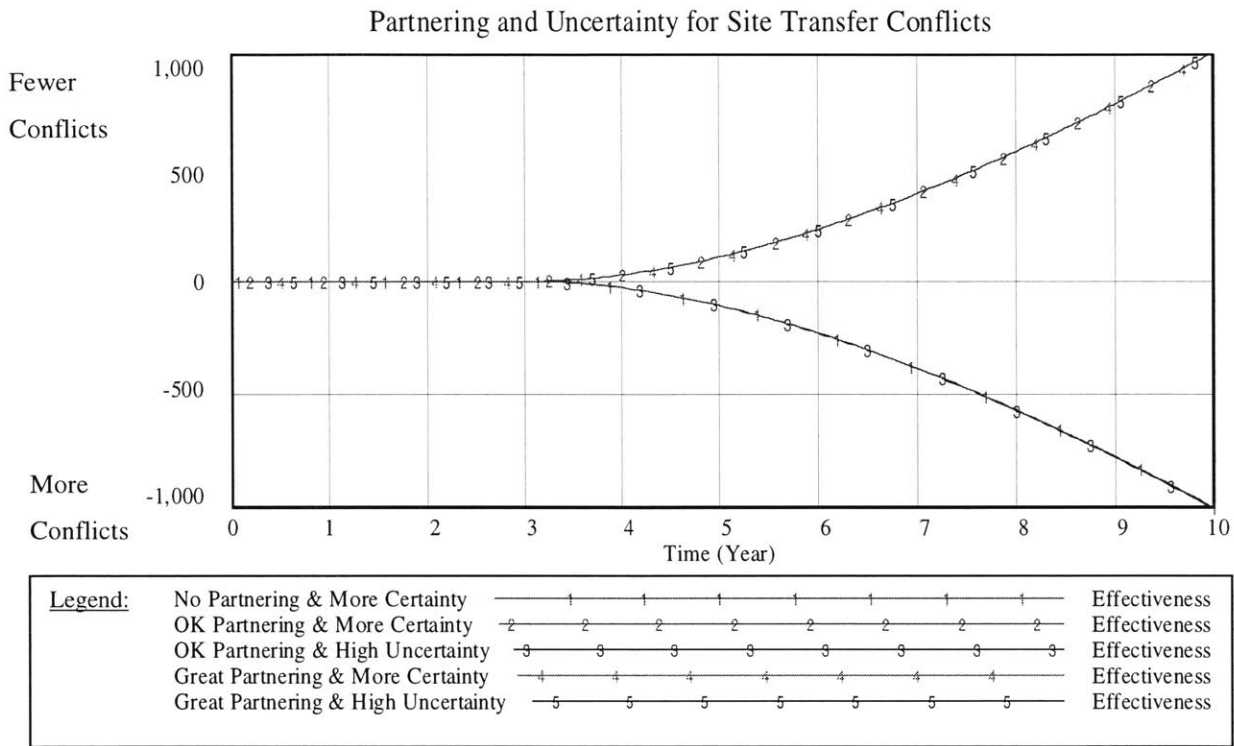


FIGURE 31: UNCERTAINTY AND PARTNERING FOR SITE TRANSFER CONFLICTS

For both site transfer conflicts and claim management, as seen in Figure 31 and Figure 32, an okay partnering effort was not adequate in projects with high uncertainty to produce good claim management and few site transfer conflicts. However, with fewer uncertainties, okay partnering was adequate. Great partnering would be needed if a project has many uncertainties in order to achieve fewer site transfer conflicts and better claim management.

Partnering and Uncertainty for Claim Management

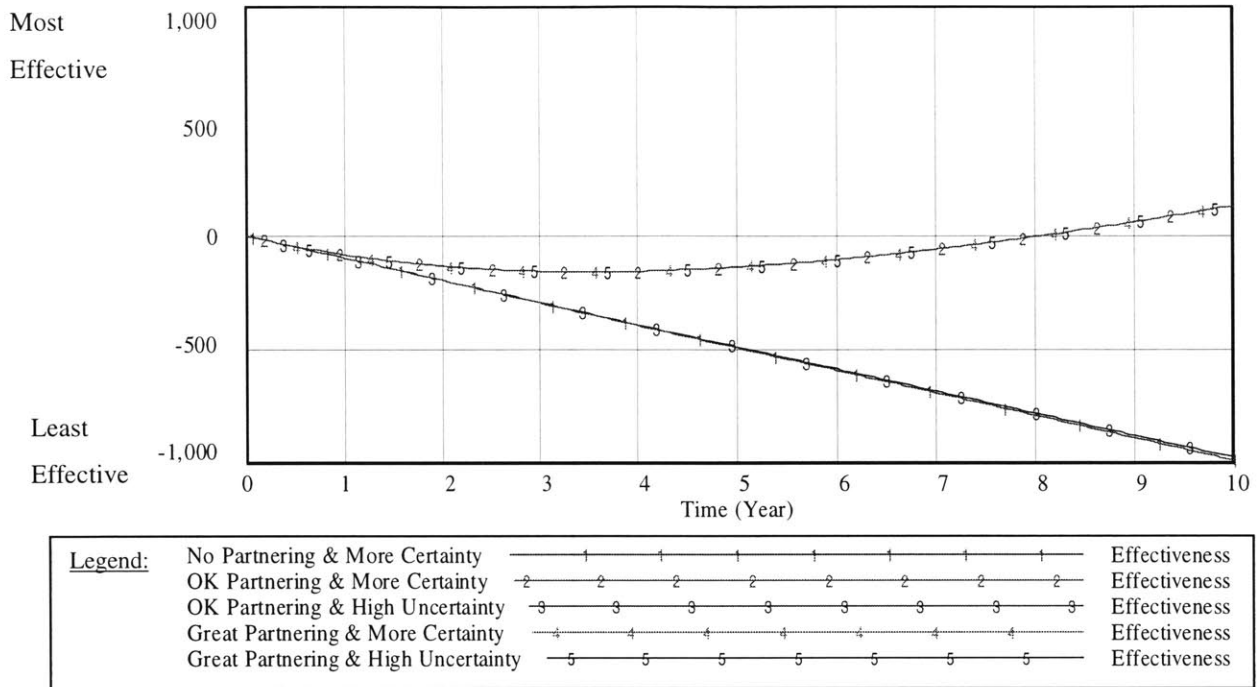


FIGURE 32: PARTNERING AND UNCERTAINTY FOR CLAIM MANAGEMENT

Thus, for the best overall resulting project, use good partnering efforts. However, if there are many uncertainties, use even larger efforts to improve the effectiveness of partnering.

7.4.5 Action Plan versus Partnering for Site Transfer and Claim Management

Now, let’s look more closely at how partnering and an action can affect site transfer conflicts and claim management. The next two graphs will show that an effective plan for claim management and a specific action plan for site transfers can reduce conflicts and claims. The effectiveness of the action plan will be compared to the effectiveness of partnering.

The values used for partnering and an action plan to generate the graphs for site transfer and claim management are shown in Table 10. The results at year 10 from the runs can also be seen in the right two columns in Table 10.

TABLE 10: PARTNERING AND ACTION PLAN AFFECT ON SITE TRANSFER CONFLICTS AND CLAIM MANAGEMENT

Run	Delay of Action Plan	Action Plan (Allocated/ Max.)	Partnering (Allocated/ Max.)	End Result for Claim Management (Allocated/ Max.)	End Result for Site Transfer Conflicts (Allocated/ Max.)
Immediate Action Plan & Full Partnering	None	300/300	2000/2000	1000/1000	1000/1000
Immediate Action Plan & No Partnering	None	300/300	0/2000	50/1000	-700/1000
Late Action Plan & Full Partnering	2 years	300/300	2000/2000	130/1000	1000/1000
Late Action Plan & No Partnering	2 years	300/300	0/2000	-870/1000	-800/1000

Graphs of the runs corresponding to Table 10 are shown in Figure 31 and Figure 32. From the table and graphs, it can be seen that an action plan with no partnering can improve claim management and site transfer conflicts slightly above the minimum (negative 1000 points) for a late plan and even more for an early action plan. If fully effective partnering is used with an action plan, the best case scenario is reached (1000 points) for claim management and site transfer conflicts. Thus, partnering becomes essential to reduce claims and conflicts significantly. The action plan could also be incorporated in the partnering meetings and this would further strengthen the understanding of all project participants that partnering cooperative relationships is important for reducing claims.

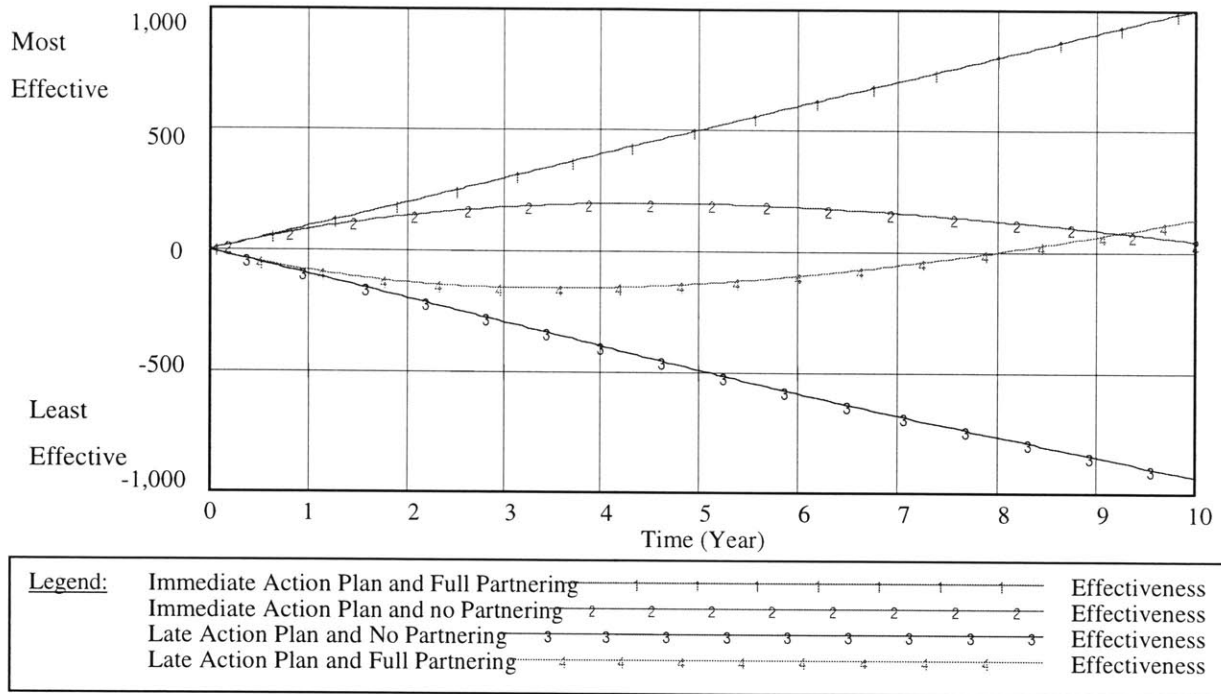


FIGURE 25: ACTION PLAN FOR CLAIM MANAGEMENT

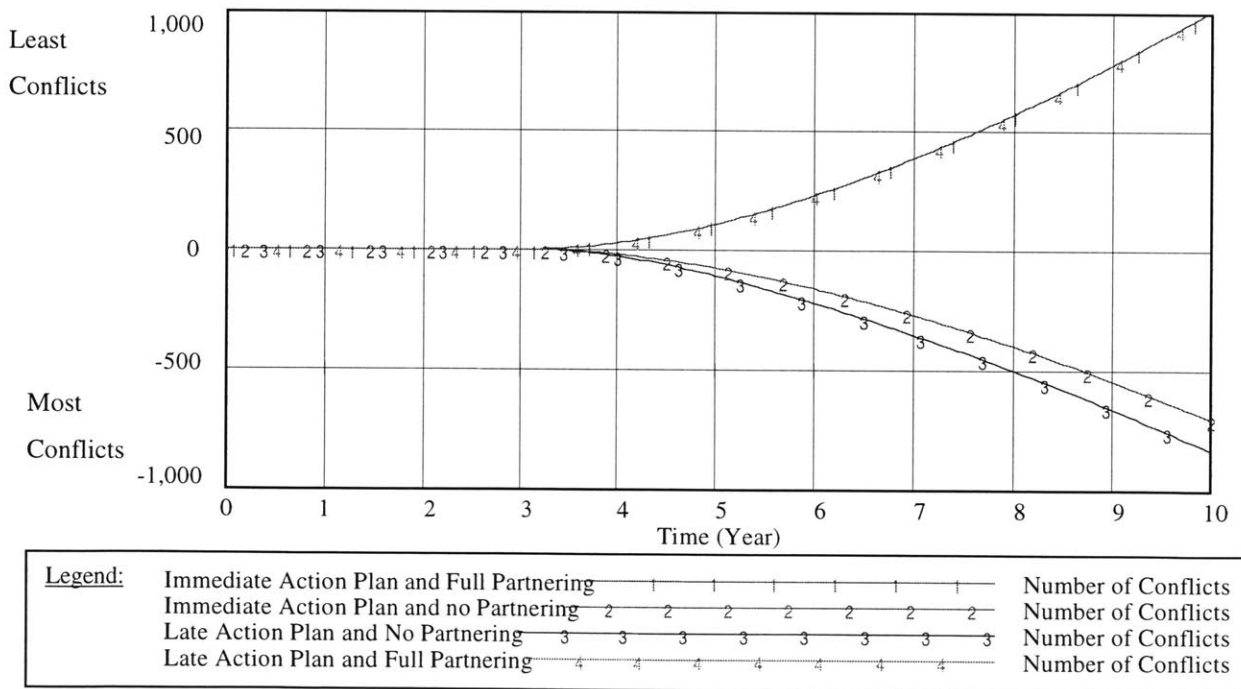


FIGURE 26: LACK OF SITE TRANSFER CONFLICTS

Although the graphs for site transfer conflicts and claim management differ, general conclusions can be drawn from both graphs. Conflicts and claims can be reduced most significantly with fully effective partnering. Second, the claims and conflicts can be reduced with an early action plan. This demonstrates that partnering among party participants is very important to reduce tension and conflicts during a site transfer and that an action plan may only be a “Band-Aid” for conflict and claim reduction.

7.5 TREN URBANO RESULTS

The behaviors in Section 7.4 illustrated how various factors can affect variables such as partnering, champions, micro-management, conflicts at site transfer, and claim management. This section will focus on the same factors’ effect on the same variables, but in the Tren Urbano Project context. The system dynamics partnering model will be run with points allocated to the factors in the Tren Urbano Project as shown in Table 11.

