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Implementation of Zürich's Transit Priority Program

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Andrew Butler Nash
Ronald Sylvia, Ph.D.

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16. Abstract

Zürich is famous for the quality of its public transit system and it has one of the highest levels of per capita transit ridership in the world. This is because its transit service is fast, frequent, reliable, and inexpensive, due in large part to its transit priority program. The research describes transit priority techniques implemented in Zürich and discusses the relevance of the Zürich experience to other cities interested in developing similar systems, highlighting the unique benefits and challenges of a transit priority system. Transit priority improvements are relatively low-cost ways to make a transit system work better by reducing vehicle delays. Specific improvements fall in the following categories: roadway improvements and traffic regulations, traffic signal preemption, exclusive transit lanes, transit malls, transit system operations, transportation system improvements, major transit facilities, and bus rapid transit. Zürich's experience offers valuable insight to the process of developing and sustaining a transit priority system. These insights include: the importance of public support, planning land use to support transit use, implementing improvements comprehensively, interdepartment coordination, leveraging institutional change, and adopting appropriate technology. Ultimately, what is important is that Zürich's transportation system is a major contributor to the city's high quality of life and livability. Cities interested in implementing transit priority systems can learn much from Zürich's experience and be encouraged by its success.

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College of Business BT-550
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EXECUTIVE SUMMARY

Zürich is famous for the quality of its public transit system. Zürich's transit system is an attractive way to move about the city. The system is easy to use, fast, frequent, reliable, and inexpensive. Zürich's well-functioning transit system makes a significant contribution to the city's overall high quality of life.

Critical to Zürich's success is a comprehensive "transit priority" program implemented over the last 30 years. Transit priority improvement techniques are designed to speed up transit. According to Professor Robert Cervero, "The results of this program have been nothing short of exceptional. Zürich has one of the highest rates of transit usage today, about five hundred sixty transit trips per resident per year, almost twice as many as Europe's largest cities."[1]

The most important quality of Zürich's public transit system is that it functions as a network. It is fast, easy, and comfortable to get from point A to point B in the city or region. Public transit is easy at almost any time of day and any day of the year. While many trips require transfers, this is no problem because all the lines in the network work well. The transit priority program is a fundamental reason why this is true.

The transit priority program enabled all of Zürich's surface transit lines to improve more quickly and for less money than constructing a new underground rail line. Consequently, the entire transit network could be improved rather than just building a single line. This was the choice that Zürich faced in a 1973 election that asked voters to spend 1.2 billion Swiss Francs (SFr) for construction of a new underground transit system. Voters rejected that measure and voted instead to provide 200 million SFr over 10 years to implement transit priority measures to make the existing surface transit system more efficient.

Improving a surface transit system that can operate with transit priority has many advantages over an underground system. A surface line can have more accessibility and does not require people to go underground to access the system. A surface system is simple to operate and is designed to fit well into the urban environment. The natural trade-off is less space for automobiles. However, Zürich's economic success and high livability prove that this does not need to be a problem. It is still possible to drive in Zürich, but public transit is so good that driving is not necessary for most trips.

The objective of this research was to describe transit priority techniques in Zürich and understand how the city implemented its program. Most transit priority improvements are relatively simple and inexpensive; however, they have proved to be difficult to implement and sustain. The research effort consisted of a case study with interviews and surveys. We interviewed many persons associated with the development and implementation of Zürich's transit priority program. A survey to evaluate support of transportation decision-makers in Santa Clara County, California, illustrated transit improvements in a typical U.S. city. The data was compared to a similar survey in Zürich. The findings help us to understand how elected officials think about transit improvements.

This report summarizes the case study findings and the Santa Clara County survey. The report targets cities and transit agencies interested in implementing transit priority techniques, specifically those considering low-cost ways to improve transit service quickly and efficiently.

WHY IS TRANSIT PRIORITY IMPORTANT?

Transit priority is important, extremely cost effective, and a way to improve transit service. Transit priority improvements advance customer service by providing faster and more reliable service. Improvements empower transit's bottom line by enabling it to operate more service with the same resources and by attracting more passengers. By reducing conflicts with private traffic, transit priority improvements also can reduce accidents and driver stress.

Transit priority is especially relevant because the vast majority of transit service today shares right of way with other traffic. Whether buses or light rail systems, operating transit in mixed traffic leads to delays and unreliable service. Unfortunately, transit priority improvements are neglected. Improvements could address these problems in favor of larger projects such as new rail transit systems.

