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Integrating Light Rail Transit into Traditional Bus Systems

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“Integration of Light Rail Transit in a Traditional Bus City:
A Case Study of the DART Experience”

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ABSTRACT

This document identifies those dynamics that facilitate a city's addition of light rail as a successful component of its urban system, with success deemed to be opening on schedule with minimal start-up issues. The study examines several new systems and queries the tasks undertaken prior to initiation of service. The similarities are iterated based on the research findings leading to a defined order for including light rail transit in a previously all bus system with a large portion of attention to role of the operators.

EXECUTIVE SUMMARY

More than thirty cities in the United States were identified that are adding new rail components establishing the need to document the protocol for transitioning from all bus to bus/light rail transit (Appendix 2). As of December 2006, there were 20 cities with a light rail system in existence (APTA, 2006). The majority operate under the same agency as the bus system. To properly document the components of success, as well as to describe the process of transition from all bus to bus/light rail system, an assessment was performed. It is the objective of this report to document the protocol for transition from all bus to bus and light rail based on the research.

A sequential start-up process, particularly the inclusion of visiting and training on an in-service system, has helped agencies start on time, ensuring a well-working product. The right personnel must be in place and properly trained in system operation. The research was not extensive enough to fully develop the protocol, but rather sets the framework for such a protocol. Additional research is necessary to answer the second tier of issues raised by this work. A self-assessment by agencies who have added light rail to their fleets would also be valuable.

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DISCLAIMER

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INTRODUCTION

Purpose

The purpose of this document is to identify those dynamics that facilitate a city's addition of light rail as a successful component of its urban system; success was considered to opening as scheduled with few start-up problems. The study examines several new systems and queries the tasks undertaken prior to initiation of service. The similarities are iterated leading to a defined protocol for transition from all bus to bus and light rail based on the research.

Statement of the Problem

The exponential growth of American cities has promoted an increase in vehicular rather than pedestrian oriented or shared ride modes of transportation. Roadways are becoming more congested and are often not capable of accommodating daily traffic patterns generated throughout the city. To address the growth and congestion, cities have looked towards alternative modes of transportation. The focus of transportation planning today has moved from vehicular oriented design to place a greater emphasis on pedestrian-based and mass transit options. One of the most popular alternatives is light rail transit (LRT). There are many elements involved in developing the urban infrastructure and designing a system conducive to a transit riding culture. Among these elements is a receptive public decision making body that supports incentives for transit utilization, joint uses of properties around rail stations attracting rail patrons, and park and ride and feeder bus systems that facilitate access to rail. None of these supportive measures will be effective, however, if the light rail start-up activities do not proceed smoothly.

There is a need to document the components of success, particularly as related to starting on schedule and with only minor problems, as well as a need to describe the process of transition from all bus to a combination of bus and rail system. The variations in adding the light rail component are numerous, but include different training for the operator. The light rail operator has little to no interaction with the public, while the bus driver's public interface is extensive. Light rail operation is more technological with functions centering on controls and bus operation

includes total control of the vehicle. As the light rail's path is controlled by the track, the decision making sequences and arena are far different Appendix 1.

As of January 2007, there are 20 cities with a light rail system in existence and over 30 cities in the United States that are adding new light rail components (Appendix 2). The majority operate under the same agency as the bus system. To properly document the components of success, as well as to describe the process of transition from all bus to bus/light rail system, an assessment will be performed. It is the responsibility of this document to describe the typical order for transition from all bus to bus and light rail based on the research assessment.

The variations in adding the light rail component are numerous, but training focuses on vastly different functions for the operator. As the light rail's path is controlled by the track, the decision making sequences and arenas are far different. Light rail operation is more technological with functions centering on communication panels and a high level liaison with central control; bus operation includes total control of the vehicle by the operator. The light rail operator has little to no interaction with the public, while the bus driver's public interface is extensive.

Limitations of the Study

This study is designed to query existing light rail systems and to determine a protocol in the documenting transition process from all bus to bus/light rail system. Four cities were the focus of this study as the research team documented their activities leading to implementation of integrated bus and light rail systems. Financing and scheduling parameters prohibited a broader review of additional transit agencies and more in-depth analysis of the four case study cities. The results of this study may be used by new light rail systems to enhance their transitioning from one mode to two modes and as a springboard for more extensive analysis.

METHODOLOGY

Procedures

The research includes a literature review to define the historical, current and future trends, and the need for a protocol in the transition from all bus to bus and light rail transit services. Based on the retrieved information, researchers developed a survey to examine selected existing agencies with relatively new systems. A schedule was developed to conduct personal interviews and email interviews with personnel within the agencies.

Researchers conducted the interviews to obtain information related to the start up of rail lines in cities with an existing bus system, examine the transition of management from all bus to bus and LRT and to document the steps. Specifically, the interviews were conducted with the following agencies:

- Dallas Area Rapid Transit (DART)
- Denver (RTD)
- Houston Metropolitan Transit Authority (METRO)
- Utah Transit Authority (UTA)

These agencies were identified because of their relative newness, reputation as having smooth start-ups, and they have no other rail component such as heavy rail or people mover. The data collected during the initial interviews served as the conceptual framework for constructing the protocol.

Instrumentation

A survey instrument was developed and used to collect data from existing agencies that have transitioned from all bus to bus and LRT. The survey covered the start-up process and the management strategy during and after the transition. The instrument consisted of 16 closed questions. The items were used to determine if a uniform guideline could be developed for the transition process and start-up process. A copy of the survey instrument is Appendix 3.

Survey Administration

The survey instrument was administered to a sample of subjects extracted from LRT agencies in the nation that recently added a light rail component to their systems. Three out of four subjects identified were emailed a survey containing an explanation of the survey, as well as a request for participation. Contact was made over the phone with the fourth subject and they agreed to participate in a telephone survey.

Significance of Study

Many important benefits will result from the development of the protocol for the communities considering the addition of LRT. Among the many anticipated benefits are the following:

1. Evidence of a successful transition process for management from all bus to bus and LRT will be produced.
2. Proper placement of personnel will be illustrated.
3. Recommendations in implementing a transition process will be produced.

It is anticipated that this activity will add insight and facilitating implementation of existing methods of integration.

LITERATURE REVIEW

Light Rail Transit Historical Perspective

One of the most contemporary and prolific sources of passenger rail transportation in the United States is Light Rail Transit (LRT). The impetus for the LRT is from many societal forces including traffic congestion and delays, escalating cost of roadway construction, depletion of fossil fuels and the need for energy conservation, environmental pollution (air and ground), and an aging transportation infrastructure (APTA 2003, BHRA 2002, Taplin, M 1998). The combined strength of these forces pressured federal, state, local governments to identify, develop and implement alternative means of public transportation. The LRT system was viewed as a contributing solution for these national issues, capable of meeting the needs and demand of dynamic growing urban and suburban centers. It was expected that the LRT would also provide high standards in service and infrastructure.