The points are allocated based on direct observations and interviews with project participants as follows. The initial meetings were generally very good, but there needed to be a better belief in the partnering cooperation and better trust, which is the basis for partnering. The follow-up meetings were held, but these were generally weaker than the initial meetings because they were not focused in partnering objectives and did not serve to improve communication process; instead they were used for direct issue resolutions. Also, they were not held by a third party in a neutral location. Due to the procurement method and numerous cultures such as ethnic, professional, corporate, and the multi-phased aspect, there were inherently many uncertainties. Thus, only one point was allocated to certainties in the Tren Urbano Project. Last, the action plan to prepare for the site transfer has components in the contracts, but specifics, such as allocating delays, still needs further work. The plan for claim management is improving, but few claims are being resolved at the current time, hence there could be many claims left for the courts by the end of the project. Thus, the action plan still needs much improvement.

TABLE 11: FACTORS ALLOCATED TO TREN URBANO

Factors	Points in for Tren Urbano Project (Allocated/ Max.)	Reason for Point Allocation
Initial Partnering Meetings	1000/2000	Generally great but there could be better belief in the partnering process and genuine commitment by all parties
Follow-up Parting Meeting	30/3000	Meetings were held but there needs to be major improvement in the agenda of the meetings to focus more on partnering issues
Delivery Method Certainties	1/5	Very new hybrid delivery method which has never been tried before .(1 point allocated for this project)
Cultural Differences Certainties	1/5	Many types of cultures: ethnic, corporate, professional and multi-phase. Thus, there are many uncertainties. (1 point for this project)
Action Plan for Site Transfer and Claim Management	2/300 for 1 st 4 years 3/300 from 4 to 10 years	Needs a major improvement in detail and implementation. Some improvements have been made after the first couple of years.

When the model was run with these point allocations for Tren Urbano, the results for micro-management, champions, partnering, site transfer conflicts, and claims management were graphed as seen in Figure 33 to Figure 37. These results were compared to the ideal situation described in Section 7.4.1 of the best and worst case scenarios. To summarize the results of the best case scenario, it had great partnering, no uncertainties, and a great action plan. The Tren Urbano Project, on the other hand, had okay partnering, high uncertainties and a weak action plan.

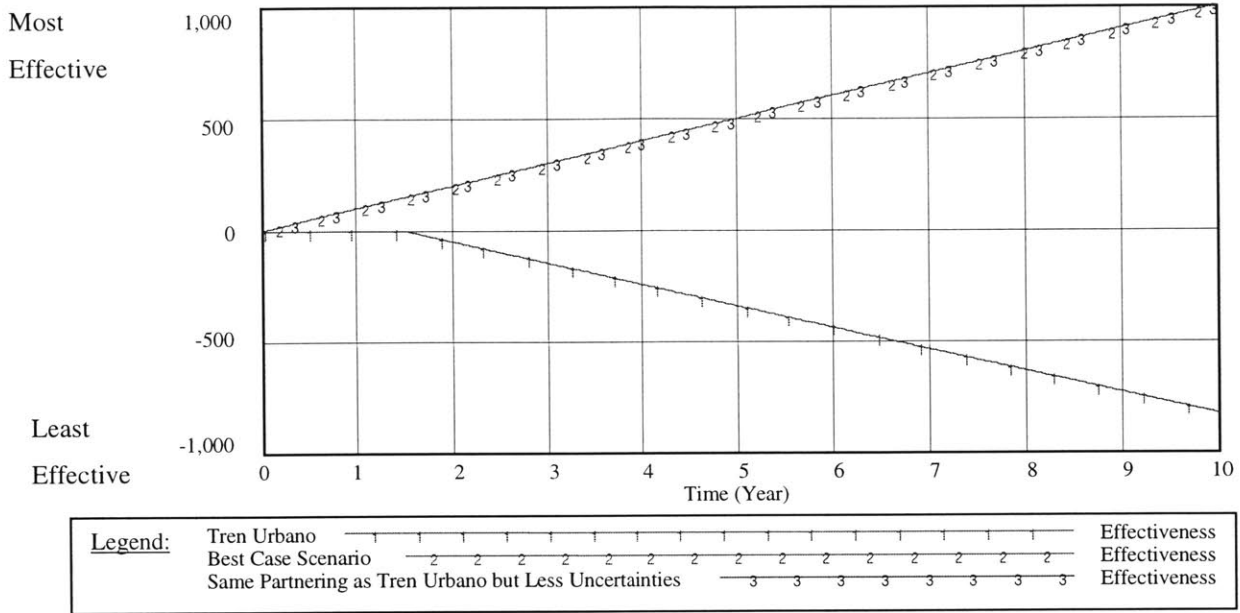


FIGURE 35: TREN URBANO RESULTS - PARTNERING

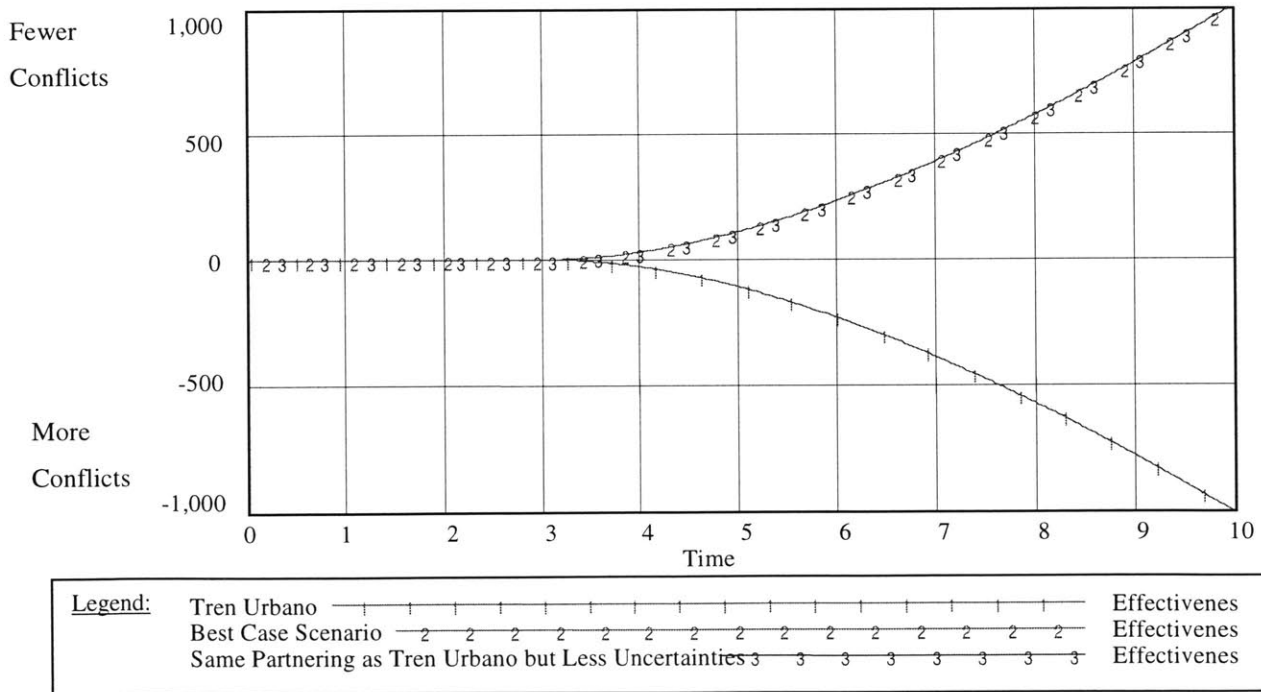


FIGURE 36: TREN URBANO RESULTS - SITE TRANSFER CONFLICTS

meetings are lacking slightly in effectiveness, follow-up meetings can ensure full partnering. The amount of effort needed for partnering increases with increasing uncertainties in the project. Finally, an action plan for site transfer and claim management can be useful, but partnering has an even larger positive effect.

The amount of partnering effort in the Tren Urbano Project is adequate for traditionally procured projects with few uncertainties, but as shown in the system dynamics model, the amount of partnering was not enough for the challenge of Tren Urbano. Much greater partnering effort is needed to receive the benefits of partnering.

CHAPTER 8

CONCLUSIONS OF RESEARCH

As newer and more innovative delivery methods are used in an increasing more global market with numerous cultures in each project, partnering becomes especially important to bridge the cultures for the success of a project. Also, an innovative delivery method's advantage over traditional projects may ride on the assumption that effective partnering is in place as partnering has become more common place globally. Therefore, in many projects special attention should be given to partnering. However, although partnering is more important, it is more challenging to partner effectively in such projects because there tends to be more uncertainties and issues to resolve in these projects which often overshadow the partnering efforts.

8.1 CONCLUSIONS FOR TREN URBANO

The Tren Urbano Project in San Juan, Puerto Rico is used as a case study to show challenges of partnering in an innovative procured, multi-phase, multi-culture project with many uncertainties. The Tren Urbano Project is heavy rail project that is being built in several phases. Phase I is currently under design *and* construction as well as planning for the future alignments. Tren Urbano's delivery system consists of a hybrid of a design/build/operate turnkey contract, multiple prime design/build contractors,

construction management each with different professional, corporate, and ethnic cultures that results in a complex network of relationships.

Partnering is especially needed in Tren Urbano for several reasons. First, the owner, PRHTA, and the turnkey contractor, STT, need to form a partnering bridge from which a unified management team can form. Without this bridge, STT loses authority as part of the owner's team to manage the interface between the multiple prime contractors. Also, the partnering bridge is necessary for STT to act on the incentives incorporated in its contract for operations and maintenance, which should promote STT to reduce long-term cost for maintenance and operations. STT must be viewed as part of the owner's team and less like a contractor for STT to be effective in ensuring a complete, turnkey project with high quality and low operations and maintenance costs. Once the partnering bridge between the owner and STT is formed, then all parties that are part of the owner's and SST's team can work together more effectively. The parties which especially need this bridge is the owner's consultants, GMAEC, and Parsons Brinkerhoff which both perform management duties and overlapping tasks, but both have little authority without the owner and STT, respectively.

Second, partnering is important in Tren Urbano because there is a lot of overlap and duplication. Duplication can act as a double check and provide better quality. It can also give duplicating parties motivation to work harder under competition to provide the best service to the owner. But unless parties work together on the tasks in a partnering environment, duplication can lead to a hostile competitive environment and wasted time coordinating the numerous parties' tasks. Moreover, duplication in the lack of partnering can result in "all responsible, no one is" and the quality would actually suffer. Thus, partnering can enhance the pros of duplication: quality and motivation, but duplication in a ineffectively partnered environment can increase time for coordination of tasks, cause adversarial relationships and decrease the quality.

Partnering is also necessary between STT and the multiple prime contractors as they need to work together without any monetary flow or contract. If partnering breaks down, the owner would stand in the middle between STT and the multiple prime contractors. Then STT would be ineffective in delivering the project as a whole to the owner, which was the major aspect of the turnkey concept.

Several good steps have been taken to implement partnering in Tren Urbano. Initial meetings with all contractors, designers, and a quality summit have been held. Follow-up partnering meetings have also been held but these could use major improvement in terms of objectives of these meetings and the neutrality of the meetings. As the Tren Urbano Project has an uncertain environment with many

challenges and issues to resolve, this may be why partnering got sidelined. Additional partnering efforts, compared to a typical project, should be used to ensure trusting partnering relationships. Several lessons to improve the effectiveness of partnering can be learned from this project.

The evaluation of partnering in Tren Urbano shows that there were areas where good steps toward partnering were taken such as the initial meetings, but some areas could be improved upon, for example,

1. A clear champion for partnering was not clearly identified in the pre-planning stage.
2. The initial partnering conferences was done well, but more faith and genuine commitment was needed to be elicited from all parties in the partnering process
3. Follow-up meetings could be improved if run by a third party.
4. The need for and the value of partnering should have been emphasized and explained better to all project participants.

More initial effort should have been put into the partnering venture. Once some deterioration of partnering started in Tren Urbano, it became difficult to reverse. Additional meetings should be hold in informal settings in order to gain better understanding of other parties' cultures in a relaxed atmosphere. A voluntary and genuine commitment from all parties from the beginning is necessary for the success of partnering.

Another major lesson learned was that all management parties should form one united management team, otherwise STT would just be another prime contractor and few benefits could be gained from the turnkey concept.

Partnering should occur at all levels. For example, field inspection occurs separately by numerous parties. Partnering could help field inspection if teams were formed between the numerous field inspectors. This could ensure complete inspection in all areas of the work site whether the site was divided by location or by discipline. Thus, partnering should be implemented at all management and across entities.

Partnering across many entities can also help form an environment where champions for quality, cost, schedule and partnering can foster. Champions can help champion a cause but can also create a clearer and more orderly and structured organization. The organization is currently somewhat confusing as is evident by the different perceptions of the organization chart. The Tren Urbano Project also tends to

have elements of micro-management, and this creates inefficiencies in the organization. One reason that micro-management starts could be that when management foresees many uncertainties they tend to take control of the issues. A trusting environment needs to be formed where delegation of responsibilities can occur.

A system dynamics partnering model developed in this thesis illustrated how the components of effective partnering behave over time. The model showed that initial meetings are more important than follow-up meetings, but both are needed for a fully effective partnership. The model also showed that the uncertainties a project has in terms of delivery method, cultures and technical difficulties, the more partnering effort is needed to achieve the same level of effectiveness of champions, claim management, site transfer and reduced micro-management. Last, the model showed that an action plan for site transfer and claims can be beneficial, but partnering is more instrumental because it can prevent claims and conflicts at site transfer.

The model was also run with the variables from the Tren Urbano Project: high uncertainty, medium level of partnering and relatively weak action plan. The results illustrated that the partnering effort in Tren Urbano would be adequate for a traditionally procured project with few uncertainties. However, since the Tren Urbano project has many uncertainties, more partnering effort is needed. At this time, in the middle of the project, a partnering effort for Tren Urbano could include more effective follow-up meetings to redefine the partnering objectives and aims. The partnering process also needs to be evaluated more carefully in the project to detect any decay of the partnering relationships. However, partnering efforts earlier in the project would have been more beneficial. Earlier detection of partnering deterioration symptoms could have led to a better recovery of partnering. Today, the number of claims is increasing at a high rate and parties are starting to prepare themselves in case of court battles. Partnering may be a challenge to repair at this point in time. However, the partnering environment that still remains should be fostered until after the construction is complete and until all claims are settled in good faith negotiations. Then a final evaluation of the partnering effort can be done.

8.2 CONCLUSIONS APPLIED TO PROJECTS IN GENERAL

The lessons learned from Tren Urbano can be generalized in order to apply them to any project, which uses an innovative delivery method in a multi-phase, multi-party, multi-discipline, multi-culture project.

The lessons learned can be divided in three categories, initial, operational and resulting factors. The initial factors define how the remainder of the project will be carried out. They are set at the beginning of the project, but their impact will not be seen until the end of the project as they affect the other factors. The operational factors occur throughout the project. They are affected mostly by the initial factors, but can also be improved slightly upon themselves. The resulting factors are mostly a product of the other initial and operational factors. Conflicts, quality, schedule and cost of the project is more directly linked to the resulting factors.