TRANSIT PRIORITY IMPROVEMENTS: A FEASIBLE TRANSIT INVESTMENT

While rail transit clearly provides an attractive and environmentally friendly transit system, it is feasible only in major corridors where high ridership justifies the large capital investment. Furthermore, it is difficult to find funding for these expensive projects. In contrast, in the cost-benefit analysis, transit priority improvements are less expensive and easily justified. Therefore, transit

priority improvements represent a significant opportunity for improving transit service in many U.S. cities.[2]

Transit priority improvements enhance the overall effectiveness of the transit network in cases where large capital investments are justified. For example, implementing a comprehensive transit preferential program on feeder services for a new rail line can create a transit network that maximizes the major capital investment's effectiveness.

Finally, transit priority improvements can build transit demand to a level that will support construction of more significant investments, such as a light rail lines, in the future. In these cases, the initial transit priority improvements can often be enhanced for the new service (for example, constructing a light rail line in a bus facility, as is being done in Seattle).

Today, many cities have growing traffic congestion and are trying to rebuild their transit networks. They have two main choices: build an entirely new transit network or line, an expensive and long process, or focus on making the existing network work better by implementing transit priority techniques. Zürich took the second approach, a relatively unique choice in an era of major transit capital projects, and created one of the world's best transit systems.

TYPES OF TRANSIT PRIORITY IMPROVEMENTS

Transit priority improvements are generally defined as a "range of techniques designed to speed up public transit vehicles and improve the transit system's efficiency." They include physical improvements, operating changes, and regulatory changes. They are often relatively low-cost ways designed to reduce transit vehicle delays.

For purposes of this research, a relatively broad definition of transit priority techniques was adopted in order to consider improvements that can significantly benefit from simultaneous implementation of transit preferential techniques. The best example is a transit mall, which some might not define as a transit priority improvement. However, transit malls are clearly most effective when implemented with transit system operations improvements such as coordinated scheduling and proof of payment, and therefore they are included in this analysis.

This research categorizes transit priority improvements into the following four types:

Roadway Improvements/Traffic Regulations—Minor changes to roadways, relocation or reduction in the number of transit stops, and traffic regulations designed to reduce transit vehicle delays.

Traffic Signal Priority—Traffic signals that reduce delays to transit vehicles by providing them with green lights when they approach.

Transit System Operations—Changes to operation of the public transit system designed to reduce delays, including low-floor buses, proof of payment, and system control centers.

Separate Right of Way—Sections of roadway designated for the exclusive use of transit vehicles, allowing transit to bypass congestion. For purposes of this research, two special cases are included under the separate right of way category: transit malls and major capital investments.

As this list indicates, there are many types of transit priority techniques. The next chapter describes each of these general categories in more detail.

IMPLEMENTATION OF TRANSIT PRIORITY TECHNIQUES

The effectiveness of a transit priority program depends on implementation. Implementation of transit priority improvements can be categorized in the following four levels:

Limited Implementation—Transit priority techniques are implemented individually in various locations in the transit network (for example, individual roadway improvements).

Route Level Implementation—Transit priority techniques along the entire route (for example, building exclusive transit lanes).

Areawide Implementation—Transit priority improvements are implemented in a particular area (for example, transit malls).

Comprehensive Implementation—Transit priority improvements are implemented to all transit routes and changes made to the way the whole system operates (for example, proof-of-payment fare collection).

The best way to implement a transit priority program is to implement it throughout the network, as Zürich has done over the past 30 years. This type of

program would evaluate each aspect of transit operation systematically and seek ways to speed up the service to make it more attractive to customers and more efficient to operate. It would perform this analysis on the entire transit network.

In this context, it is interesting to consider the overall operation of many transit systems today. Typically, they are similar to the horse-drawn omnibuses that first provided transit services. Transit vehicles still stop at almost every corner, fares are collected, and transit vehicles share the road with other vehicles. However, the number of other vehicles has grown astronomically, and operating procedures have not taken significant advantage of new technology such as automatic vehicle location.[3]

DIFFICULTY IN IMPLEMENTING TRANSIT PRIORITY IMPROVEMENTS

Many cities, including Zürich, implemented transit priority improvements in the early 1970s. While Zürich continued to expand its program over the last 30 years, many U.S. cities have neglected and not expanded their transit priority programs. Examples of neglect include lack of enforcement, opening bus lanes to other traffic, and reduced interest in implementation of new programs.[4]

Implementing transit priority techniques is difficult because providing priority for transit can mean taking capacity from other roadway users. The difficulty in implementing transit priority improvements is ironic, because most transit priority techniques are relatively simple and inexpensive. Essential transit priority implementation difficulties include:

- Low technical competence and lack of expertise on transit priority techniques and implementation
- Lack of support or direct opposition by different agencies or departments
- Difficulties of coordination between agencies and departments
- Pressures by automobile users
- Poor public understanding of the benefits of transit priority
- Opposition to changes by businesses and residents.