America's contemporary interest in the LRT has a long history. It has a lineage that includes the streetcars, trolleys cars and trams (See Definitions in Appendix 4). The first streetcars came into existence in New York City in 1832. They were a boxy car structure pulled by a horse over rails imbedded into the street (BHRA 2002, Taplin, M 1998). This source of public transportation connected riders throughout the city to varied central business districts, neighborhoods, railroads, and ferries. The streetcars flourished and even induced economic growth until the advent of the trolley car (electric street car).

Following the Civil War, the streetcar was all but replaced by the cable car, which operated by attaching the car to a constantly running underground cable (BHRA, 2002). There was also the streetcar that received power by catenary. These cars were larger and faster than the streetcars, but were expensive to operate and maintain. In 1888, the cable streetcar that used the underground cable was replaced by a new all electric cable car. This advance was introduced in Richmond, Virginia, and Brooklyn, New York in 1890 (Taplin, M 1998). The electric cable car ended its run in New York City in 1905.

The all-electric streetcar became the dominant means of urban transportation throughout most of America. It became known as a trolley after its original electronic pick-up device called a trawler (Taplin, 1998). The trolley was instrumental in establishing new centers of urban growth as its track were extended. However, the popularity of the trolley and use of all other

light rail was thwarted by America's love affair with the automobile (Wyatt, May 5, 1996; Schneider, 2002; Taplin, 1998).

While the use of the automobile was the beginning of the decline in utilization of public transportation, an even greater source of difficulty was escalating cost of maintenance and the scandal perpetrated by the National City Line (Taplin, M 1998).

Standard Oil, Firestone, and General Motors owned the National City Line jointly. Its purpose was to buy up all transit operation, public and private, and replace them with buses. (Taplin, M 1998). Many cities abandoned their trolley operations during that period. On October 31, 1956, the last three trolley lines in Brooklyn ended their runs. The trolley experience ended in Washington, D.C. in 1962. However, some busy lines were preserved in a few major cities including New Orleans, Boston, Cleveland, San Francisco.

Concurrent with the increase in travel by auto was the expansion of the nation's roadway systems. The National Highway System (NHS) has become the backbone of our nation's transportation system, consisting of some 161,188-road miles with interconnected urban and rural principal arterials and strategic highways. In the year 2000, 2.8 trillion vehicle miles were traveled on all national roads and highways, which covered 3.9 million road miles (US DOT FHWA 2000). The proliferation of motorized transportation, principally automobiles and trucks in America facilitated the movement of people, goods, and materials throughout the nation. However, the increased use of motor vehicles created a revolving cycle of new roadway expansion, more vehicles, and the desire for additional roadways.

By the early 1990s, transportation professionals and planners began to increasingly question the status quo. Ideas such as intermodalism, the seamless movement of people and goods by several modes of transportation on the same journey gained proponents.

Interest was peaked in the environment and transportation's impact on natural resources, the quality of life, national security; and safety in all modes of transportation.

This rethinking, fueled by projected population growth, means the United States can expect more of the same problems; increased congestion, populated air, increased urban-service costs and taxes, reduced urban open space, sprawl, and the need for more capacity for public mass transportation, unless policy responses change. Accommodating increasing demands in a more multimodal, and environmentally sensitive manner is a priority for many areas of the country.

To some degree, the focus of transportation planning has moved from vehicular oriented design to placing greater emphasis on mass transit. One of the most popular alternative modes of transportation chosen by many communities to address these problems is the light rail transit. As more cities identify light rail as an option for their region's transportation, a look at experiences of other cities may assist in their decision making.

EXAMINATION OF LRT START-UP

Several cities served as the cases for examining the steps transit agencies used to ready their systems for light rail start-up. The identified cities represent operations in various regions of the country; most began operation within the last 20 years and were considered successful in the opening days of their systems. One of the systems Buffalo, New York has been in operation longer, but provided an east coast example.

Other cities studied are Portland, Oregon (began 1986), Los Angeles, California (opened 1990), Denver, Colorado (began 1994), Dallas, Texas (started 1996), Salt Lake City, Utah (beginning in 1999), and Houston, Texas (started 2004). Information about the system initiation in Buffalo, Portland, and Los Angeles are based on accounts in the literature. A survey was distributed, which provided the information for the other cities.

Findings from Literature

Buffalo, New York

The Buffalo, New York area started preparing for a light rail system shortly after the creation of the Transportation Development Program (TDP) in 1971. The TDP is a department of the Niagara Frontier Transportation Authority (NFTA). The NFTA is responsible for developing air, water, and surface transportation as well as assembling mass transportation policy for the Erie and Niagara counties. The TDP encompassed three major elements: the establishment of a regional bus transit network, the construction of a Metropolitan Transportation Center in downtown Buffalo, and the design and construction of a rail transit system between Buffalo's waterfront and the suburban community of Amherst (Bishop, 1988). To properly incorporate a light rail transit system into an existing bus system, a unique method of planning was used to begin service productively.

NFTA began addressing the concern to have the right personnel at the right position with a move that helped them tremendously. The recruitment for a rail operations leader with a background in research and development enhanced the start up process.

With this superintendent aboard two years before the system began revenue service, start-up task such as developing a rulebook and standard operating procedures began (Bishop, 1988).

Having one key person in the right place at the right time facilitated better recruitment and training. Tours of existing agencies was a key part of the development process. Central to the coordinators position was the knowledge to address union and employment issues.

The superintendent of the rail transportation department played a key role in advancing the transition process from construction to actual revenue operations. The recruitment of employees with industry liaisons to gain knowledge and experience from others in the industry was vital. Of the existing employee pool, individuals from bus transportation were reassigned to rail transportation for positions such as training, supervision, and operations. Once the initial candidates for transfer to rail management were identified and approved, it was necessary to establish a training program (Bishop, 1988). Buffalo's future rail employees had the opportunity to tour the Port Authority Transit Corporation (PATCO) facility in Lindenwald, New Jersey for four-weeks. The tour-covered operations of the PATCO facility and key issues to look for once Buffalo's system were in operations.

Newly hired employees participated in the training program. Each week consisted of various tasks to be covered. The first week of training covered the review of the rulebook, standard operating procedures and all current orders and notices. The second and third weeks allowed the trainees to get familiar with the train and how it operates. The last week covered actual revenue service testing and a final test on signals and the rulebook. Trainees who did not pass the test after two attempts were not hired. An annual re-certification exam maintained the knowledge gained in the training class.

Buffalo's light rail line began revenue services smoothly because the right people were in the right place at the right time. Hiring an experienced employee advanced the transition stages tremendously. The knowledge the superintendent shared provided crucial insight to the overall operation.

Portland, Oregon

The first light rail line in Portland, Oregon called MAX (Metropolitan Area Express) opened on September 5, 1986 (Gephart, 1988). The rail line had the opportunity of having two managers, Oregon's Department of Transportation and the Tri-County Metro Transportation District of Oregon (Tri-Met). Tri-Met is the public transportation agency and was responsible for the transition of management and operations from bus to bus and rail in Portland. As light

rail start-up activities began, some bus personnel transferred to rail operations. This summary discusses the method Tri-Met used to integrate the light rail system using bus personnel.