Project Factors:

- Initial Meetings: Start early with a full partnering initialization. Do whatever it takes, especially if the delivery system relies on partnering to become effective. A little extra time or money spent early on partnering may have a large pay-off later. Trust, as the key ingredient of partnering, must be developed here because it will only be more difficult to install later.
- Education: Use experienced employees if possible, otherwise educate intensively in the need and benefits of partnering and, of course, at the task at hand
- Numerous Cultures: Cultural differences must be recognized and special seminars with played out examples of business differences may help parties see the differences before they are in real situations and their relationship deteriorates.
- Delivery Method: An innovative procurement method is generally done to meet special project objectives and can provide a fresh start for a new improved partnering relationship. But be careful, there may be special challenges such as non-contractual relationships that need higher commitment to partnering.

Operational Factors:

- Follow-up Partnering Meetings: Follow-up meetings can prevent the initial trusting partnering relationship from decaying.
- Knowledge Transfer: Partnering can provide open communication for knowledge transfer that is often needed between various cultures

- Evaluations: Evaluate partnering throughout the project. Thus, if there seems to be skepticism of partnering, this trend can be reversed immediately before becomes too difficult to reverse. Use more ‘soft’ measures initially such as problem solving methods, and evaluate ‘hard’ measures such as number of claims when it becomes relevant.
- Champions for Objectives: There needs to be clear champions for quality, cost, schedule and partnering itself. A confusing organization may be a sign that nobody knows who is in charge of what and when. Party participants need to know who the champions are, and the champions need adequate authority to be effective.
- Benefits of Duplication: The amount of duplication in the particular delivery method must be evaluated based on factors of duplication such as extra cost versus greater quality. The method that parties work together should be mapped out, especially if work functions overlap. Partnering processes must be put in place here to ensure duplication does not lead to adversarial relationships and the “all is responsible, nobody is” syndrome. If the delivery system is some hybrid of multiple primes with similar tasks, standardization with enforcement must occur.
- Unified Management Team: Create a unified management team for highest effectiveness. Certain relationships may be needed to be bridged by partnering in order for other entities to work together effectively. Then partnering can occur at all levels.
- Turnkey Contractor Acting as Part Owner: If a contractor is to perform both tasks both in the owner’s interests and tasks not as well aligned with the owner’s interests, partnering can help pull the contractor to act more in the owners interest.

Resulting Factors:

- Site Transfer Conflicts: Hand-over between contractors may prove to be tricky. If there is no direct contractual link, the owner should oversee that the hand-over will be done in good faith, otherwise the owner would have to monitor the site hand-over in detail.

- Micro-Management: If the owner remains in control, it must spend great number of resources to oversee contractors in detail. Effective partnering will aid the process to letting go of control and save on resources. It will also make the owner more confident to use more innovative contracts for future projects. Trust must be developed so managers can delegate responsibilities in an uncertain environment and to avoid micro-management.
- Claim Management: Claim management is important to improve costs, and schedule. Claim management, however, can not only be improved upon itself, first the factors throughout the project, operational factors, must be improved upon through effective partnering in order to greatly improve claim management. The partnering effort must be emphasized after construction completion until all claims are settled.

The project, operational and resulting factors are interrelated in a complex network. The important relationships between the factors have been illustrated in a system dynamics partnering model. The model was run in a time span for various initial project factors and several outcomes were presented. Most notably, effective partnering increased the effectiveness of champions, decreased micro-management, and improved claim management. Also, initial meetings were shown to be more effective than follow-up meetings for the same amount of effort. The runs using data from Tren Urbano illustrated that if there are many uncertainties, greater effort is needed.

In summary, as newer and more innovative delivery methods are used in an increasing more global market, partnering becomes especially important to convey to all parties. Also, an innovative delivery method's advantage over traditional projects may ride on the assumption that effective partnering is in place. Therefore, in many projects partnering becomes especially important and special attention should be given to partnering. However, partnering can also be especially challenging because of the numerous other issues that must be resolved that can easily overshadow partnering if specific attention is not pointed towards partnering.

8.3 FUTURE RESEARCH

This research provides a stepping stone for further research in several areas. First, it provides a step towards integrating Information Technology (IT) in Tren Urbano. This research provides better understanding of the issues involved in the organization and information flows in order for IT to be

applied in a better context. Some of the needs and requirements can also be better understood by this research. Building on this research, Tong Li at MIT is currently pursuing implementing IT in Tren Urbano (Li, 1999). The special requirements for IT in construction projects can, then, be better understood.

Another area where this research provides a stepping stone is for further partnering research. This research focuses on partnering in one innovatively, multi-cultural project. The results from this research could be tested in future research on other such projects to further redefine special characteristics and requirements for effective partnering.

The third area for further research is in collaborative negotiations. This research is part of a group at MIT, the Da Vinci Agent Society Initiative, that is pursuing the research of collaborative negotiation that aims at computer supported negotiations. As part of this group study, this research provides a conflict avoidance aspect to collaborative negotiations.

8.3.1 Information Technology

This paper provides an understanding of the organization and information flows in Tren Urbano. Future research can investigate how IT can best be applied to the Tren Urbano Project.

A computerized management information system is being proposed by Tong Li at MIT (Li, 1999) to track information among the different organizations in the Tren Urbano project. This system will integrate the information communication systems within each organization. It is important that the system is diffused to all parties involved and to the key people within each party. The web-integrated system may be the best answer, this way all parties are not obligated to buy specific software.

8.3.2 Partnering

The success or failure of partnering has been researched many times. This research provides some basis for understanding the needs to partnering in innovatively procured, multi-cultural projects. Since this research only takes one project, Tren Urbano, into consideration. The general conclusions could be tested on further projects that are innovatively procured and multi-cultural like Tren Urbano.

This research is part of a larger effort of Da Vinci Agent Society Initiative at Intelligent Engineering Systems Laboratory at MIT. Da Vinci aims to enhance the collaboration and negotiations between professionals across distance and time. Collaborative negotiation will be used to help develop solutions and yield more satisfaction with the conflict solutions. Several steps are needed to develop a methodology for the collaborative negotiation model. First, since every delivery system impacts the methodology of negotiations differently, the impact of this particular delivery system on negotiations needs to be clearly understood. Second, the potential conflicts need to be managed more efficiently within the delivery system already in place (this area of research will build on the results of the research project being undertaken by Tamaki, 1998). Last, future benefits of the collaborative negotiation model can be explored.

8.4 SUMMARY OF CHAPTER

This chapter summarizes the recommendations specifically for the Tren Urbano Project and generalizes them for innovatively procured, multi-cultural, multi-phase project.

The Tren Urbano Project especially needs partnering because its delivery method and numerous cultures that creates uncertainties. Parties in Tren Urbano have overlapping tasks, several parties are involved with management functions, and the turnkey contractor does not have contractual relationships with the multiple prime design/build contractors for which it must coordinate. Thus, partnering becomes an integral part of the success of its delivery method. However, the partnering effort in the Tren Urbano Project could be improved in terms of genuine commitment to partnering from all parties, and the focus on the partnering effort.

In general, projects such as Tren Urbano have more uncertainties, and, hence, more partnering effort is needed to achieve the same benefits of partnering that a traditionally procured project would for the same amount of partnering. Also, partnering can easily be overshadowed by other the numerous issues that arise in these types of projects, and, therefore, partnering becomes more challenging as well. In summary, partnering is more important to the success of the project, but partnering also becomes more challenging.

This research can be used for further work in incorporating information technology in large-scale civil engineering project by better understanding the issues and processes of such projects. Further research could also be done for partnering in other innovatively procured, multi-cultural project to verify the conclusions in this paper. Finally, this research is part of Da Vinci Agent Initiative for developing collaborative negotiations. This research adds to conflicts avoidance part of collaborative negotiations, but further work in this area, besides partnering, could improve the robustness of collaborative negotiations.

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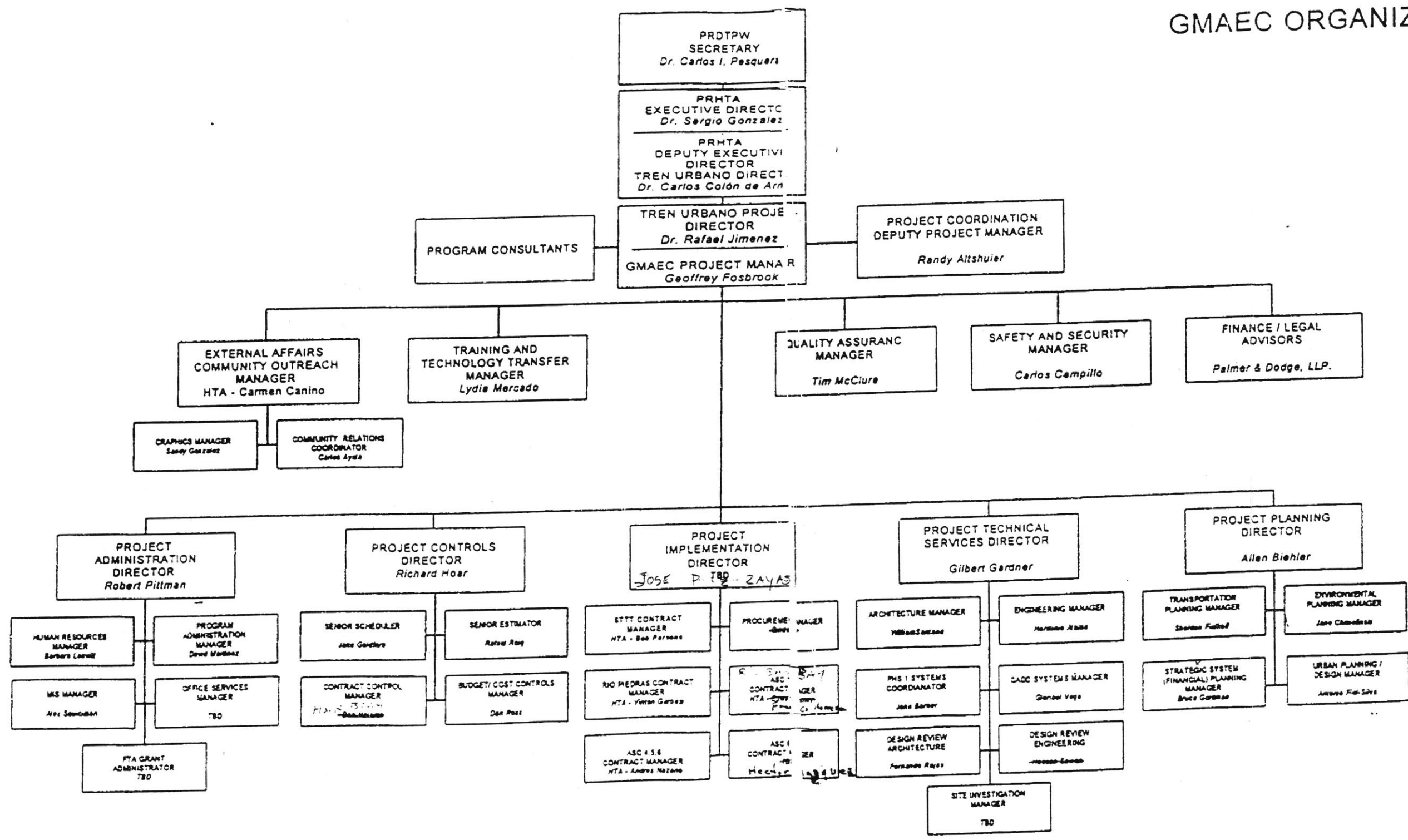
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APPENDIX A :

GMAEC VIEW OF
PROJECT ORGANIZATION

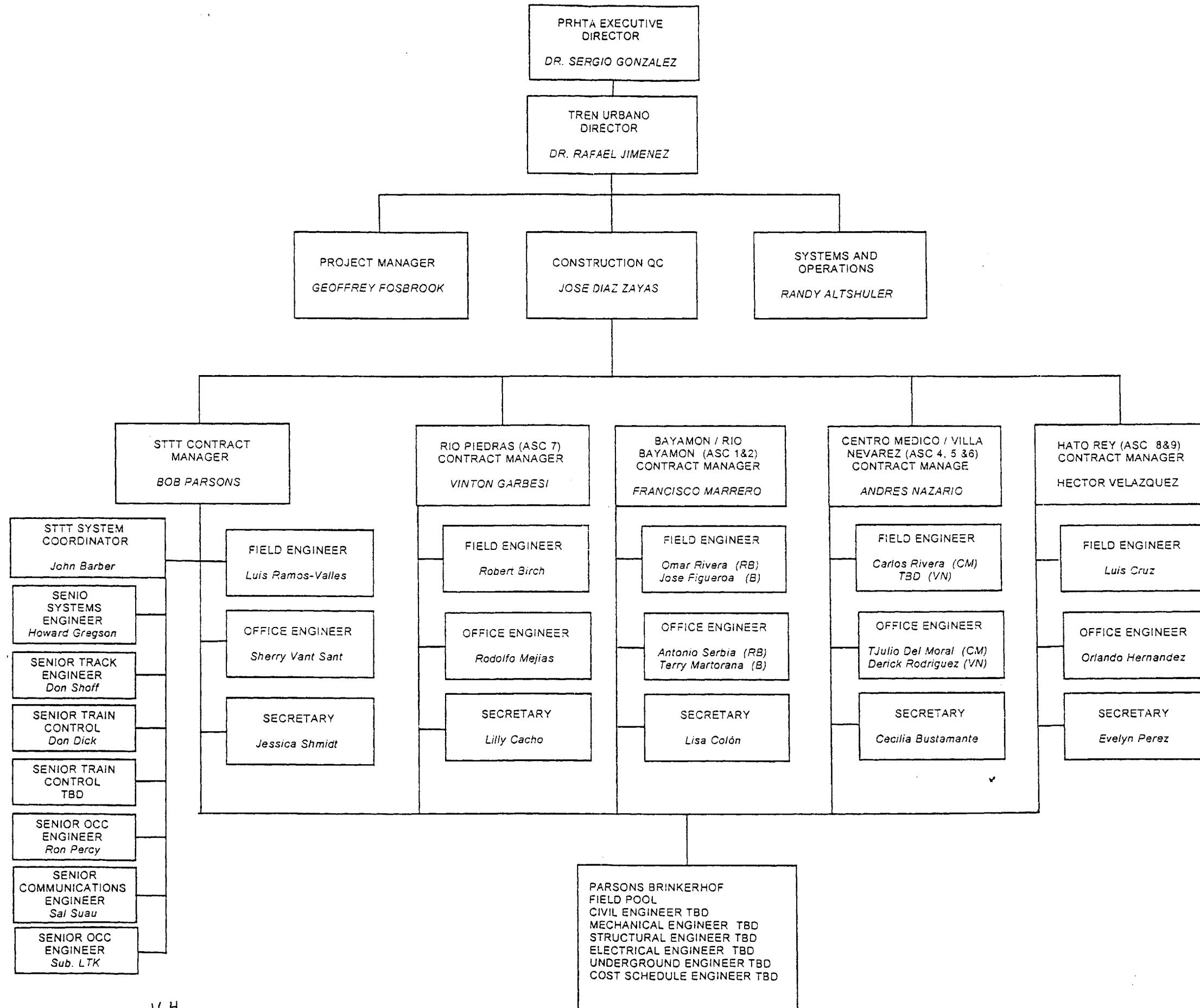
GMAEC ORGANIZATIONAL CHART



APPENDIX B:

PROJECT
IMPLEMENTATION
ORGANIZATION

GMAEC - IMPLEMENTATION



APPENDIX C:

SIEMENS TRANSIT TEAM
ORGANIZATION

Quality Summit

STT Design/Build Team Organization



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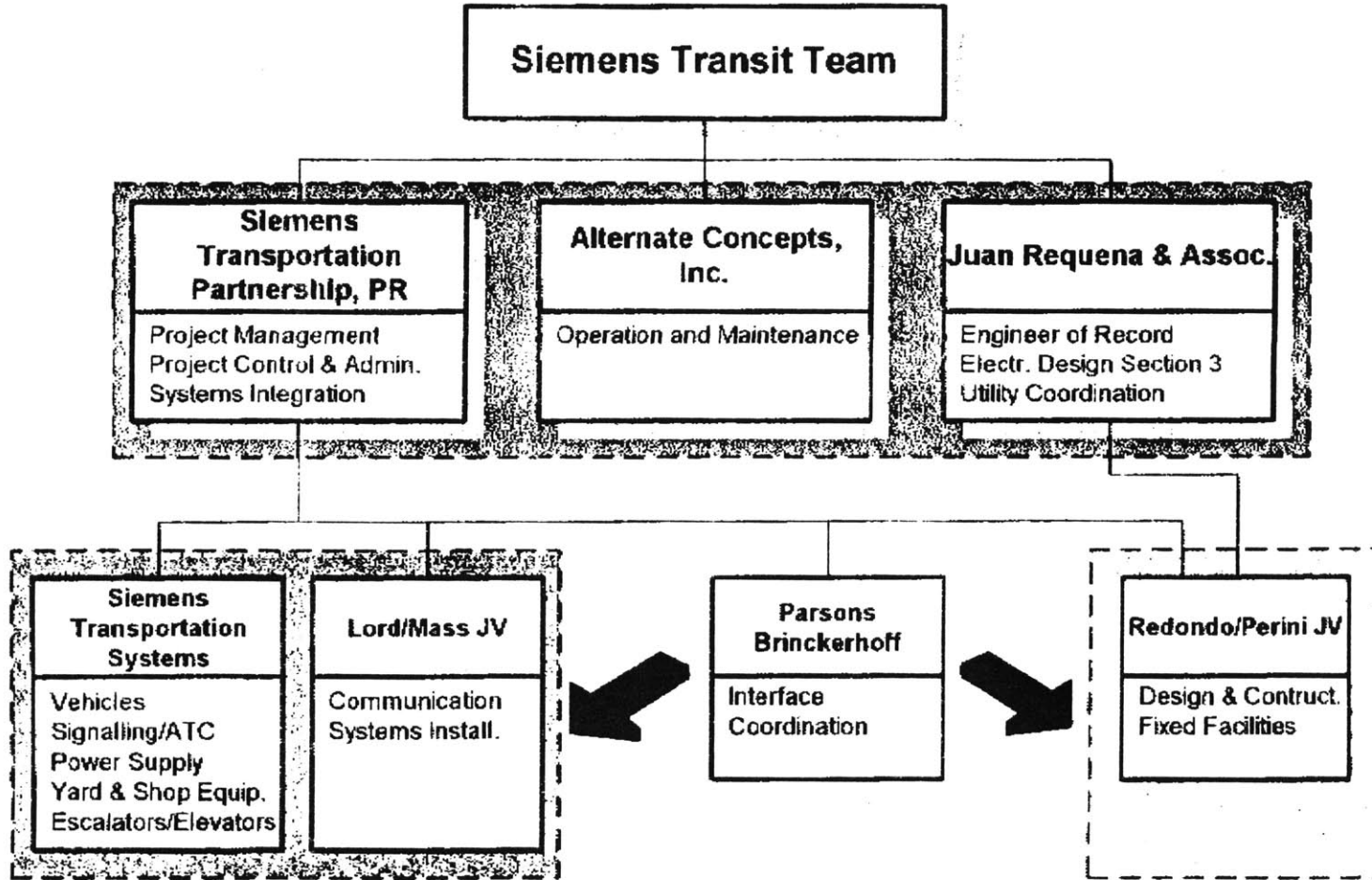
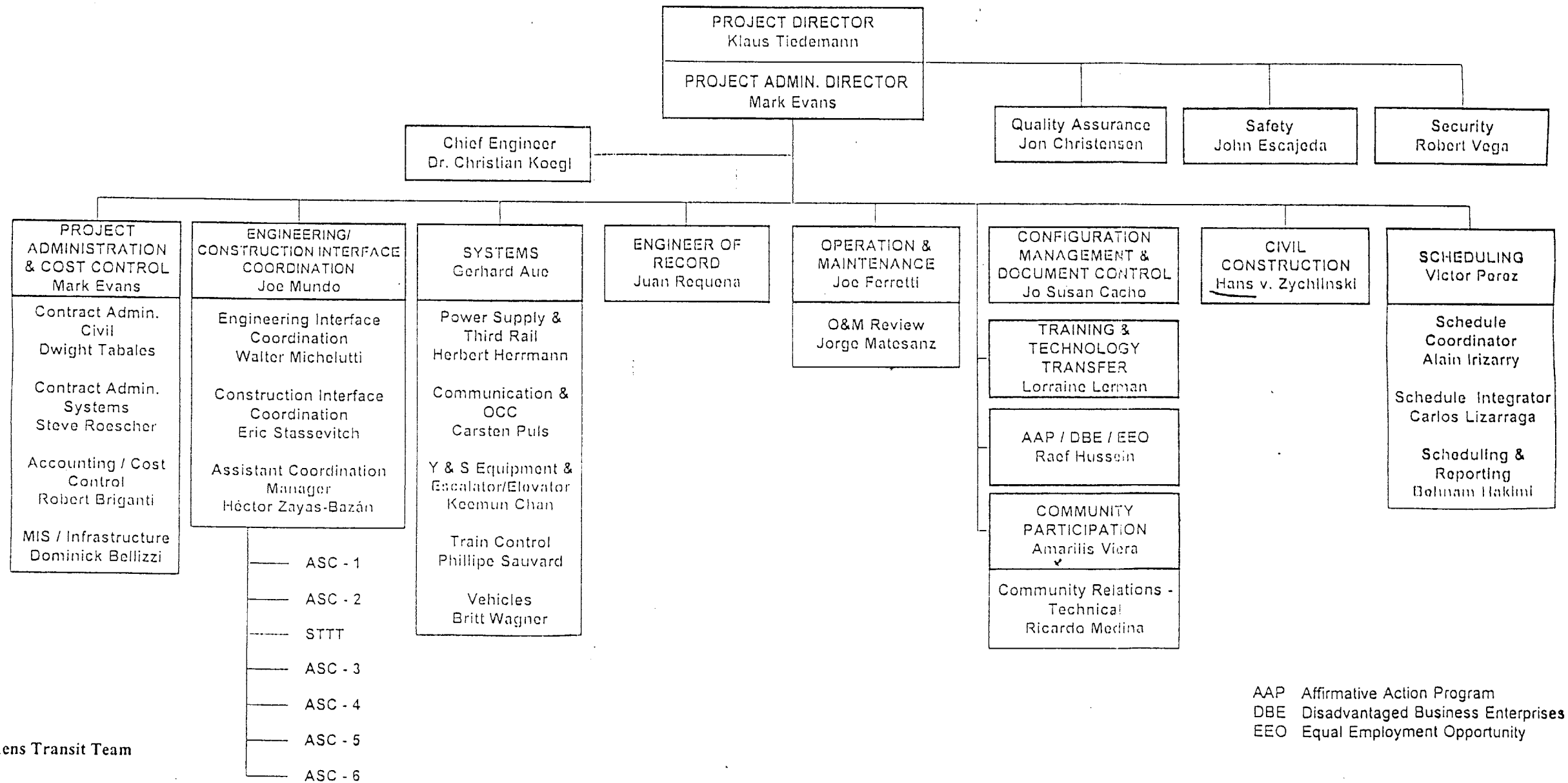


FIGURE 2-1

Siemens Transit Team Overall Project Management Organizational Chart



AAP Affirmative Action Program
DBE Disadvantaged Business Enterprises
EEO Equal Employment Opportunity

Siemens Transit Team

APPENDIX D:

EARLY PROJECT

PROCEDURE PROTOCOLS



TREN URBANO

CONTRACTOR RFI

PROTOCOL

TREN URBANO CONTRACTOR RFI PROTOCOL

RESPONSIBILITY OF: ORDER OF PROCESS:

CONTRACTOR	1. Submits Request For Information (RFI)
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CONTRACT MANAGER	2. Receives Contractor's RFI for review and date stamps the Design Submittal Document Form and the submittal. 3. Enters the submittal with the received date and a brief description into the RFI Log and Change Control System (CCS) 4. Indicates due date for return to Contract Manager. 5. Submits original of RFI to Document Control and retains one copy in Contract Manager files. 6. Issues remaining copies to the Support Team departments to review and answer. (Support Team Departments are: Technical Services, Quality Assurance, Financial, Legal and Project Control.)
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SUPPORT TEAM DEPARTMENTS	7. Support Team Department Manager(s) distributes RFI to Department Reviewer.
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DEPARTMENT REVIEWER	8. Reviews RFI and prepares response.
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CONTRACT MANAGER	9. Ensures all Support Team Departments assigned to respond have prepared answers. 10. The date the answers are received is recorded in the RFI log. 11. Reviews the answers to ensure a comprehensive and consistent response. 12. Prepares the written RFI response and sends it to the contractor, if the RFI has no Change Order implications (i.e. it does not affect the contract cost or schedule, nor does it have project-wide implications). If it has Change Order implications (i.e. it does affect the contract cost or schedule, or has project-wide implications) the Contract Manager reviews the answers with the Client's legal representative and the Project Manager to ensure a comprehensive and consistent response.
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TREN URBANO CONTRACTOR RFI PROTOCOL

RESPONSIBILITY OF: **ORDER OF PROCESS:**

CONTRACT MANAGER 13. When the definitive answer is established, the Contract Manager prepares the written RFI response for PRHTA to approve.

PRHTA 15. Reviews and dispositions (approved or not approved) response and returns to Contract Manager.

CONTRACT MANAGER 16. If approved by the PRHTA, the Contract Manager sends the written response to the contractor. If it is not approved, the response is rewritten and resubmitted to the PRHTA.

17. The RFI response return date to the contractor, the correspondence reference of the response and the indication that the RFI is "closed out" is recorded in the RFI log and CCS System



TREN URBANO

TREN URBANO

**CONTRACTOR DESIGN
SUBMITTAL**

PROTOCOL

TREN URBANO CONTRACTOR DESIGN SUBMITTAL PROTOCOL

RESPONSIBILITY OF: ORDER OF PROCESS:

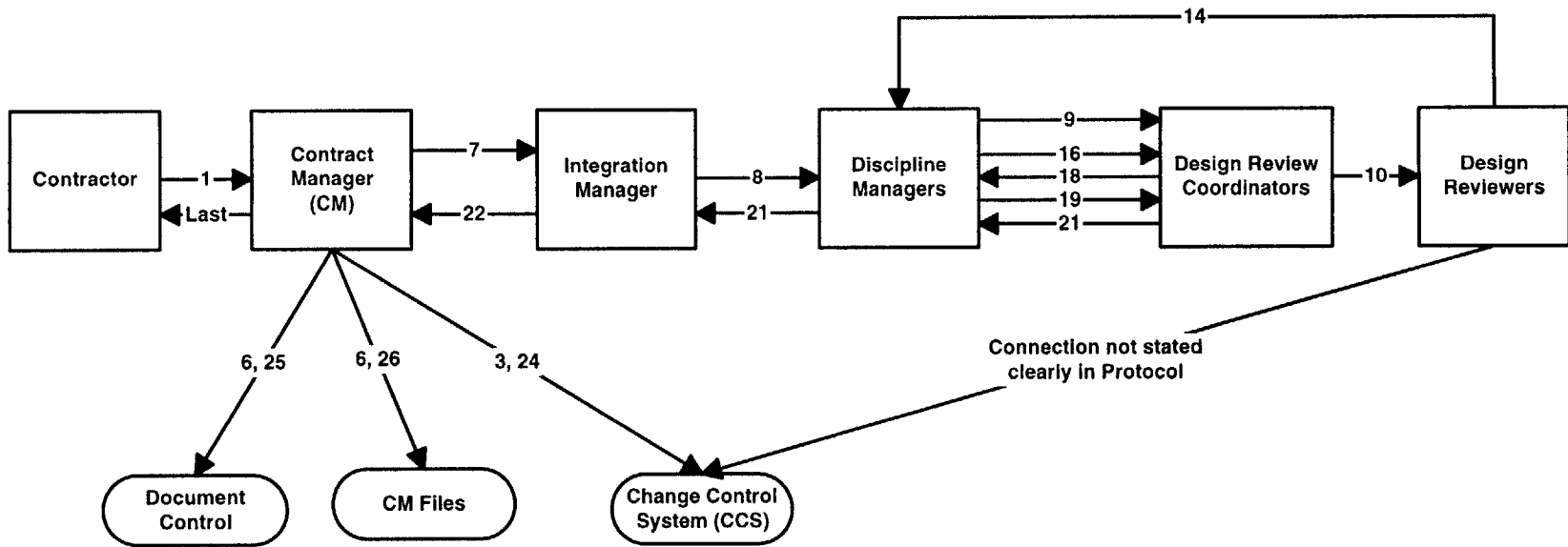
CONTRACTOR	1. Submits Designer approved design submittal
CONTRACT MANAGER	2. Receives Contractor's design submittal for review and date stamps the Design Submittal Document Form and the submittal. 3. Enters the submittal into the Change Control System (CCS) 4. Verifies if submittal is critical or not based on the Submittal Schedule 5. Indicates due date for return to Contractor 6. Submits one copy to Document Control and retains one copy in Contract Manager files. 7. Issues remaining copies to Integration Manager in Technical Services Department for review process.
INTEGRATION MANAGER	8. Distributes copies of the submittal to the applicable Discipline Manager(s).
DISCIPLINE MANAGERS	9. Distributes copies of the submittal to applicable Design Review Coordinators.
DESIGN REVIEW COORDINATORS	10. Distributes copies of the submittal to Design Reviewer(s) predetermined by the Discipline Manager
DESIGN REVIEWERS	11. Reviews scope of work and other Contract Documents for the contract being reviewed to determine design requirements. 12. Using the appropriate Design Review List(s) for Contractor Design Documents, reviews the contractor's submittal for conformance based upon the Contract Document requirements and fills out the Review List(s). 13. Marks the Design Documents in red to indicate the information requiring clarification and/or change, and completes the Contract Design Review Comment form (see attachment) for documenting all comments. Comments must be electronically entered on the Contract Design Review Comment form. 14. Submits review lists and comments to the Discipline Manager.