The difficulty of overcoming these obstacles led to skepticism and a defeatist attitude in transit agencies and planning departments about implementing transit priority improvements.[5]

The support of elected officials is an essential requirement to defeat obstacles and implement a transit priority program. A 1973 citizen's initiative to improve operations of the existing surface transit network sparked transit support in Zürich. The general initiative provided funding and political support for implementing transit priority improvements. Elected officials became supportive of the transit priority program after passage of the initiative. The chapter "History: Zürich's Transit Priority Program" presents a brief background on the citizen's initiative and its history.

In terms of elected official support, an especially interesting survey was done for the City of Zürich in 1993, comparing people's opinions of the degree to which transit should have priority to elected officials' perceptions of what the people thought.[6] This survey showed that elected officials significantly underestimated the degree to which their constituents supported transit priority. A similar survey done in Santa Clara County for this research project shows elected officials there also may underestimate the degree of public support for transit improvements.

In both surveys, constituents substantially prefer roadway solutions, although the elected officials themselves said that they supported transit solutions. The survey respondents believed that voters support mass transit primarily to get others off the road and therefore campaigns must emphasize transit's impact on traffic congestion. The fact that public officials seem to underestimate public support for transit improvements is troubling for the transit industry. Strong public official support is needed to implement complicated transit improvement projects. "Public Support for Transit Improvements" describes the Santa Clara County survey.

In summary, most transit priority techniques provide clear, significant benefits to transit systems. The past and future problem is always how to get them implemented. One of the main objectives of this research is to learn how Zürich was able to implement its comprehensive transit priority program.

TRANSIT PRIORITY IN ZÜRICH

Zürich implemented all four types of transit priority improvements throughout its network, specifically:

1. Priority transit vehicles require new traffic regulations and roadway changes on all city routes.
2. Zürich designed and built a unique citywide traffic signal prioritization system that provides transit priority without affecting other traffic. This extremely sophisticated system also controls traffic volumes in the city to prevent gridlock and improve livability.
3. Zürich adopted system operating techniques such as proof-of-payment and has constructed a high-tech systems operations center to maintain schedule reliability and service quality.
4. Much of Zürich's transit system operates on exclusive right of way constructed by redistributing road space from mixed traffic to transit only. In some cases, creative traffic signals provide transit priority when there is not enough room for exclusive lanes. The Bahnhofstrasse, Zürich's main downtown street, is a transit mall with some of the highest rents and most elegant shopping in the world.

The city implemented improvements designed to reduce the amount of through traffic and reduce traffic speeds in neighborhoods as part of a comprehensive program designed to improve both transit priority and livability.

Commuter Railroad Network

A canton is approximately the geographical and population equivalent of a U.S. county but the political equivalent of a U.S. state. In addition to Zürich's transit service, the Canton of Zürich led the effort to build a regional commuter railroad network (S-Bahn or fast train) in the 1980s. As part of the S-Bahn project, the Canton formed the Züricher Verkersverbund (ZVV), a regional agency responsible for coordinating fares and schedules of 42 different transit operators.

Efficiency and quality of service heightened the city's public interest in the transit system. Zürich's regional transit system directly feeds the city's tram and bus system. The city continued dedicating roadway space for transit and to reduce parking. Zürich developed a two-level transit system to serve the transportation needs of a major urban region. Zürich improved the efficiency and speed of the surface transit network by comprehensively implementing transit priority throughout the city network, increasing the number of stations located within the city on the regional S-Bahn system.

Consequently, the tram and bus networks provide shorter intermediate-length trips. Longer intermediate-length trips will be made on the S-Bahn network, alleviating the need for an intermediate, third-level system (that is, a subway or Metro system). "Zürich's Transit Priority Program" describes Zürich's major types of transit priority implementations. "Complementary Transportation Programs" outlines the complementary measures used, including traffic calming, the S-Bahn, and transit system coordination.