Tri-Met's goals were to operate MAX safely, reliably, and efficiently and to integrate the rail line's operation with bus services for the greatest convenience to the public (Gephart, 1988). The formal development of the plan began one year before rail operations started. Before the plan was formally developed, planning began in 1980. In 1980, estimates for staffing plans, operating plans, and operating budgets were developed by two outside organizations. As a result of the pre-planning and initiatives established at that time, Tri-Met began recruiting rail operations staff. As staff recruitment continued, placement of personnel became an issue.

Tri-Met created an organizational structure for rail operations with two departments: rail transportation and rail maintenance. The two department head positions were filled by internal promotion and outside hiring. Filling these positions early aided the overall process by allowing the two to participate in various planning and design assignments.

These two positions led development of a rail start-up core team. The rail start-up core team was charged with developing the rail operations plan and a complementary start-up activities schedule (Gephart, 1988). Fourteen important areas were identified to be addressed in the start-up process. Each area was assigned a manager with the responsibility of creating a schedule and plan. The development of the rail operations plan supported the overall start-up plan in the transition of rail transportation and rail maintenance into operating departments. Before staffs prepared the plan they addressed issues such as the operator's rule book, maintenance rule book, standard operating procedures, training programs and supplemental agreements.

The purpose for the start-up activities' schedule was to summarize the sequence and timing of all activities required to establish revenue service on the target date, September 5, 1986 (Gephart, 1988). Every month the team posted a schedule update illustrating progress made leading to the opening date. A computer automated scheduling system was adopted to identify tasks and subtasks. Team members became worried that open floor discussions would be diminished because of computer input.

Staffing agreements were developed, as well. All normal work would be performed by Tri-Met's employees and outside contractors would perform emergency, specialized work that required equipment not owned by the agency. The rail department would appoint positions

according to seniority from the ranks of bus operators to rail controller and supervisors. Rulebook exams, medical exams, and the training class had to be done before hiring.

Staffing estimates were based upon the organizational structures of other transit properties and Tri-Met's labor practices and productivity rates (Gephart, 1988). Through streamlining numerous tasks, Tri-Met reduced the original estimate of required staff by 11 percent compared to projections within the first year of service. Due to the time between the 1980 consultant report and 1986, a start-up core team contributed to the reduction.

Los Angeles, California

The planning for the Los Angeles light rail system began nine years before opening in 1990 when citizens began paying for the system through a sales tax. The \$700-million, 21-mile project required effective management to efficiently open the system. The agency hired and trained new staff.

A test track was constructed so that vehicle acceptance could proceed uninterrupted while construction of the system continued (Jester, 1988). The LACTC constructed a test track that resembled the proposed track. The track consisted of a distance of 10,300 feet, with two at-grade crossings and a distance that allowed the light rail vehicle to achieve its maximum speed of 55 miles per hour.

A special effort was made by the residential engineers to construct the test track in a timely manner so that the agency could make adjustments before opening the mainline. LACTC and their consultants assisted in the staffing for the light rail department by developing a plan before hiring.

An important task of the LACTC was to provide training to new personnel in order to ensure safety to passengers once the light rail system began service. Training was provided for operating and maintenance personnel. Experienced supervisory and specialized employees were hired. Training of operators consisted of two separate classroom sessions with a hands-on training in operating the vehicles before and after each session (Norman J. Jester, 1988). Performance was evaluated and graded; persons needing additional training or practice were identified.

The maintenance personnel hired for skilled positions were required to possess at least several identified basic skills (Jester, 1988). At the time, a decision had not been made to hire

existing personnel for these positions. If hires had been made from existing personnel, the supplemental training needs would have been conducted at a local technical school. Existing employees had the opportunity to monitor tests and to aid in repair work on equipment. This opportunity allowed them to gain more experience with light rail equipment.

The test track, staffing estimates and the training of personnel all contributed to LACTC proficiency. Although L.A. differed somewhat from other systems examined by relying more on experienced new hires, rather than internal promotions or position transfers, there are consistencies in the training and other preparation steps.

Findings from Surveys

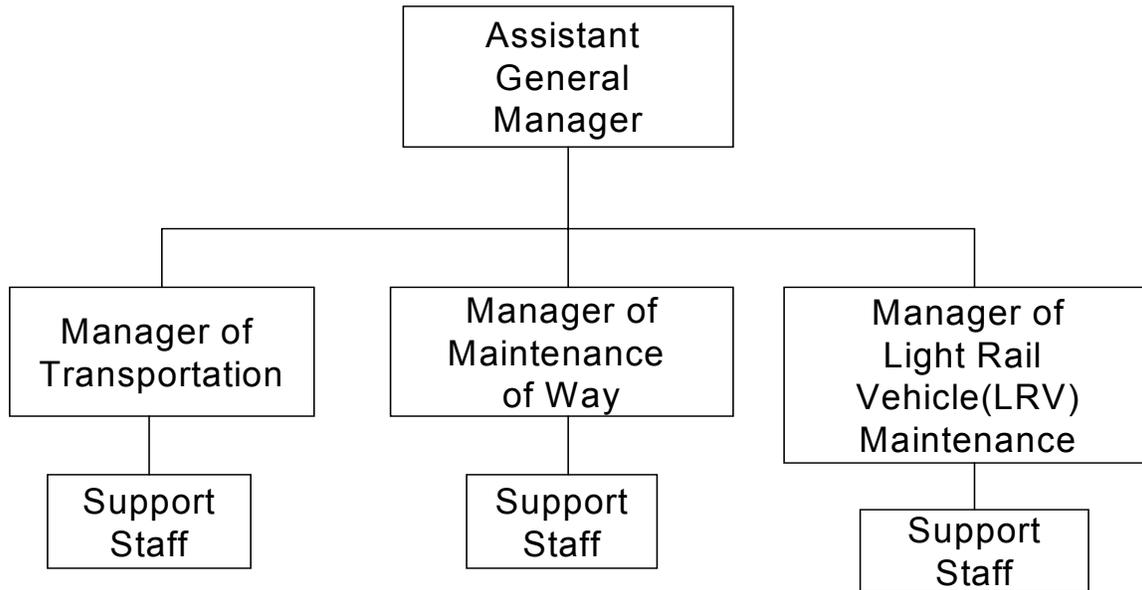
Denver, Colorado (Regional Transportation District)

Denver, Colorado's 5.3-mile Light Rail transit system opened in 1994. Regional Transportation District (RTD) is the organization that runs the rail system. Denver did not have the opportunity to have a pre-rail organization to help them in the start-up stage. Consultants and agency staff provided sufficient aid in the start-up process.

The organizational structure is shown in Figure 1. To support the organizational structure, the RTD had to estimate the staff requirements. Staffing estimates were drawn from industry standards based on equipment used and ridership projections. A manual for training was developed before training began. Revisions to the manual were done several times throughout the start-up stages. RTD gathered knowledge from the experience of exiting agencies to aid them in the development of the manual.