TREN URBANO CONTRACTOR DESIGN SUBMITTAL PROTOCOL

RESPONSIBILITY OF: ORDER OF PROCESS:

DISCIPLINE MANAGER	15. Reviews completed Contract Design Review Comment forms and Review Lists for accuracy and completeness, 16. Submits all documents and forms to Design Review Coordinator.
DESIGN REVIEW COORDINATOR	17. Reviews and consolidates the Design Reviewer Comments 18. Submits to Discipline Manager
DISCIPLINE MANAGER	19. Checks and signs off the review comments and returns to Design review Coordinator.
DESIGN REVIEW COORDINATOR	20. Completes Design Review Lists, including marked copies of the documents, resolves any differences between reviewers, notes redundant comments, and consolidates the comments into one set of comments. 21. Indicates status of design review on Design Document Submittal form, has the form signed off by the Discipline Manager and submits along with the consolidated list of comments, marked drawings and the Design Review Lists to the Integration Manager.
INTEGRATION MANAGER	22. Reviews Contract Design Review Comments and submits comments, Design Review Lists and marked documents to Contract Manager.
CONTRACT MANAGER	23. Reviews, signs and transmits Design Document Submittal Form and a letter of "Exceptions and Clarifications" along with the design review comments and marked documents to the Contractor. 24. Enters the transmittal date in the CCS. 25. Sends copy of documents to Document Control 26. Retains a copy of transmitted documents and the review lists in Contract file.

Design





TREN URBANO

**CONTRACTOR SUBMITTAL
(NON DESIGN)**

PROTOCOL

TREN URBANO CONTRACTOR SUBMITTAL PROTOCOL (NON DESIGN)

RESPONSIBILITY OF: ORDER OF PROCESS:

CONTRACTOR	1. Submits Contractor approved non design submittal
CONTRACT MANAGER	2. Receives Contractor's non design submittal for review and date stamps the submittal's transmittal. 3. Enters the submittal into the Change Control System (CCS) 4. Verifies if submittal is critical or not based on the Submittal Schedule 5. Indicates due date for return to Contractor 6. Submits one copy to Document Control and retains one copy in Contract Manager files. 7. Issues remaining copies to GMAEC Departments Heads based upon submittal type as defined in attached Submittal Distribution Matrix for review process.
DEPARTMENT DIRECTORS / QA & SAFETY MANAGERS	8. Distributes copies of the submittal to the applicable Discipline and Department Manager(s).
DISCIPLINE MANAGERS	9. Distributes copies of the submittal to applicable Review Coordinators. (Applies only to Technical Services Department.).
REVIEW COORDINATORS / DEPARTMENT DIRECTORS / QA & SAFETY MANAGERS	10. Distributes copies of the submittal to Reviewer(s) predetermined by the Discipline Manager (Applies only to Technical Services Department.). and Department Manager
REVIEWERS	11. Reviews scope of work and other Contract Documents for the contract being reviewed to determine Contract requirements. 12. Completes the Contract Review Comment form for documenting all comments. Comments must be electronically entered on the Review Comment form.
DISCIPLINE MANAGER	13. Reviews completed Contract Review Comment forms for accuracy and completeness. 14. Submits all documents and forms to Review Coordinator (Applies only to Technical Services Department.).

TREN URBANO CONTRACTOR SUBMITTAL PROTOCOL (NON DESIGN)

RESPONSIBILITY OF: ORDER OF PROCESS:

REVIEW COORDINATOR	15. Reviews and consolidates the Reviewer Comments (Applies only to Technical Services Department.). 16. Submits to Discipline Manager (Applies only to Technical Services Department.).
DISCIPLINE MANAGER	17. Checks and signs off the review comments. 18. Returns to Review Coordinator. (Applies only to Technical Services Department.).
REVIEW COORDINATOR / DEPARTMENT DIRECTORS / QA & SAFETY MANAGERS	19. Resolves any differences between reviewers, notes redundant comments, and consolidates the comments into one set of comments (Applies only to Technical Services Department.).
INTEGRATION MANAGER / DEPARTMENT DIRECTORS / QA & SAFETY MANAGERS	20. Reviews comments and submits to Contract Manager. (Applies only to Technical Services Department.).
CONTRACT MANAGER	21. Reviews, signs and transmits a letter of "Exceptions and Clarifications" along with the review comments and marked documents to the Contractor. 22. Enters the transmittal date in the CCS. 23. Sends copy of documents to Document Control 24. Retains a copy of transmitted documents and the review lists in Contract file.

**TREN URBANO CONTRACTOR FIXED FACILITIES
SUBMITTAL (NON DESIGN) DISTRIBUTION MATRIX**

REVIEWERS⇔	Project Director	Project Manager	Systems & Operations	Construction Director	ROW PM Group	Project Admin.	Technical Services	Project Controls	Quality Assurance	Safety & Security	Community Relations	Training & Technology	STTT CM	Archaeological Paleontological	Palmer & Dodge (Legal)	ITEM #
	Dr. Rafael Jiménez	Geoffrey Fosbrook	Randy Altshuler	José Diaz Zayas	Rudy Lewy	R. Pittman B. Leavitt	Gil Gardner	Richard Hoar	Tim McClure	Carlos Campillo	Carmen Canino	Lydia Mercado	Robert Parsons	Dr. A. Gus Pantel	D. Rogers J. Whelan	↓
⇓ SUBMITTALS																
1. Organization and Management Plan	X	✓	X	X			X	X	X	X	X	X	X		X	1.
2. CPM Schedules & Updates				✓ hc			X hc	✓ *					X			2.
3. Work Plan Schedule				X				✓ *					X			3.
4. Monthly Progress Format & Reports, Progress schedule, schedule status report, and draft payment invoice	X	X	X	X			X	✓	X				X		X	4.
5. Payment Invoice	✓	✓		✓				✓								5.
6. Submittal List				X			X	✓	✓							6.
7. Submittal Schedule & Schedule of Values				X				✓								7.
8. Record Documentation, Record Documents Log and Inspection Records				✓				✓	X							8.
9. Quality Plans & Quality Records Index				✓					✓							9.
10. Construction Safety & Security Plans and Procedures				X			X	X	X	✓						10.
11. Record of Design Reviews Fixed Facilities				X			✓	X					X			11.
12. Contract Directory	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	12.
13. CADD Management Plan				X			✓	X	X							13.
14. Weekly Payrolls				X				X								14.
15. DBE Quarterly Reports	✓	X		X		X		X							X	15.
16. Field Survey Control Point Maintenance Plan				X	X		✓	X								16.
17. Environmental Plans and Reports				X			✓	X								17.
18. Maintenance of Traffic Plan				X			✓	X			X					18.
19. Lighting System Maintenance Schedule				X			✓	X					✓			19.
20. Contractor's Control Inspection and Testing Firms (Qualifications)				✓			✓	X	✓							20.
21. Location of Relocated Utilities				X	X		X	X								21.
22. Survey of Encroachments				X	X		X	X			X					22.
23. Permit Applications and Approvals				X			X	X								23.
24. Final Geotechnical Report				X			✓	X								24.
25. Drainage Report				X			✓	X								25.
26. Station and Site Equipment Interface Alignment Control and Installation Procedure			X	X	X		✓	X								26.

Notes: 1. The originals of all correspondence and a copy of the associated Contractor submittals, with the exception of schedules, must be routed to Document Control.

2. A copy of all correspondence and its associated submittal(s) must be retained in the Contract Manager's file.

Legend: * = Original plots & electronic files hc = hard copy
X = For information ✓ = Review and/or Approval

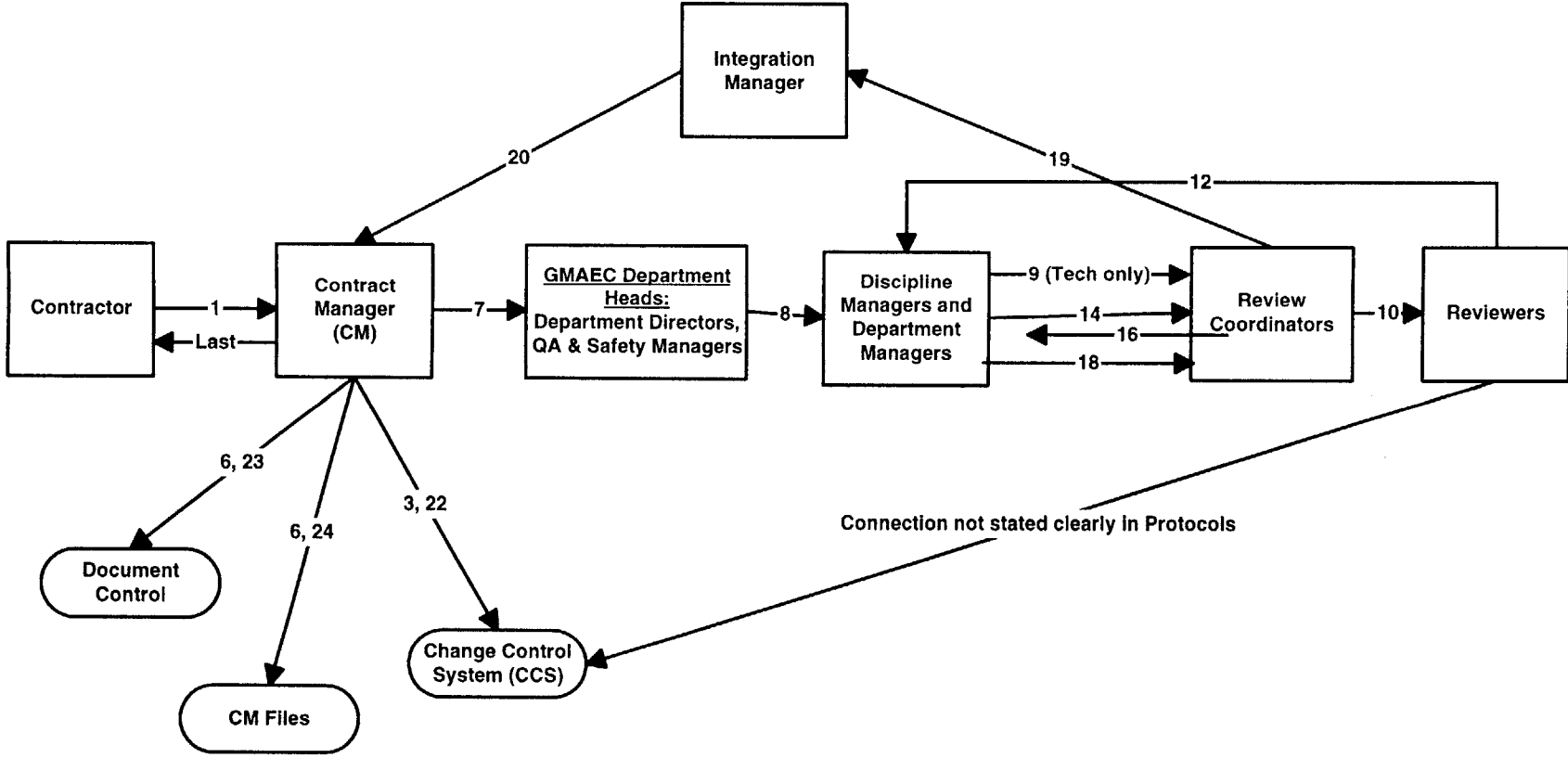
**TREN URBANO CONTRACTOR FIXED FACILITIES
SUBMITTAL (NON DESIGN) DISTRIBUTION MATRIX**

REVIEWERS⇔	Project Director	Project Manager	Systems & Operations	Construction Director	ROW PM Group	Project Admin.	Technical Services	Project Controls	Quality Assurance	Safety & Security	Community Relations	Training & Technology	STTT CM	Archaeological Paleontological	Palmer & Dodge (Legal)	ITEM #
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⇓ SUBMITTALS																
27. Health and Safety Plan and Manager Qualifications				X			✓	X		✓						27.
28. Photographs, Video, Slides (Other than those in Monthly Progress Report)				X			X	X								28.
29. Asset Management Forms			✓	X				X					X			29.
30. Layout of Construction Site				X	X		X	X			X					30.
31. Archaeological and Paleontological Mitigation Program and Qualifications				X				X						✓		31.
32. Hazardous Materials Health and Safety Plan				X			✓	X		✓						32.
33. Field Office Site Plan				✓			X	X								33.
34. Operation and Maintenance Data format and Manual			✓	X			✓	X				X	X			34.
35. Demolition Schedule				✓			X	X			X					35.
36. Dewatering Fluid Treatment (DFT) Basis of Design Engineering Report, Groundwater Analyses and NPDES Compliance Reports				X			X	X								36.
37. Leak Survey Report				X			X									37.
38. Construction / Installation Test and Inspection Reports				X			X	X	X							38.
39. Construction / Installation Test and Inspection Procedures				✓			✓	X	✓							39.
40. Submittals to Utility Agencies				X			X	X								40.
41. Finish Hardware Masterkeying plan			X	X			✓	X					X			41.
42. Electrical Demolition Schedule				X			✓	X								42.
43. Vibration Isolation and Restraining Devices List of equipment			X	X			✓	X		✓			X			43.