Implementation Lessons from Zürich

Important and overarching lessons can be learned from Zürich. Primary ingredients for success are continuing public support, effective political leadership, and motivated city employees. Successfully implementing a transit priority program means taking a comprehensive, long-term approach to improving the transit system.

Lessons from Zürich are transferable to other cities. First, Zürich shares many of the same problems facing other modern cities. Jobs and housing are decentralizing from the center, automobile ownership and traffic congestion are increasing, and employment is shifting out of traditional industries to service and professional sectors. Zürich's elected leaders face the same pressure as politicians in other cities, including reducing taxes and improving livability. Finally, the reliance on local funding (taxes) for capital improvements and the importance of the initiative process in capital improvement decision-making are becoming more common in the rest of the world.

Zürich started with a big advantage over other cities—had a well-used and highly respected transit system. Zürich simply needed to upgrade, by incrementally adding transit priority improvements. Cities with less-developed transit systems might not achieve the same quick results. Zürich's approach remains an excellent model.

Many lessons presented below are not surprising but common sense, for example, obtain and maintain strong public support. In these cases is not so much the lesson, but rather the specific techniques and strategies that Zürich used to attain these conditions. "Implementation Lessons from Zürich" describes these lessons and strategies in more detail.

Lesson #1: Obtain and Maintain Strong Public Support

Public support is the most critical element of implementing any government program. Public support is particularly important for a transit priority program. Effective transit priority programs create winners (public transit) and losers (other roadway users). A particularly problematic aspect of transit priority programs is that they are most effective when implemented comprehensively so it takes some time before they can generate public support, but the specific improvements generate immediate criticism from other roadway users. In Zürich, the public took an active role in forcing the city administration to implement transit priorities more comprehensively and more boldly than would have been possible without strong public support.

A group of citizens put forward the concept of implementing transit priority improvements throughout Zürich's existing surface transit system as an alternative to constructing a major new rail transit line. Passage of their transit priority initiative provided funding and a degree of political support for program implementation. Thirty years later, it is obvious that their plan was better from the perspective of transportation and urban livability as well as being significantly less expensive than the proposed rail system.

Persistent activists forced the city leaders to implement the transit priority improvements to a higher degree than they might have otherwise. Transit priority improvements can be implemented by degree, and strong implementation is better for transit but has more impacts on private vehicles. Without continuing support for transit priority from activists, it would have been difficult to overcome the objectives of private vehicle drivers. Activists placed pressure by lobbying, multiple initiative campaigns, and political endorsements.

The Zürich lesson clearly shows that public support is required to implement a transit priority program and less active support is required as evidence of system benefits become convincing. The program provides a winning solution for all by following those lessons.

Lesson #2: Enlist Elected Official Support

The public support of elected officials is required to implement a transit priority program. Elected officials force government departments (often overwhelmed with their day-to-day responsibilities) to undertake long-term and challenging citywide programs.

In Zürich, elected official support was slow in coming. Almost all officials supported construction of the heavy rail transit system over comprehensive implementation of the transit priority program. They did not want to implement the more controversial parts of the transit priority program. Slowly, after years of active pressure from citizens groups and as they began to see the benefits of a comprehensive transit priority program, elected officials began to support the program. It is still difficult to implement improvements to the optimum degree, but elected officials in the city of Zürich are generally on-board with the program.

Obtaining elected official support is not always easy. Based on surveys in Zürich and in Santa Clara County, elected officials often underestimate the depth of support for transit among the voters and are too timid in their support for transit priority techniques.

Lesson #3: Use Smart Implementation Techniques

Outside advocates are needed to force government to take action. However, to maintain and sustain public support, government officials must implement intelligent programs. In Zürich, city planners used several techniques to foster public support for the transit priority program, including:

Implement high-impact projects quickly and publicize their benefits—In Zürich, high-impact projects were quickly implemented and their benefits were well publicized. A lesson from Zürich is that having good projects on the shelf and ready for implementation was helpful to the program.

Don't unnecessarily alienate people—There are cases where transit priority improvements impact private transportation, but the lesson from Zürich is to only do this where it is really necessary and try to minimize the impacts. For example, Zürich designed its traffic signal priority program to provide the minimum amount of time necessary for transit priority. This enabled the system to provide extremely effective transit priority without hurting traffic circulation.