The training for RTD began and order was established with the creation of the manual to aid management in training new employees. Trainee's transition was design to expose them to existing operating facilities and to inform them on how light rail transit operations are performed. RTD provided trainees with a five-day tour of Portland, Oregon's LRT system. Portland was chosen based on the similarity of the system to the one in Denver.

Figure 1. Denver's RTD Organizational Chart



Once potential employees were trained, they were given a test on the training experience. A thorough peer review was conducted using individuals selected from other agencies. Certification was provided based on the passing of this test and the peer review. Some organizations require a refresher or re-certification process to keep employees abreast with innovative knowledge. Operators are required to attend recertification twice a year. Controllers and supervisors are required annual certification.

The superintendent was initially responsible for setting up the operations at RTD. At this time, an agreement was established between the union and the agency. The bargaining agreement allowed for the creation of a separate seniority category for represented employees in maintenance and transportation. This agreement did not need revising at first. However, later union membership eliminated the separate seniority for rail employees and the succeeding bargaining agreement reflected that change.

Dallas, Texas (DART)

Dallas' Light Rail transit line began in 1996 and is operated by Dallas Area Rapid Transit (DART). DART provides bus, rail, paratransit, HOV lanes and rideshare services around 13 cities in the Dallas metropolitan area (www.dart.org).

The Trinity Railway Express (TRE) serves the Dallas Fort Worth International Airport and the Fort Worth area. The city of Dallas has an established multi-modal system and has the ability to commute more than 200,000 passengers per day across a 700-square-mile area

The start-up for LRT at DART involved consultants, as well as agency staff. Also personnel from other agencies advised DART staff in establishing the LRT in Dallas. A pre-rail organizational structure was created. Minor modifications occurred in the existing organizational chart to incorporate operations and management of bus and rail.

The training manual for operations was developed based on other agencies' experiences and knowledge gained during their start-up process. With the development of a comprehensive manual, the training process began. Trainees participated in tours and hands-on training at other systems to learn how operations are performed. The approximate six weeks tour was a very important element in the transition stage. Management provided training for supervisors, conductors, and operators once they were hired. The training process was complete after trainees passed several tests on signals, management, and operations with a score of 85% or higher. A certification was given to each trainee upon completion of the training program.

The project manager with experience operating and maintaining light rail transit in another city was initially responsible for setting up the operations. The ability to set up LRT in Dallas was best suited for an experienced consultant. The existing agreement between the agency and the union focused primarily on seniority. Primary issues included the transition for bus employees transferring to rail, the amount of time spent on rail operations, and the amount of time allotted to transfer back to bus operations.

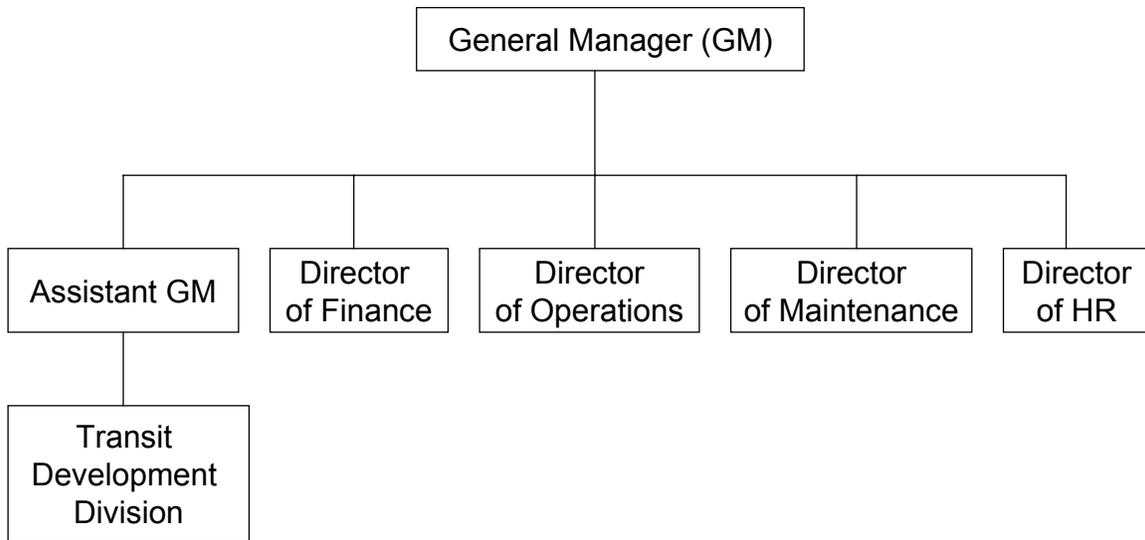
Salt Lake City, Utah (Utah Transportation Authority)

Salt Lake City's light rail transit opened in December of 1999. This system was installed and is operated by the Utah Transportation Authority (UTA). The official name for the transit system is TRAX. The UTA provides bus, light rail, paratransit, rideshare vanpool and carpool services to approximately one million people in six counties. UTA averages nearly 32 million riders a year (www.rideuta.com).

The start-up for light rail transit began with the help of consultants and agency staff. Consultants from Parsons Brinkerhoff, Siemens, Granite Construction, Wasatch Electric, contributed to this project. Agency staff consisted of a General Manager, Assistant General

Manager, Manager of Engineering, as well as planners. The UTA developed a pre-rail organizational structure to manage light rail start-up operations. The pre-rail organizational structure consisted of one GM and five directors. The five directors are as follows:

Figure 2. DART’s Organizational Chart Bus to Bus/LRT



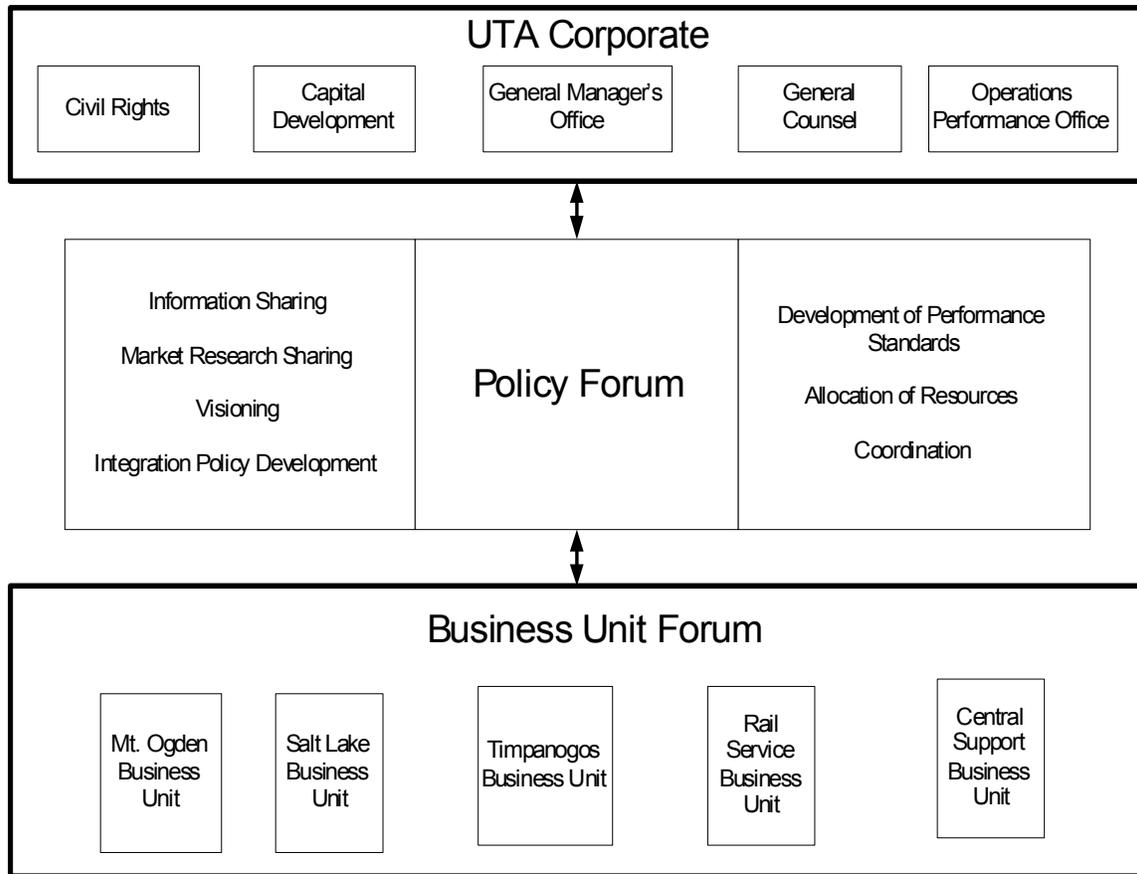
The current organization is divided into Business Units focusing on major locations of transit activity. Some of these changes, such as the creation of a rail operations department, resulted from light rail startup. The majority of these changes resulted from recent attempts to “get closer” to the customers served by the system. A new organizational structure was developed to maintain the operations of the light rail.

The current organizational structure consists of a corporate bracket that communicates to a business unit through a policy forum. In the corporate bracket, there are five divisions, all managed by the General Manager (GM). The GM manages the entire organization through contacting each unit’s regional GM as well as handles the management of marketing, public relations, and communications. Capital Development is responsible for planning; the engineers are responsible for identifying funds and managing construction for transit projects including light rail, commuter rail and bus rapid transit. General Counsel provides legal counsel to the company. Civil Rights ensure that UTA complies with government regulations for its employees and customers. The Operations Performance Office provides a quality assurance function to

verify the quality control of the business units. The policy forum bracket is the liaison for the corporate and business brackets. The policy forum bracket is where information sharing is done to enhance coordination.

The following are key positions in the current organizations:

Figure 3. Salt Lake’s UTA Organizational Chart for Bus to Bus/LRT



In order to hire properly without exceeding the budget, a staffing estimate was conducted. The nature of service required, the ability of facilities to support staff, and experiences of other properties were aspects used to determine staffing estimates. Before the hiring process started, the UTA developed a manual. Once the UTA was able to hire, a training process had to be conducted. The experiences of existing agencies and their documents provided the backbone for the manual and the procedures to be carried out.

The creation of the manual aided the UTA's training process throughout the transition from bus to rail. To assist employees with the transition, trainees were provided the opportunity to tour an existing LRT system to view operations. Cities were selected to illustrate first line supervisors, operators and mechanics. The tour lasted five days.

Management provided training for the supervisor, conductor, and operators positions before and after hiring. After the training of the new positions, completion of the training process was determined by a combination of tests. The passing of the tests determined whether employees received the certification. To sustain knowledge gained in the training class, refresher courses were given to operators every year and supervisors received them every two years.

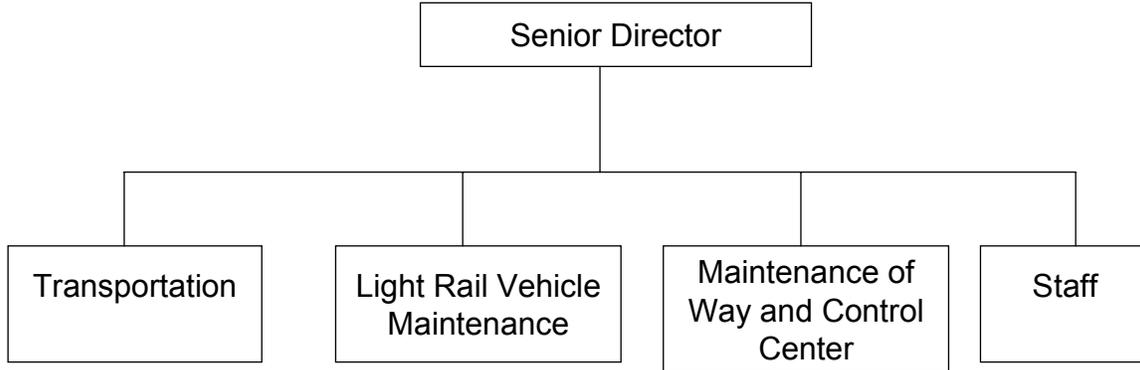
The manager of Engineering and Construction, as well as the Director of Rail Operations were responsible for setting up the overall operations for the light rail system. The existing agreement between the UTA and the union covered all aspects of service. The initial agreement was carefully crafted. The agreement represented the thoughts of many individuals and has worked very well, requiring no modifications.

Houston, Texas (METRO)

Light Rail Transit revenue services in Houston, Texas operated by METRO, began on January 1, 2004. Prior to the start of revenue services, a pre-rail management team was established. The objective for the pre-rail team was to begin setting up the revenue service organization, preparing for start-up, pre-revenue service, and the grand opening.

All of these tasks were completed one year before the opening. All directors and some support staff were in place to begin setting up the organization. The support staff for start-up consisted of consultants, rail operations staff and other agency staff. Once operations began, an organizational structure had to be formulated. The structure is as follows:

Figure 4. METRO's (Houston) Organizational Chart Bus to Bus/LRT



The organization determined the available amount of funding to hire employees based on a staffing estimate. METRO determined staffing estimates by function, the number of rail cars, the schedule, and the technical rail equipment along the right of way. The determination of appropriate staff served as input to the training process. This training process was monitored through a manual developed by METRO prior to training. METRO used experience and the expertise of other agencies, as well as hired experienced training staff as a source to aid in the development of their manual.

The start-up process gave METRO the opportunity to gain knowledge and experience with the entire system. METRO used new technology; new staff had to be trained, and a timeline was used to help facilitate the entire process.

The rail car is a new proto-type; therefore testing was an ongoing process that required training and tweaking for up to two years. Some of the maintenance of way system elements are also new and a reviewing of these elements was needed, as well as training. The majority of the transportation staff was new to rail operations, after coming from bus operations, and had to be trained on rail operations.

Because there was a short schedule regarding the opening of the rail system, the desired length of training in all areas had to be reduced.