Legend: * = Original plots & electronic files hc = hard copy
X = For information ✓ = Review and/or Approval

Non-Design

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APPENDIX E:

DIAGRAMS FROM

MANUAL OF PROCEDURES

REVIEW OF CONTRACTOR DESIGN SUBMITTAL

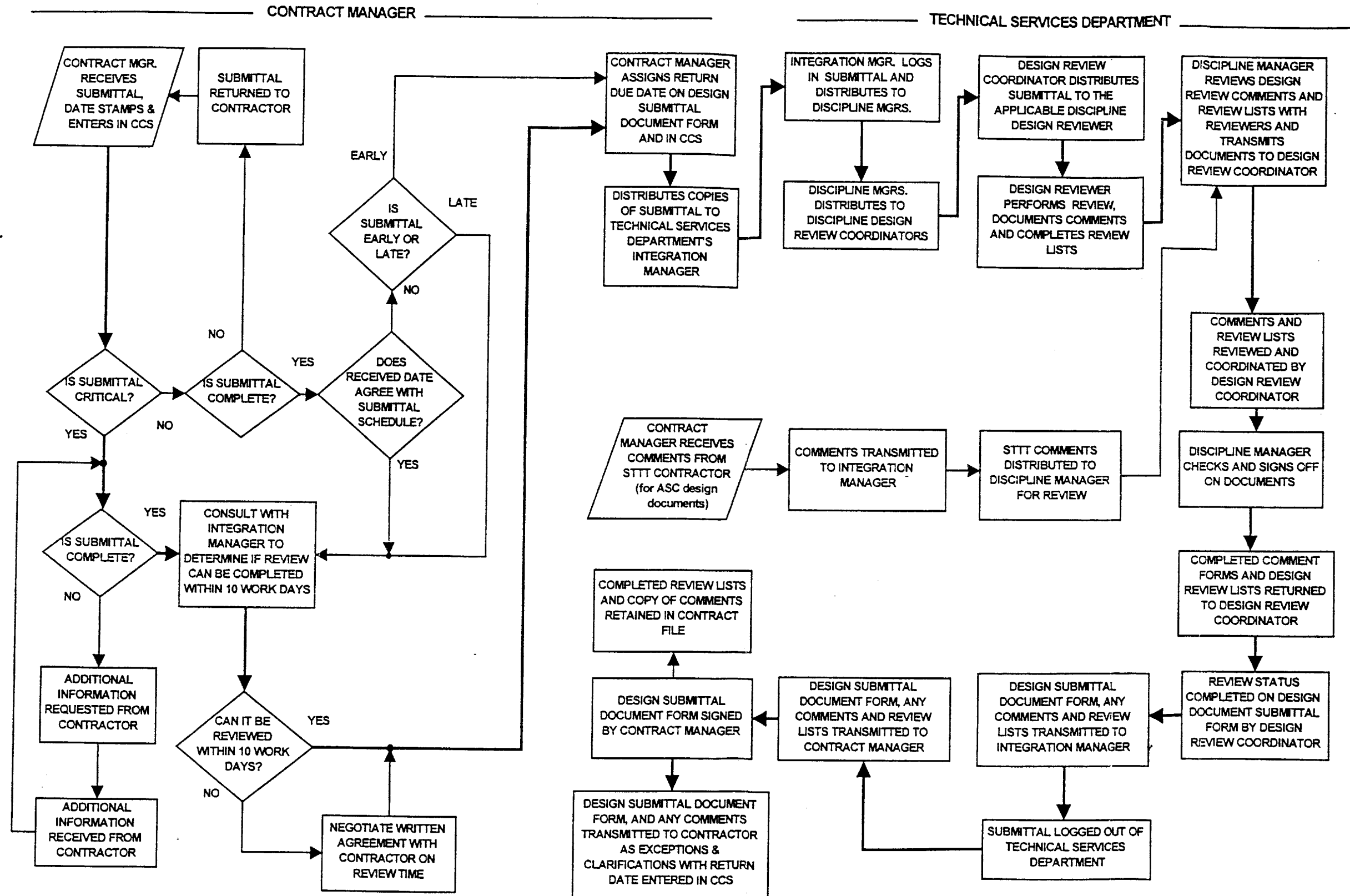
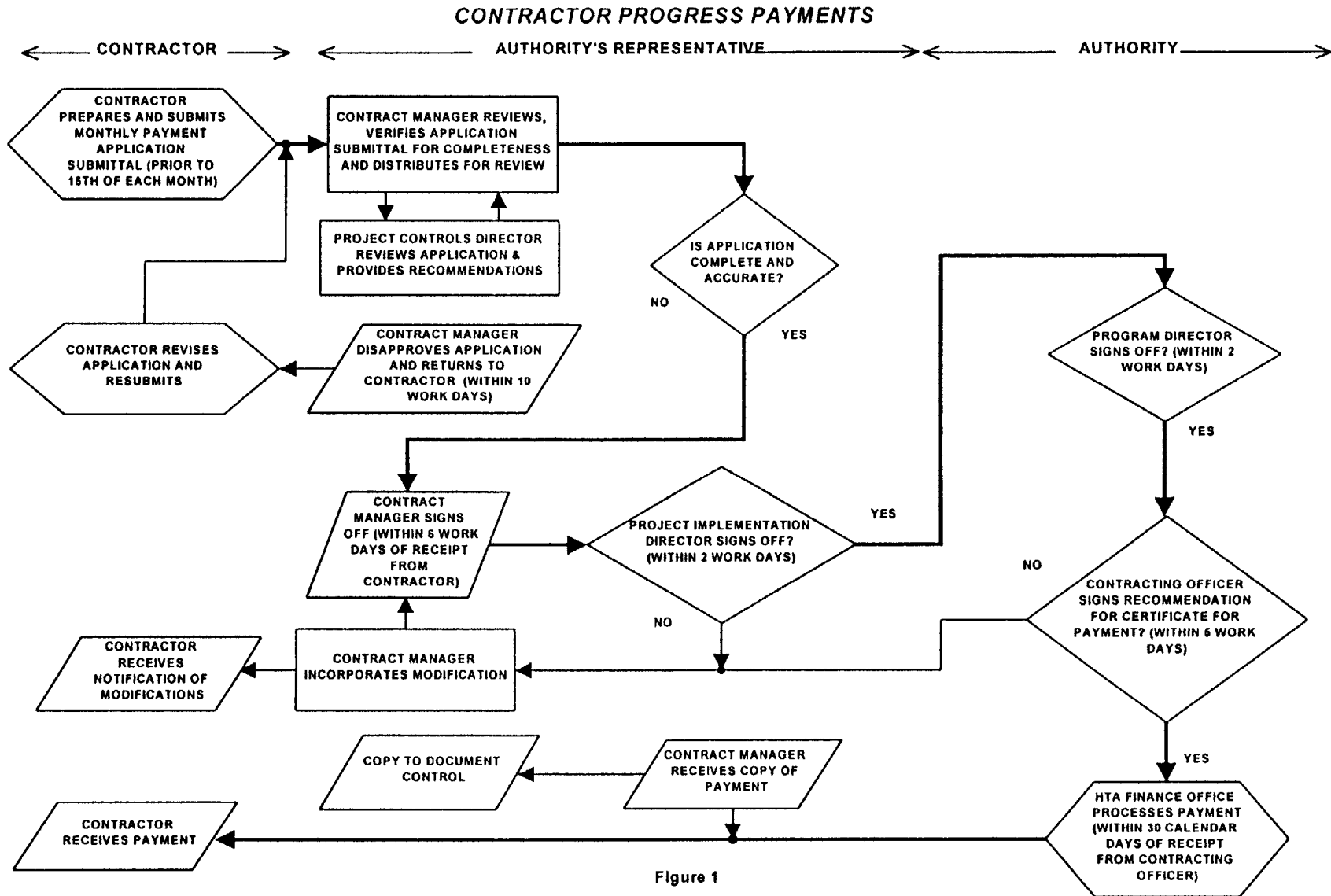
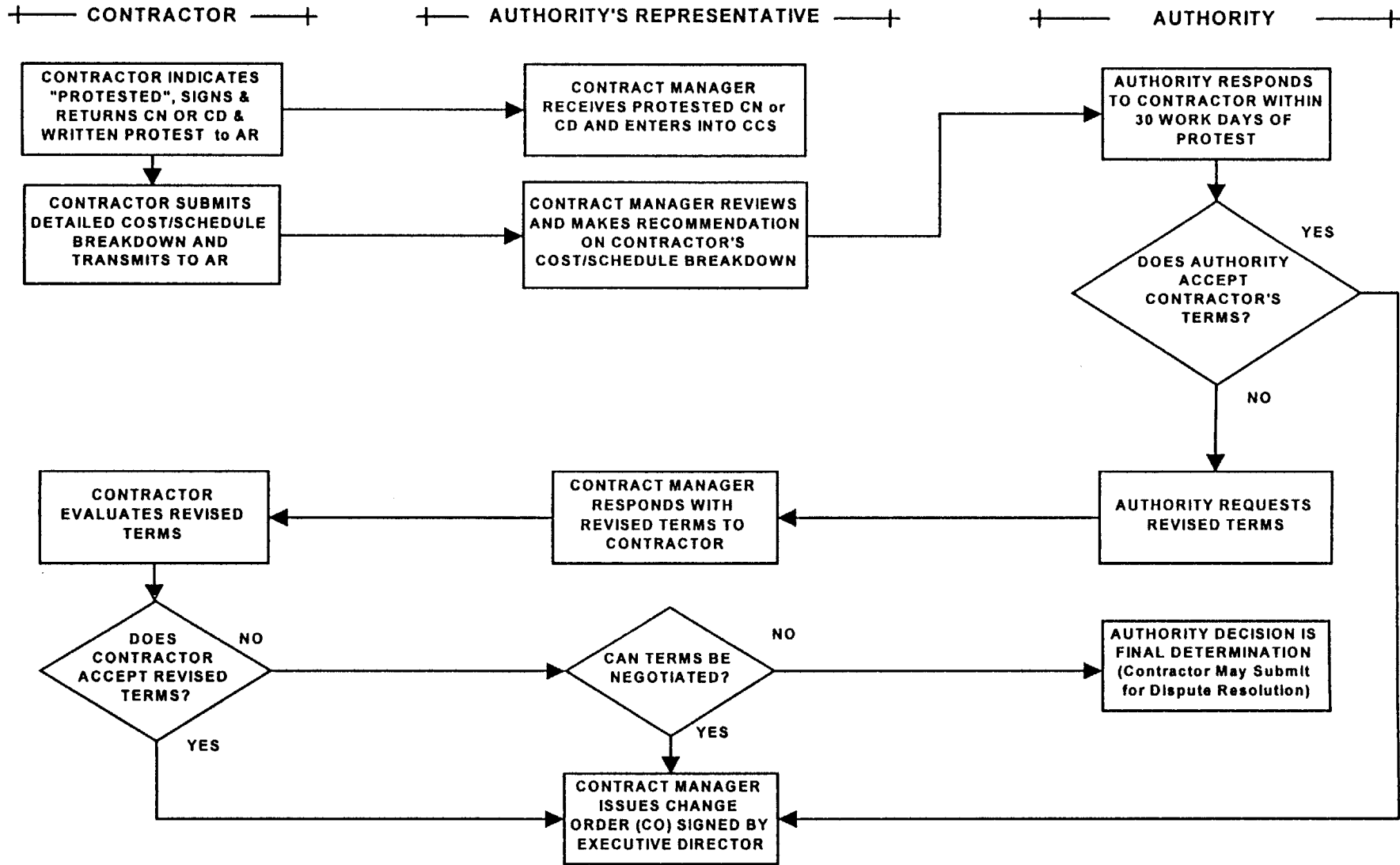