Implement transit priority techniques together with improvements that increase neighborhood livability—In Zürich, transit priority improvements were implemented as part of a larger and more comprehensive program designed to improve city livability. As a result, Zürich sped up transit and improved neighborhoods. Examples include building bus stops that are pleasant

pedestrian spaces and introducing turn restrictions that reduce delays to transit vehicles and eliminate through traffic in neighborhoods.

The lesson from Zürich is that smart implementation helped provide public support for the transit priority program and minimize criticism.

Lesson #4: Organize Government to Effectively Deliver Program

Transit priority improvements by their nature affect many different departments, and frequently, bureaucratic concerns prevent them from being implemented effectively. Zürich addressed the issues by creating the following task forces:

Executive Council—A group of elected officials and city department heads that direct city departments to develop transit priority improvements and provide the political support for implementing them.

Working Party—A group of department heads and planners from several departments who collaborate on the development of specific transit priority improvements. An interesting aspect of the Working Party is that as a group with changing representation, many members of city departments have participated on it at one time or another. This has provided many staff members with an understanding of transit priority techniques that they use in their other projects.

While departments work together on developing projects, the Traffic Police has the sole responsibility for making changes to the roadway system, including signs, traffic signals, painted markings, and road construction. This allows changes to be made quickly and efficiently, once a plan has been adopted.

Lesson #5: Careful Traffic Engineering and Technology Is Critical

One argument against complex programs such as transit priority is technology. People often say that something cannot be done. This was also true in Zürich. Government officials said that certain programs could work in smaller, less complex situations but not in a large system with a great deal of private traffic like Zürich. Once Zürich voters approved the transit priority initiative, the city was forced to implement the program. Difficult technical solutions were developed; it was not easy, but it was done.

Two main points regarding Zürich's technology development and applications are as follows:

Technology Application—Careful Traffic Engineering—The lesson from Zürich is that sophisticated traffic engineering helps reduce opposition to transit priority techniques. Providing transit priority often means taking street space that has been used for mixed traffic and dedicating it to transit. This requires creating new routes for private vehicles. In Zürich, sophisticated traffic engineering techniques such as channelization and traffic signal placement enable private vehicles to circulate while still providing transit with priority. Many of Zürich's main transit stops serving seven or eight transit routes are in squares shared with private vehicles. However, these squares are carefully designed to ensure transit is the priority and private vehicles efficiently travel through the square.

Technology Development—Traffic Signal System—Existing traffic signal technologies could not achieve the desired degree of transit priority. One advantage Zürich had in taking a fresh perspective is that staff members were operational research specialists, not traffic engineers. Staff members took a systems approach to transit priority and worked closely with other departments to understand the problems. Staff members learned to drive buses and trams to research what drivers could and could not do. City engineers took a fresh look at the problem and developed their own technology. Today, the system successfully provides transit priority throughout the city as well as improving vehicle traffic flow.

In combination, thinking carefully about applications of transit priority techniques, addressing technical implementation issues, and creating new technologies solve problems. However, all are fundamental requirements to programmatic success.

Lesson #6: Implement Complementary Programs to Improve the Transit System

Transit priority alone will not create an excellent transit system. Basic requirements are safety, good service, and efficiency. The transit system itself has to provide good service in terms of frequency and customer attractiveness, for example, safety. In addition to this basic transit service, there are several complementary programs that cities can implement to further support and improve the transit system. In Zürich the following complementary programs were implemented:

Plan Land Uses to Support Transit—Zürich worked aggressively to encourage land uses that support transit, both through conventional land use planning techniques such as increasing density with zoning and development agreements, and by making the areas best served by transit attractive places to live, work, and visit. Initial efforts focused on improving center city urbanity by reducing parking and traffic and then using the freed-up space to speed up transit, create pedestrian zones, provide space for public events, and create a lively and entertaining downtown. This helped business, and now the program is being applied to redeveloping areas and new development.

Reduce Traffic Volumes—Zürich has a relatively long history of developing measures designed to actively restrain and reduce private motor traffic in the city. Zürich has used three main approaches to control the vehicle traffic in the city: traffic calming, reduction of roadway capacity, and parking controls. As with other programs, Zürich has taken a comprehensive and thoughtful approach to controlling vehicle traffic. While activists would argue that there is still too much traffic in the city, the government would say that there is less than there would be without these programs.