All trainees were provided the opportunity to experience how other agencies handled rail operations during a tour. METRO chose a city that had a system and train similar to METRO's future system. Field supervisors spent 30 days in the city for training. During this training event, the supervisors were certified. This certification allowed them to train future operators.

METRO provided training before and after the hiring of employees. The completion of the training process was determined by a test that required a minimum of 80% to pass in order to receive a certification. A yearly certification is required for the operator and field supervisors. Refresher training is provided after evaluating an operator is deficient in a specific area.

Training was provided for the following positions:

- Field supervisors
- LRV Maintenance supervisors
- LRV technicians (mechanics)
- Maintenance of way supervisors
- Maintenance of way maintainers
- Operators

METRO established an agreement with the union. This agreement covered pay, established a separate rail seniority, a probationary period, the time period an operator could elect to voluntarily go back to bus without losing seniority, and how and if an operator could return to bus.

SUMMARY FINDINGS

This study examines the transition process from all bus management to combination bus and light rail management. The ultimate goal of this study was to affirm the need for a protocol for the transition process. This study provides historical and contemporary perspectives of light rail transit systems.

According to the existing transportation agencies queried in this study, attention to the transition process is important to smooth initiation of service.

Table 1. Key Steps in New Light Rail Implementation

STEP	TASK
1	Develop organizational structure in the pre-rail or pre-revenue stages
2	Identify and hire appropriate rail organization and management consultant
3	Develop staffing plan
4	Develop equipment procurement schedule
5	Prepare training manual
6	Train all rail personnel in management or operations
7	Tour an existing system, allowing hand-on operational time for operators

This sequential start-up process, particularly the inclusion of visiting and training on an in service system, has helped agencies start on time, ensuring a well-working product. The right personnel have been in place and properly trained in system operation. To document their experiences and processes for sharing with agencies at the embryonic stages of looking at light rail transit in their city might aid their decision making process.

RECOMMENDATIONS

The idea for this study is to set the foundation for developing a protocol for transitioning from all bus to a combination of bus and light rail. The examinations of agencies in the industry that have completed the transition process provided enough data to formulate a starting point of recommendations for a protocol. The research was not extensive enough to fully develop the protocol, but rather sets the framework for such a protocol. Additional research is necessary to answer the second tier of issues raised by this work. A self-assessment by agencies who have added light rail to their fleets would also be valuable.

The findings of this suggest a series of steps that are essential.

Step 1: Establish the organizational structure in the pre-rail or pre-revenue stages.

The organization prior to light rail has no component that can be responsible for the new rail service. The decision about the reporting stream for the rail section and how interface occurs with the bus system should be made early in the process. This allows for better structure of management and other personnel before operations begin.

The same structure may or may not be retained after operations begin, depending on needs determined after the start-up process begins. The decision there will be whether “rail start up” activities, if no longer needed are absorbed into other areas of the organization or eliminated.

Step 2: Involve consultants and experienced personnel.

Each of the studied transit agencies hired consultants skilled in rail start-up operation to supplement in house capabilities and add new knowledge. There are many elements to be addressed simultaneously and those with previous expertise are generally intensely needed for a short time.

Schedules leading to “opening day” are usually compressed and there is no time for on-the-job training or trial and error. The involvement of consultants can be very beneficial in advising the agency about a number of areas, as determined by the specific transit authority, but can include who and when to hire, advice about training, recommendations of similar properties to visit and suggestions about technical matters.

Step 3: Develop Staffing Plan and Schedule.

The staffing plan can be developed by the agency with or without consultant recommendations. It is important for the transit agency's employees to share in development of the staffing plan and the transition process so they can advise other employees about how, when, and why things work. Agency staff from bus management often has the first opportunity to work in the light rail department. Their experience in transportation is utilized to smooth integration of the light rail system in with the bus system.

Step 4: Establish Equipment Procurement Schedule.

An important element of budget consideration is to ensure that the right personnel are at the right place at the right time and synchronized with the procuring of equipment. This estimate allows the pre-revenue organization to know when to order equipment and hire personnel to manage and run the equipment. Organizations want to avoid ordering equipment early, prior to needing it, thus causing the organization to lose money before operations began.

Step 5: Prepare Training Manual.

A manual for training should be developed before training. This manual will help to assure that training is conducted in a structured manner. This manual can be developed with the examination of experiences of existing agencies or knowledge gained through the start-up process.

Step 6: Train All Personnel.

The training process is imperative before operations can begin. A manual for training should be developed before training. Training should be provided for management and operating positions. Once the training process is completed, a test should be conducted. This test will illustrate who passed and who did not. Those who did not should retrain and take the test again. A retake time should be established; those who take the test more than twice should not be allowed to take the test again. The passing of the test will result in a certification. A refresher course could be determined by the organization.

Step 7: Tour an Existing System.

Trainees should tour an existing light rail transit system to view operations. The tour city should exhibit conditions similar to the city of the transit system of the trainees.

An agreement between the agency and the union is usually established. This union protects the rights of the employees and clarifies working standards and guidelines. The light rail transit system may hire personnel from the bus organization.

These employees have the right to work in the light rail system and if they want to go back to the bus have time period to let a manager know. Any other agreement may be developed between the agency and union.

These recommendations are culled from the synthesis of information and assessment of seven agencies that have completed a transition process from all bus to bus and light rail transit. More than thirty cities are proposing to add light rail to their transportation systems. These recommendations could be used to save time, money and to make for a better transition process from all bus to bus/light rail.

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Appendix 1

Example of Variation in LRT and Bus Operator Skill Requirements**

A number of agencies that have moved from all bus to bus/rail operation have developed an aptitude test for potential operators. Whereas the rail operator typically is not faced with face to face contact with each individual (perhaps a great blessing), the operator must astute with following procedures, particularly with respect to signals. The rail operator must possess a sound technical understanding of operating a large vehicle which cannot maneuver away from the track. The operator must understand, for example, braking and variation thereof associated with weather and grades. Of course the bus driver must also do the same; however a hard brake with a bus may terrify riders and set packages afloat within the bus, but in general the vehicle survives. A hard brake with a rail vehicle could put a flat spot on the steel wheels – this means immediate maintenance and its associated costs. A bus can take a corner too fast – again creating an uncomfortable/unpleasant sensation for riders. Rail speeds must be adhered to: otherwise derail on curves (at grade most likely will not be a big deal other than blocking the trackway and street lanes; derail from an aerial structure is indeed problematic). Switches should change automatically, but they may not, the operator must be sure points are set correctly at diverge locations. Rail diverges depend on the infrastructure, bus diverges depend on the operator. Train length must be acknowledged as acceleration from a curve must not adversely affect the car within the curve. Interaction with dispatch is critical.

For the bus, interaction with the public is critical (including anger management and psychology). Rail maintenance is strictly a garage activity requiring nothing from the operator. A bus with an on street problem might require attention from the operator.