FIGURE 2



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CONTRACTOR CHANGE PROTEST



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FIGURE 1

TREN URBANO CONTRACT CHANGE CONTROL
CHANGE ORDER PROCESS

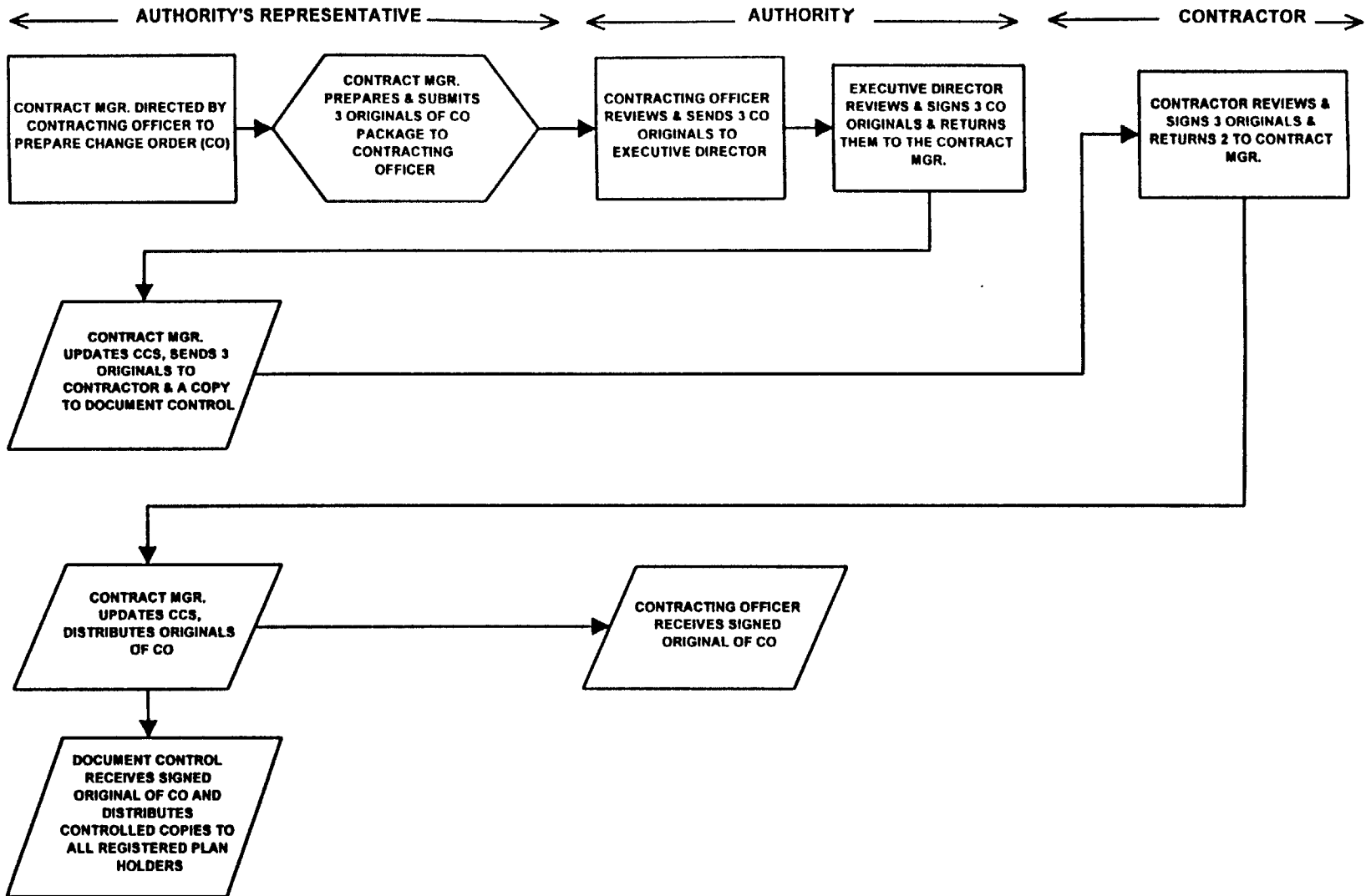


FIGURE 4

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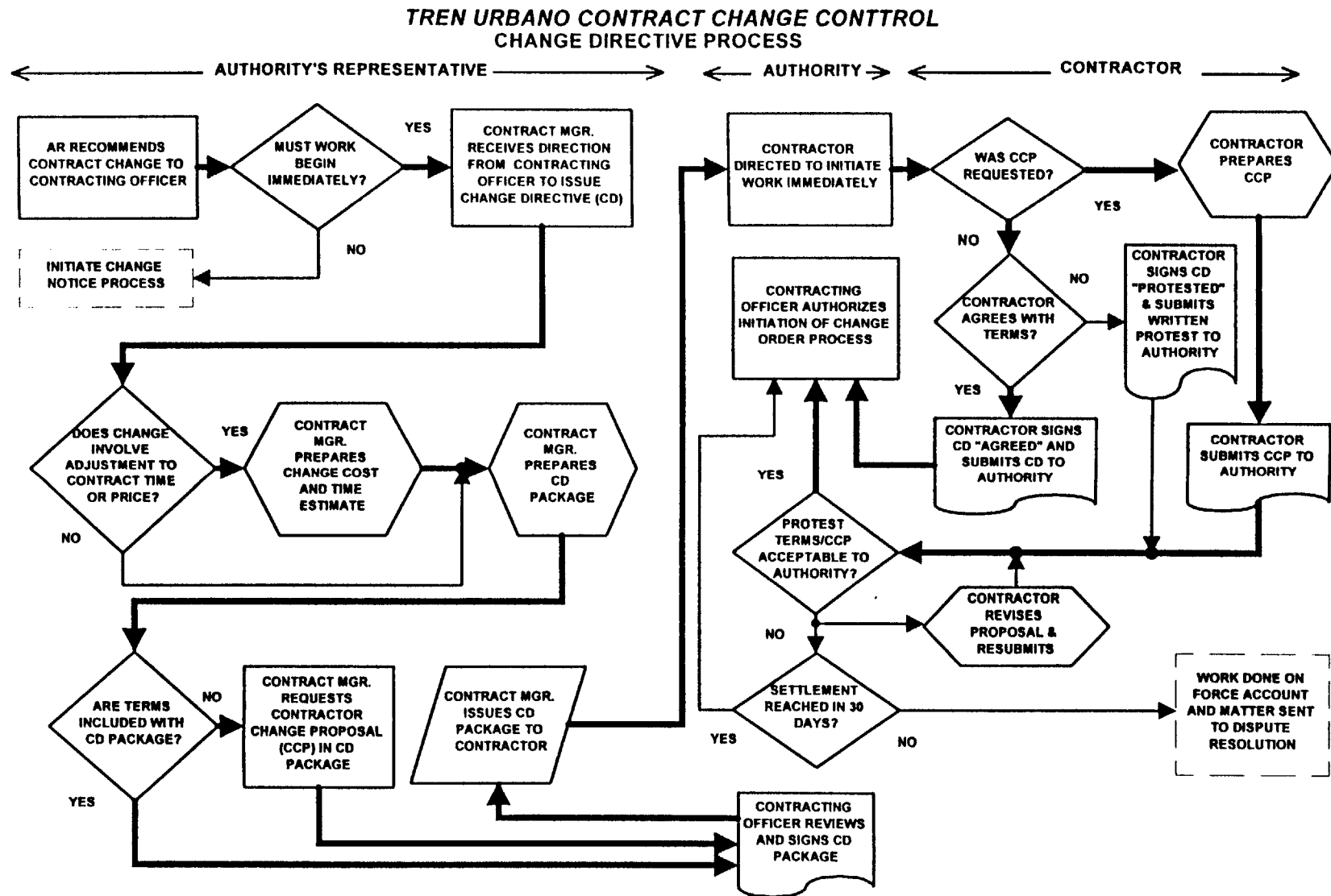


FIGURE 3

TREN URBANO CONTRACT CHANGE CONTROL CHANGE NOTICE PROCESS

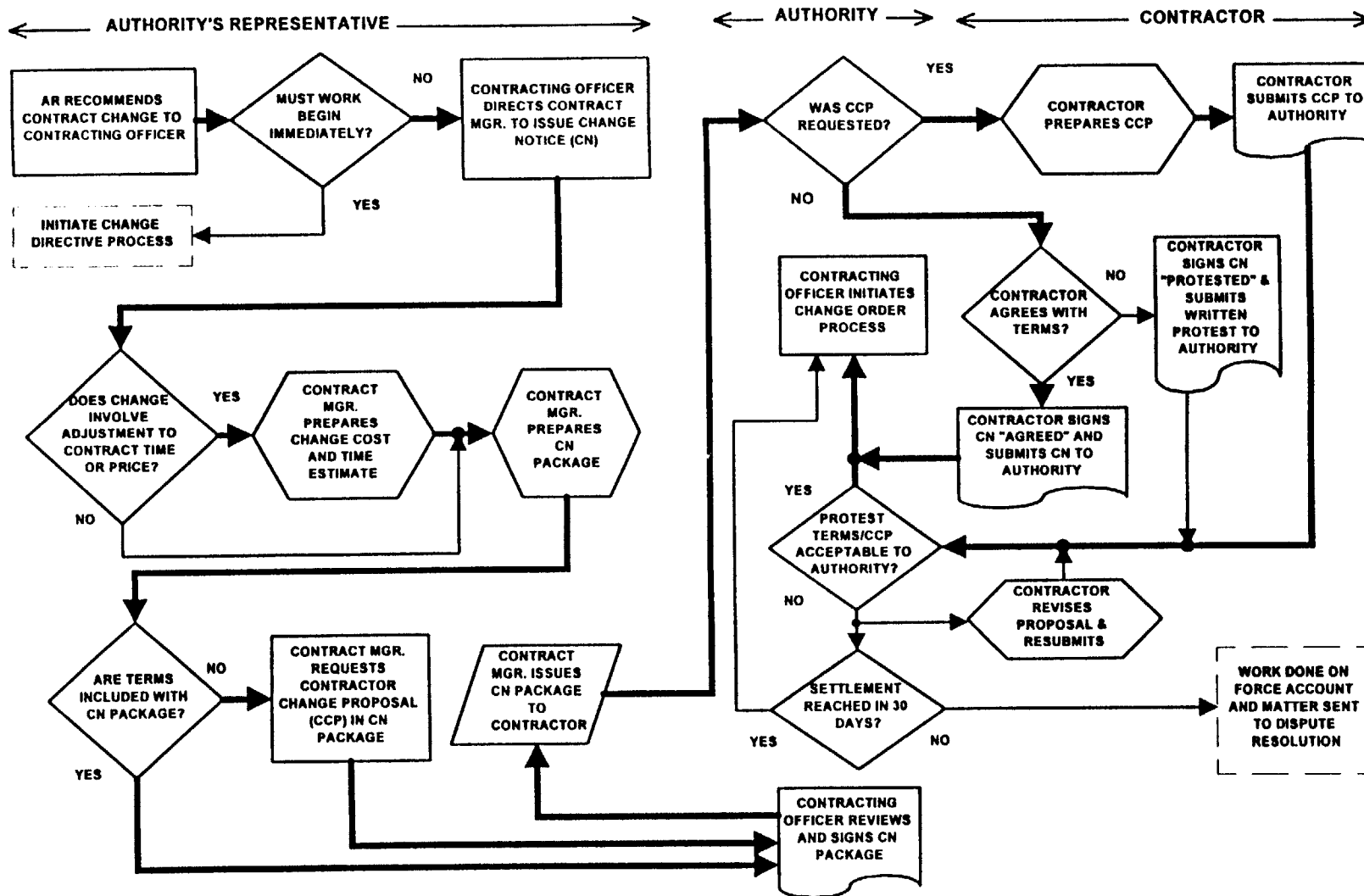
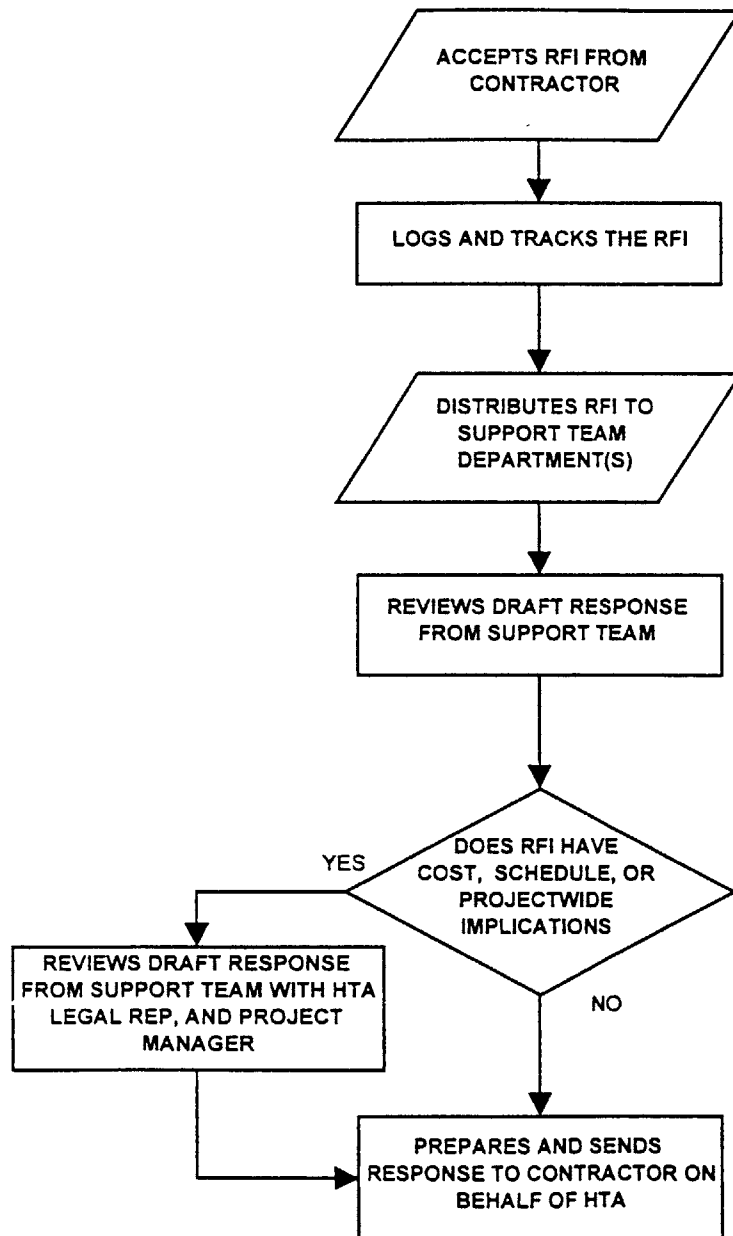


FIGURE 2

REQUEST FOR INFORMATION PROCESS

CONSTRUCTION PHASE

CONTRACT MANAGER



AUTHORITY REPRESENTATIVE'S INSPECTION AND TEST

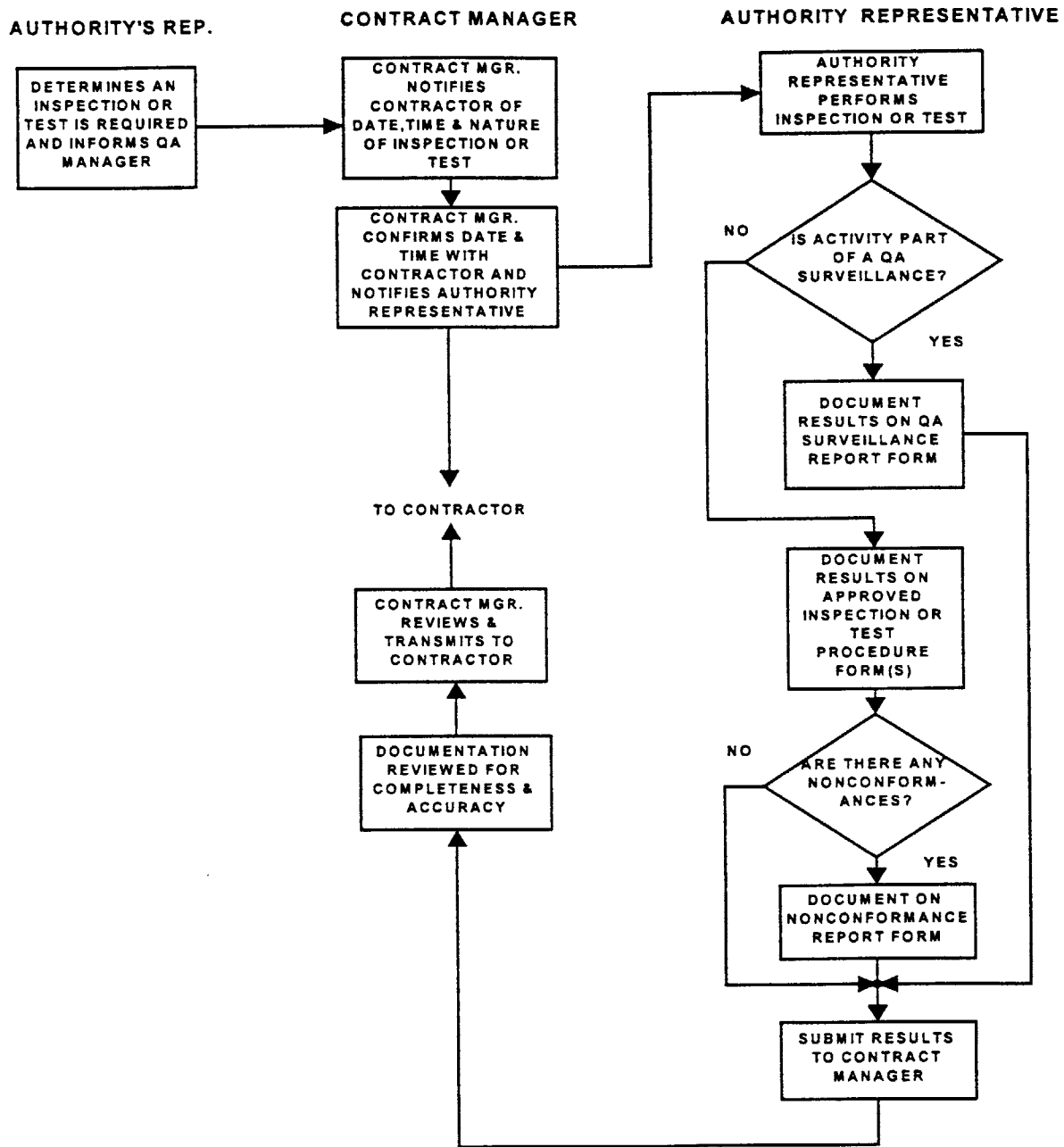


FIGURE 1

DESIGN REVIEW COORDINATION INTERFACES

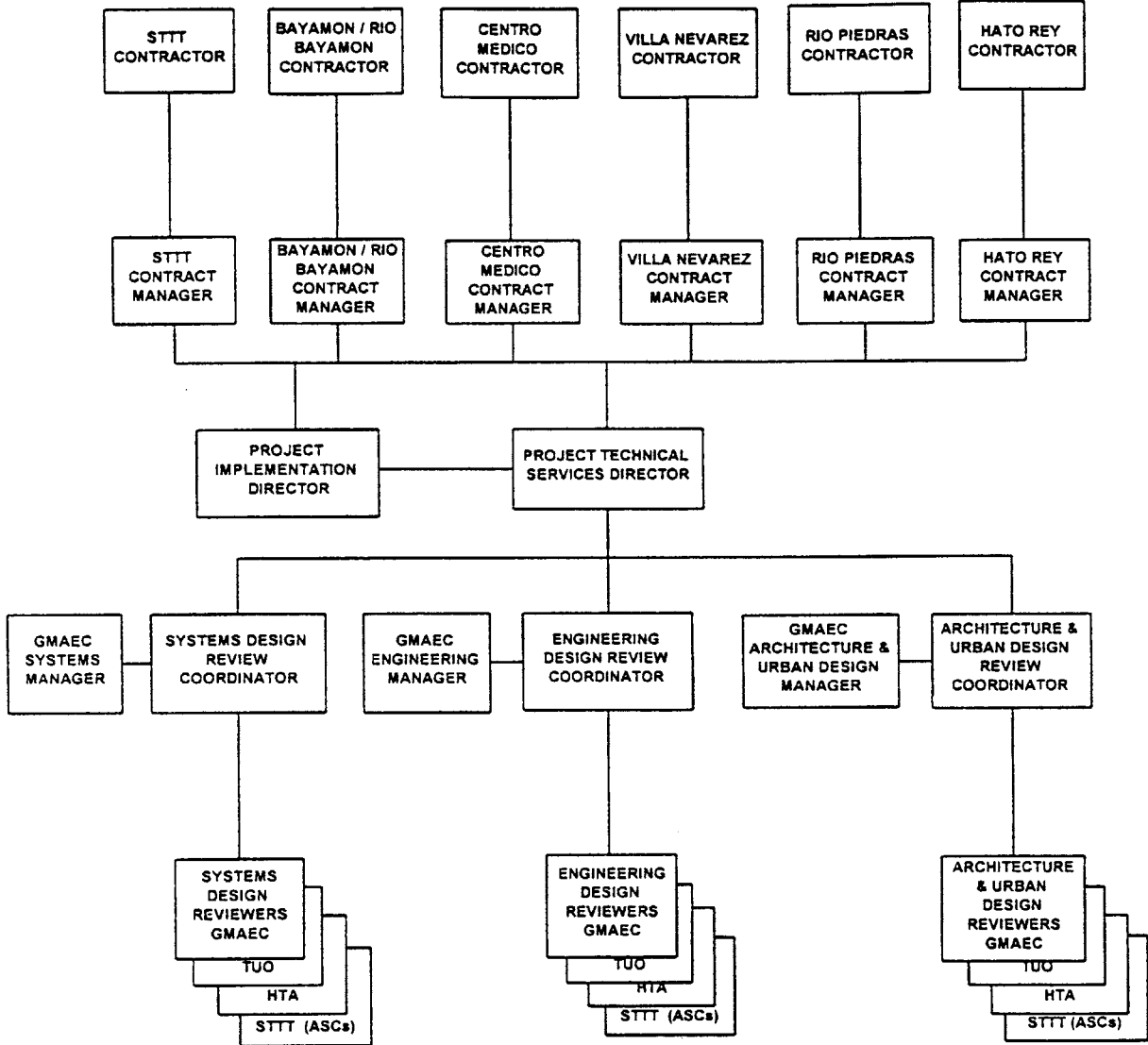


FIGURE 1

APPENDIX F:

DOCUMENTATION FOR
SYSTEM DYNAMICS
PARTNERING MODEL

- (01) Benefits of Duplication =

$$\text{MIN}(2000, (\text{MAX}(1, (\text{Effective Partnering}))^2 * (\text{"Turnkey Contractor as Part-Owner"}^2) * \text{Knowledge Transfer}))$$
Units: Dimensionless

The benefits of duplication is the amount that a project benefits when there are two or more parties performing duplicating tasks. The benefits include better quality due to double check and better motivation due to competition. On the flip side (lower values) It can also increase time coordinating multiple functions and adversarial relationships. Transfer of knowledge and turnkey contractor as part owner can increase the benefits of duplication.

- (02) Certainties in Project =

$$\text{LACK of mix of Cultures} * \text{Experience with Delivery Method} * \text{LACK of Project Technical Difficulty}$$
Units: Dimensionless

The certainties in a project is defined in this model by the number of cultures, experiences with delivery method and technical difficulty of the project.

- (03) Change in Effectiveness of Champions =

$$(\text{MAX}(1, \text{MIN}(2000, \text{Delegation of Authority} * \text{MAX}(1, \text{Effective Partnering}) / \text{Change time})) - 1000)$$
Units: Dimensionless/Month

In the equation above a thousand is subtracted in the above equation because this is the worst case scenario. The reason for this is that this model have stocks increase and decrease with positive and negative flows into them. The stock can only decrease with negative numbers, but the rest of the model is positive for simplicity of the equations. Thus, for the lowest possible number, 1, of the values inputted to the flows, this would be the worst case scenario and correspond to -1000. This variable is the amount that either increases (positive value) or decreases (negative value) the Effectiveness of Champions. The change (up or down) of the effectiveness of the champions is affected by partnering and delegation of authority.

- (04) Change in Effectiveness of Claim Management =

$$\text{MAX}(1, \text{MIN}(2000, ((\text{MAX}(1, \text{Effective Partnering} * 5))^2 * \text{MAX}(1, \text{LACK of Site Transfer Conflicts}) * \text{Conflict Management} / \text{Change time})) - 1000)$$
Units: Dimensionless/Month

This is the amount that either increases (positive value) or decreases (negative value) the Effectiveness of Claim Management. Partnering is most important as it can prevent claims and is hence multiplied twice above in the equation. Few conflicts at site transfer can also reduce claims and make claim management better. Also, a conflict management plan can also improve claim management. A thousand is subtracted in the above equation (as all other change equations) because this is the worst case scenario. The stock can only decrease with negative number, but the rest of the model is positive for simplicity of the equations. Thus, for the lowest possible number, 1, of the values inputted, then the worst case scenario is present.

(05) "Change in Micro- Management" =

$$\text{MAX}(1, \text{MIN}(2000, (\text{Delegation of Authority}) / \text{Change time})) - 1000$$
 Units: Dimensionless/Month

In the equation above a thousand is subtracted in the above equation because this is the worst case scenario. The reason for this is that this model have stocks increase and decrease with positive and negative flows into them. The stock can only decrease with negative numbers, but the rest of the model is positive for simplicity of the equations. Thus, for the lowest possible number, 1, of the values inputted to the flows, this would be the worst case scenario and correspond to -1000. The change refers to the amount that either increases (positive value) or decreases (negative value) the Lack of Micro-Management. The change is affected by the amount of authority delegated in one unit of time.

(06) Change in Partnering =

$$\text{MAX}(1, \text{MIN}(2000, \text{Initial Enthusiastic Meeting} * \text{"Follow-up Meetings"} * \text{Continuous Partnering Evaluation} / \text{Change time} * \text{MIN}(1500, \text{LACK of Struggle for Control}))) - 1000$$
 Units: Dimensionless/Month

This is the amount that either increases (positive value) or decreases (negative value) the Effectiveness of Partnering. It depends on the partnering effort (initially and follow-up partnering meetings with evaluations) and the struggle for control in the project that could decrease partnering because when parties are competing and struggle with each other they are less likely to work in a cooperate manner. This equation, like other change equations have -1000 subtracted to make the worst case (one for other variables) negative.

- (07) Change in Site Transfer Conflicts =

$$\text{PULSE}(3,10) * (\text{MIN}(2000, (\text{LACK of Confusion in Organization} * ((\text{MAX}(1, \text{Effective Partnering}))^2) * \text{Conflict Management} / \text{Change time})) - 1000)$$
Units: Dimensionless/Month

This is the amount that either increases (positive value) or decreases (negative value) the Lack of Site Transfers. The likelihood of site transfer conflicts depends on partnering (twice as much), confusion in the organization and an action plan for the transfer. A thousand is subtracted in the above equation (as in all other "change" equations) because this makes a the worst case scenario negative. The stock can only decrease with negative number, but the rest of the model is positive for simplicity of the equations. Thus, for the lowest possible number, 1, of the values inputted, then the worst case scenario is present. Note also that the site transfer does not occur until year 3 and therefore the value of Lack of Site Transfer Conflicts stays unchanged for the first 3 years.

- (08) Change time =
1
Units: Month
This is the unit of time (1 month) that changes are measured in.

- (09) Conflict Management =

$$\text{MAX}(1, \text{Effectiveness of Champions}) * \text{MAX}(1, \text{"LACK of Micro-Management"}) * \text{Specific Action Plan} * (\text{MAX}(1, \text{Effective Partnering}))^2$$
Units: Dimensionless

Conflict management is a combination of a specific action plan with partnering, champions and lack of micro-management. These variables aid setting a specific plan for how the deal with conflicts. Note, however, conflict management in this model refers to how good the plan is for resolving conflicts, NOT how well they are actually resolved, nor does the plan prevent conflicts.

- (10) Continuous Partnering Evaluation =
1
Units: Dimensionless

This measures thoroughness of the partnering evaluations. Evaluations of the partnering efforts are typically spread throughout the project and can give an indication if partnering needs to get back on track. This variable improves partnering in

the sense that it keeps the partnering program (defined in initial and follow-up meetings) on track.

- (11) Delegation of Authority =
$$\text{MIN}(2000, \text{MAX}(1, \text{Effectiveness of Employees} * \text{Certainties in Project} * \text{LACK of Struggle for Control}))$$

Units: Dimensionless

This is the amount that top managers give middle and lower level managers more authority responsibility and control. Managers delegate more with more certainties, more effective employees and less struggle for control in the organization.

- (12) Education =
1
Units: Dimensionless
Education in partnering, delivery method, project technical issues, cultures can improve the overall experience of employees.

- (13) Effective Claim Management = INTEG (
$$\text{SMOOTH}((\text{Change in Effectiveness of Claim Management})/10, 2), 1)$$

Units: Dimensionless
The effectiveness of claim management is how effective claims can be prevented and if claims do occur, how well can they be resolved.

- (14) Effective Partnering = INTEG (
$$\text{Change in Partnering}/10, 1)$$

Units: Dimensionless

The effectiveness of partnering is how well parties work together in a collaborative manner towards common objectives for the overall good of the project that benefits all parties in the end.

- (15) Effectiveness of Champions = INTEG (
$$\text{Change in Effectiveness of Champions}/10, 1)$$

Units: Dimensionless

The effectiveness of champions is how effective the project participants are in championing the objectives of the project and keeping focus in the project.

- (16) Effectiveness of Employees =
$$\text{MIN}(2000, \text{MAX}(1, \text{Efficiency of top Management} * \text{Experience of Employees} * \text{LACK of Confusion in Organization} * \text{Benefits of Duplication}))$$

Units: Dimensionless

The effectiveness of employees is how well they do their job. It depends on how they are managed by top management, their experience, the lack of confusion in the organization and the benefits of duplication, especially the benefit of fewer adversarial relationships that could occur due to duplication.

- (17) Efficiency of top Management =

$$\text{MAX}(1, \text{MIN}(2000, \text{MAX}(1, \text{"LACK of Micro-Management"})))$$
 Units: Dimensionless

Micro-management can limit efficiency because top managers have too many tasks and issues to resolve and thus creates bottlenecks in the organization. Because of the numerous issues the top management has to deal with, they will not focus on proactive tasks such as setting policies and procedures. Also managers tend to get overworked and the quality of decisions may decline.

- (18) Experience of Employees =

$$\text{Education} * \text{Knowledge Transfer}$$
 Units: Dimensionless
 Education in partnering, delivery method, project technical issues, cultures can all help the overall experience of employees.

- (19) Experience with Delivery Method =

$$1$$
 Units: Dimensionless
 The number of times the current delivery of the project has been used before. A one would indicate the current project.

- (20) FINAL TIME = 10
 Units: Year
 The final time for the simulation.

- (21) "Follow-up Meetings" =

$$30 * \text{PULSE}(1.5, 10) + 1 * \text{PULSE}(0, 1.5)$$
 Units: Dimensionless

Effectiveness of follow-up partnering meetings is how well parties are able to form cooperative communication paths depending on set objectives. Effective meetings also means that they are easily implementable. The meetings and their results occur from the first year and a half until the end of the project.

- (22) Initial Enthusiastic Meeting =
 $1000 * \text{PULSE}(0,1.5) + 1 * \text{PULSE}(1.5,10)$
 Units: Dimensionless

The effectiveness of initial meetings is how well parties are able to form cooperative communication paths and defining common objectives. Effective meetings also means that they are easily implementable. The initial meetings and their results occur during the first year and a half.

- (23) INITIAL TIME = 0
 Units: Year
 The initial time for the simulation.

- (24) Knowledge Transfer =
 $\text{MAX}(1, \text{MIN}(2000, \text{MAX}(1, \text{Effective Partnering})))$
 Units: Dimensionless
 This is the transfer of knowledge between the parties in the project.

- (25) LACK of Confusion in Organization =
 $\text{MIN}(2000, \text{MAX}(1, \text{Certainties in Project} * (\text{MAX}(1, \text{Effectiveness of Champions}))^2 * \text{"Turnkey Contractor as Part-Owner"}^2))$
 Units: Dimensionless

Confusion in the project is the level that project participants are unsure of how the project is organized and procedure go. More certainties, effective champions for objectives and a unified management team with the turnkey contractor as part owner can all help alleviate confusion in the organization.

- (26) "LACK of Micro-Management" = INTEG (
 $\text{SMOOTH}(\text{"Change in Micro- Management"}/10, 0.2),$
 1)
 Units: Dimensionless

The level of Micro-Management is the level of the number issues that get resolved by upper management that could be resolved at lower levels. In other words, the amount that top manages manage small details. This variable has "Lack of " micro-management, thus, higher values for this variable indicate less small issues at top management.

(27) LACK of mix of Cultures =
1

Units: Dimensionless

A low number would mean many cultures, high value means few cultures. Cultures in this model can mean ethnic, corporate and/or professional cultural differences.

(28) LACK of Project Technical Difficulty =1
Units: Dimensionless

This is the level of simplicity of the technical aspects of the project

(29) LACK of Site Transfer Conflicts =
INTEG (SMOOTH(Change in Site Transfer Conflicts/3.2,5),1)
Units: Dimensionless

When the site is transferred from one contractor to another, conflicts that may have accumulated throughout the project may explode. This variable has "Lack of "Site Transfer conflicts, thus, higher values for this variable indicate less conflicts.

(30) LACK of Struggle for Control =
LACK of Confusion in Organization
Units: Dimensionless

The more confusion in the organization, the more people will tend to try to take complete control in order to do the functions that needs to be done. As all parties cannot have complete control or the areas of control that people tend to take may overlap, there results a struggle for control. Ultimately control, and hence authority, will migrate to the top management. Therefore struggle for control decreases the delegation of authority.

(31) SAVEPER =
TIME STEP

Units: Year

The frequency with which output is stored.

(32) Specific Action Plan =
2*PULSE(0,5)+3*PULSE(5,10)

Units: Dimensionless

The action plan for site transfer and claim management include allocation of responsibility as well as processes to avoid conflicts.

(33) TIME STEP = 0.03125

Units: Year

The time step for the simulation.

(34) "Turnkey Contractor as Part-Owner" =

MAX(1,MIN(2000,MAX(1,Effective Partnering)))

Units: Dimensionless

Partnering can enable the turnkey contractor to act more like an owner and less like a pure contractor because the turnkey contractor would be more connected to the owner. Effective partnering has the element that all parties work together to help each other. The turnkey contractor will with effective partnering) help the owner out and act more in the owner's interests in mind.