**** Note:** *Information gathered through discussion with Derek Crider of Denver Rapid Transit District, June 27, 2007*

Appendix 2

Summary of Public Transportation in Selected Major Cities

Cities	Bus Agencies	Existing Bus	LRT Agencies	Existing LRT	Proposed LRT	Trolley Agencies	Existing Trolley	Proposed Trolley
Albuquerque, NM	ARTP	x	ARTP		x			
Atlanta, GA	MARTA	x	ABLTP & NWCS		x			
Aspen, CO	EAP	x	EAP		x			
Astoria, OR	SETD	x				ART & ARTA	x	
Austin, TX	CARTS	x	ASG		x			
Baltimore, MD	MTA	x	MTA	x				
Bangor, ME	BTTAS	x	BTTAS		x			
Birmingham, AL	MAX	x	BRTAA		x			
Boston, MA	MBTA	x	MBTA	x			x	
Buffalo, NY	Metro	x	Metro	x				
Charleston, SC	CARTA	x	CARTA		x			
Charlotte, NC	CATS	x	CATS		x	CT	x	
Chicago, IL	CTA	x	CTA		x			
Cincinnati, OH	METRO	x	SORTA		x			
Cleveland, OH	RTA	x	RTA	x				
Columbus, OH	COTA	x	Fast Trax		x			
Corpus Christi, TX	The B	x	The B		x			
Dallas, TX	DART	x	DART	x		M-Line	x	
Dayton, OH	RTA	x				GDRTA		x
Denver, CO	RTD	x	RTD	x		PVT	x	
Detroit, MI	D-DOT, SMART	x	DDMA		x			
El Paso, TX	Sun Metro	x	SMART		x			
El Reno, OK	HET	x	HET				x	

Fort Collins, CO	Transfort	x	FCMR				x	
Fort Smith, AR	FSPT	x				FSS	x	
Fort Worth, TX	The T	x	FWTA		x			
Galveston, TX	Connect Transportation	x				IT	x	
Grand Canyon, AZ	GCT	x	GCT		x			
Houston, TX	Metro	x	Metro	x				
Issaquah, WA	IVT	x				IVT		x
Jacksonville, FL	JTA	x	JTA		x			
Kenosha, WI	Kenosha Transit	x				KT	x	
Little Rock, AR	Central Arkansas TA	x				CATA		x
Los Angeles, CA	MTA	x	MTA (F4ET & MGLCA) *	x	x	WRC & (LARC)*	x	x
Louisville, KY	TARC	x	T^2		x			
Lowell, MA	LRTA	x				LNHP	x	
Madison, WI	Madison Metro	x	T2020		x			
Memphis, TN	MATA	x	MATA				x	
Miami, FL	MDTA	x	Traffic relief		x			
Milwaukee, WI	Milwaukee County TS	x	MCTS		x			
Minneapolis, MN	METRO Transit	x	CC, MTHL, MNDOT	x				
Newark, NJ	NJT & NJT River Line	x	NJT & NJT River Line	x				
New Orleans, LA	RTA	x				RTA	x	
New York, NY	NYCT	x	Vision42		x	BHRA & VCTC		x

Norfolk, VA	Hampton Roads Transit	x	NLRP			x		
Oceanside, CA	NCTD	x	NCTD			x		
Omaha, NE	Metro Area Transit	x					10ST	x
Orange, CA	OCTA	x	OCTA			x		
Orlando, FL	LYNX	x	CFR			x		
Philadelphia, PA	SEPTA	x	SEPTA	x			SEPTA	x
Phoenix, AZ	PTD	x	Valley Metro Rail			x		
Pittsburgh, PA	PAAC	x	PAAC	x				
Portland, OR	Tri-Met	x	Tri-Met	x			Tri-Met	x
Raleigh, NC	Capital Area Transit	x	TTA			x		
Richmond, VA	GCTC	x	GCTC			x		
Rochester, NY	RTS	x	RRTC			x	RRTC	x
Sacramento, CA	SRTD	x	SRTD	x				
Saint Louis, MO	Metro	x	Metro	x				
Salt Lake City, UT	UTA	x	UTA	x			SHTA	x
San Antonio, TX	VIA	x	VIA			x		
San Diego, CA	MTS	x	SDT	x			NPMSS	x
San Francisco, CA	MUNI	x	MUNI	x			MSR & MUNI	x
San Jose, CA	VTA	x	VTA	x			CTRC	x
Seattle, WA	Metro	x	Sound Transit			x	Metro	x
Spokane, WA	STA	x	SRLR			x		
Tacoma, WA	Pierce Transit	x	Sound Transit	x				

Tampa, FL	Hartline	x	Hartline		x	Hartline & TECO	x	
Tucson, AZ	SUN TRAN	x	TST		x	OPT	x	
Washington, D.C.	Metro	x	Metro		x			
Total		68		20	37		20	10

Source:

APTA (2007) U.S. Light Rail Transit System Links [as of June 27, 2007].

<http://apta.com/links/transit_by_mode/lighttrail.cfm>

Appendix 3
Survey Instrument

- 1) Please describe your organization structure or chart?
- 2) How is this structure different from the pre-rail organization?
- 3) Who was involved in the LRT start-up?
Consultants
Agency Staff
Others
- 4) How were staffing estimates determined?
- 5) Did management provide training before or after hiring for the following positions?
Supervisor
Conductor
Operator
- 6) What determined the completion of the training process?
Certification
Test
Other
- 7) How often are refreshers given or certifications done?
- 8) Was a manual fully developed before the training process?
Yes No
- 9) If no, describe how the process was structured or how a manual was constructed?
- 10) What resources were used in setting up the manual and procedures?

Experiences of existing agencies

Knowledge gain through the start-up process

Other (Specify)

- 11) Were Trainees provided an opportunity to tour existing LRT systems for operations?
Yes No
- 12) If yes, how did you pick your tour city?
How many days were spent on the tour?
- 13) Who was initially responsible for setting up the operations?
- 14) What did the existing agreement cover between the agency and union?
- 15) Did the initial agreement work or were modifications needed to improve the agreement?

Appendix 4

DEFINITIONS

Light Rail

An electric railway with a “light volume” traffic capacity compared to heavy rail. Light rail may use shared or exclusive rights-of-way, high or low platform loading and multi-car trains or single cars. Also known as streetcar, trolley car or tramway. (APTA)

Light rail transit is described by TRB as: “A metropolitan electric railway system characterized by its ability to operate single cars or short trains along exclusive rights-of-way at ground level, on aerial structures, in subways or, occasionally, in streets, and to board and discharge passengers at track or car-floor level.” (TRB)

“An electric railway system, characterized by its ability to operate single or multiple car consists (trains) along exclusive rights-of-way at ground level, on aerial structures, in subways or in streets, able to board and discharge passengers at station platforms or at street, track, or car-floor level and normally powered by overhead electrical wires” (www.LightRail.com).

Tram

A tram is a light rail vehicle for public transport. Trams are distinguished from the most recent other forms of light rail that they travel along tracks laid down in the right-of-way of city streets. Another distinguishing factor is the short length of the vehicle, which usually consists of a standalone car or three vehicles at most (<http://www.fact-index.com/t/tr/tram.html>).

Trolley

Trolleys, also known as streetcars, are electrically powered rail transit vehicles operating in 1- to 3-car TUs, mostly on streets. Their tracks and distinct vehicles give streetcar service a strong identity. Spacious vehicles and comfortable ride are also popular with passengers. Operation on the streets with congested traffic, however, causes considerable friction with other vehicles, impeding both the streetcars and the auto traffic (George E. Gray and Lester A. Hoel, 1992).

Appendix 5

CONFERENCE SUMMARY: INTEGRATION OF RAIL INTO A TRADITIONAL BUS CITY

A portion of transportation literature and many conventional transportation professionals contend that rail transit can only succeed in cities that are densely populated. However, light rail systems from Buffalo, New York to Portland, Oregon are thriving, thus defying those embracing the density theory. Other low to medium density cities with light rail systems include Denver, Colorado, Sacramento and San Diego, California and Dallas, Texas. There are a variety of issues involved in developing the urban infrastructure conducive to a transit riding culture and the previously cited cities with light rail confirm that point. Significant issues to consider are a receptive public decision making body that supports incentives for transit utilization, joint use of properties around rail stations, attracting rail patrons, and providing park and ride and feeder bus systems that facilitate access to the rail.

The Center for Transportation Training and Research sponsored a one-day seminar in Dallas, Texas, to explore the integration of light rail transit into a Texas city that has traditionally offered only bus service. The opening session focused on light rail as part of livable and sustainable communities with introductory remarks by Dr. Carol A. Lewis (Center Director), Dr. Naomi W. Lede (Center Founder) and Frank Waddleton (then Regional Administrator, Federal Transit Administration Region VI). The keynote address was delivered by Dr. Vukan R. Vuchic (Professor of Transportation, University of Pennsylvania). Three concurrent break sessions provided conference participants the opportunity to discuss the many elements involved in developing an urban infrastructure conducive to a transit riding culture. Seminar highlights are noted below.

Background and Purpose

Some transportation literature and most conventional thinking purport that a certain level of density is necessary to support rail transit. Of late, though, many moderate density cities have implemented light rail transit with success. These cities include Buffalo, Portland, Sacramento, Denver and Dallas. Many elements contribute to developing a transit riding culture in an urban environment. Among the elements is a receptive public decision making body that supports incentives for transit utilization, joint uses of properties around rail stations attracting rail patrons, and park and ride and feeder bus systems that facilitate access to the rail. The DART forum served to facilitate dialogue and a learning palette for transportation planners, managers and other professionals to explore the mechanisms and protocol necessary to successfully implement light rail transit systems in low to medium density metropolitan cities, which have traditionally offered bus-only systems. Supplemental objectives will be to:

- Identify those dynamics that reveal a city as a potentially successful light rail city,
- Examine the characteristics of a traditional bus system that could be considered benefits or advantages in the integration process, as well as those characteristics that may yield blockades and obstacles, and
- Establish a workable protocol for the effective integration of a light rail transit system.

The conference began with a plenary session and keynote address. Afternoon break sessions centered on: (1) marketing and consensus building; (2) land use and economic planning and policy; and (3) transit operations. The conference provided background to assist professionals nationwide in assessing the potential for light rail systems in traditional bus cities by providing tangible evidence of procedures experienced by another city that successfully implement a rail system. By examining an authentic example, this conference offered an increased level of understanding about the essential factors to be assessed when considering such an endeavor.

Conference Highlights

Dr. Vukan Vuchic delivered the keynote address and stated that any system using one mode is inferior to a system using multimodal. The extensive light rail network is a benefit for cities such as Dallas and Houston, as an alternative to the roadway congestion. These cities are typical of others in the US in which as the auto dominates, transit deteriorates. Vuchic described the history and cycle of transit in the US beginning with the street cars, which were largely abandoned and replaced by buses. By the 1970s, cities began looking again at light rail transit and considering more human oriented cities. Over the years, we learned how usage of cars requires massive land uses and damages the environment. There is a need for parking to accommodate the cars and lane requirements are huge. Buses remove cars and require fewer lane miles to accommodate the same number of people.

Vuchic noted that successful transportation systems combine modes of travel and are not limited to light rail. He described the Pittsburg busway as an alternative. He challenged transportation professionals to move from the stagnant idea that transit is only for the transit dependent individual. He stressed that transit should be an attractive alternative for all individuals of the community – even competitive with the automobile. Vuchic believes that transit can be improved by focusing on broader levels of service, simplistic direct systems that are durable, reliable and flexible. Vuchic highlighted successful systems in San Francisco and Washington, D. C. He also emphasized the need to not simply integrate rail, but to integrate the entire concept of transit. He contended that ridership will increase as transit's image and role are enhanced.

Summary of Key Points

A review of comments by the plenary and break session speakers indicates the following suggestions for cities that may be adding light rail transit to their systems.

- Recognize that the decision to utilize public transit is the customer's personal choice, so it is important to offer a light rail product that competes well with the automobile
- Educate the public about the benefits of riding transit and offer guide and "how to" brochures to introduce new riders.
- Work to diminish the segregation of transit modes, stressing the "one system" concept with all modes working together. Pro-rail is not anti-bus.
- Encourage station area development of property conducive to transit riding.
- Expect attacks from rail doubters, but keep debate about the benefits, do not allow the debate to become emotional.
- Seek consistent, loyal supporters.
- Maintain all schedules and keep the agency's commitment relative to the system.
- Identify key message and maintain consistency.

- Strategically plan events.
- Communicate with opinion leaders, but also maintain frequent liaison with the community and grass-roots citizens.

Recommendations for Future Study

- Study was completed using limited resources.
- Designed to take a first tier examination of this question.
- Raised additional questions outside the bounds of sources originally purposed for this research.

The following suggestions and questions might be the focus to obtain a logic flow in the paper and to establish arguments for the steps and their sequences in the Recommendations section of the paper and Table 1.

1. Conduct additional research targeting the opening of the system on schedule and with a minimum of operating problems after the opening.
2. Focus to determine commonalities between transit properties in their start up activities that result in a suggested protocol for a successful start up.
3. Research more extensively the major differences between operating a bus system vs. a rail system especially if. An agency doesn't have an effective protocol for initiating rail operations.
4. Expand study to establish an argument for the order from the research - e.g. all agencies indicated that it is important to prepare the manual and train employees before the tours, so lessons learned result in revisions to training and the manual, etc.
5. Consider questioning should rail operations have a separate operating structure from bus operations? Why? Are rail operations distinctly different than bus operations?
6. Further research the basic issues in hiring a management consultant?
 - Must the consultant have experience in order for the rail to get ready to operate?
 - Are there too many factors involved in learning on the job?
 - Is the risk of not having prior experience too great?
7. Focus study on underlying issues in staffing?
 - Does a new organization have enough time to work effectively together before rail operations begin?
 - Is there no room for staff problems once rail operation begins because of the 24/7 nature of the enterprise?
 - Is the ideal staffing timeline, two years before opening?
8. Identify, through research, who should develop the training manual.
9. Research information on unions:
 - Do unions set the work rules?
 - Are the work rules in the manual?
 - Should the union agreement come earlier in the start up process?