Regional Transit Coordination and System—The Canton of Zürich organized the Züricher Verkehrsverbund (ZVV) to coordinate fares and schedules of the region's 42 different transit operators. Today, careful scheduling links systems and makes it possible to use a single ticket. The canton also built a regional fast suburban rail system (S-Bahn) that provides regional mobility and serves as the basis for schedule coordination. Good regional transit has increased ridership on Zürich's city transit system and provides an argument for reducing traffic volumes on major routes into the city.

These complementary programs have helped support Zürich's city transit system. Strong ridership and public approval exist for Zürich's transit system. Public approval is a strong argument to strengthen the transit priority program.

Lesson #7: Use Capital Investments to Leverage Institutional Change

One of the most interesting lessons identified in this research was how the Zürich region used the need for a large capital investment to bring about institutional change. As part of the project to construct the S-Bahn, the Canton of Zürich required that transit fares and schedules for all 42 different transit operators be coordinated. The canton only agreed to fund the major investment if a new agency was created to bring about regional coordination. The canton's

funding provided the leverage necessary to get the different public and private transit operators to the table to develop a coordination system.

Lesson #8: Think Carefully at the Systems Level

An interesting aspect of Zürich is the region's adoption of a hybrid type of transit system. Zürich modified a two-level transit system. Surface streetcars and buses for local transit and high-speed commuter rail for regional transit provide a better match for Zürich's transportation needs. Nevertheless, the standard three-level system would have worked. A two-level system would not work for many larger cities.

There are significant cost savings and transit service benefits. The two-level system reduces transfers by carefully considering systems-level choices before choosing a planning approach for improving a transit system.

CONCLUSION

Zürich is one of the most livable cities in the world, and one reason is the high quality of its transit system. The transit system is efficient and extremely attractive to passengers. It is possible to travel easily and quickly throughout the city and region using transit.

Zürich created its excellent transit system by implementing a comprehensive transit priority program designed to speed up transit and increase its efficiency throughout the transit network. This low-cost approach was chosen over proposals for expensive new underground rail networks. The transit priority program has created a more appropriate transit system for Zürich and has cost significantly less than a new rail system. Other cities can learn a great deal from studying this approach and the transit priority techniques used in Zürich when considering how to improve their own transit systems.

Zürich transportation consultant Willi Hüsler put it best when he said, "Zürich is proof that a conventional tram and bus system, omnipresent in the most attractive streets and squares of the city and supported by a high-tech operation and control system, is an extraordinarily effective combination. A combination that is more cost effective than an underground system in a city like Zürich." [7]

"Zürich's Transit Priority Program" describes how Zürich implemented specific transit priority improvements. It includes examples of specific projects

and describes the process of developing Zürich's citywide traffic signal control system.

"Complementary Transportation Programs" outlines complementary improvements made to reduce traffic in the city and to improve the regional transit system that further supported Zürich's transit system. Transportation measures in Zürich's citywide transportation policy that have contributed to the success of the transit priority program include traffic calming and parking restrictions. A well-operating regional transit system has been critical to Zürich's success. As a result, people traveling to and from the sprawling city of Zürich can use transit rather than drive their cars into or out of the city.

"Public Support for Transit Improvements" presents an analysis of public officials' perceptions on implementation of transit improvements in Santa Clara County, California. It also describes results of a survey that asked questions similar to a 1993 survey of elected officials in Zürich, and describes the similarities and differences between the groups in order to provide ideas for implementation of transit improvements in the United States.

"Implementation Lessons from Zürich" summarizes lessons identified in this research that helped Zürich implement its transit priority program and presents a short description of why these lessons are relevant to other cities.

RESEARCH METHODOLOGY

This report presents results of an on-site case study in Zürich and a survey of transportation decision-makers in Santa Clara County, California. The Zürich research was carried out in the Fall of 1999 by Andrew Nash. It consisted of extensive, detailed interviews with individuals responsible for planning and operation of Zürich's public transit system. A list of individuals interviewed is contained in "Acknowledgements." Many of those interviewed were active in the mid-1970s when Zürich adopted its transit priority program, and their insights were especially helpful.

The survey of transportation decision-makers in Santa Clara County, as well as most of the chapter describing it, was completed in the Spring of 2000 by Professor Ronald Sylvia and Dan Goodrich of San José State University. The survey team asked specific questions of more than 30 persons currently or formerly active in transportation planning in the county, mostly elected officials.

INTRODUCTION

RESEARCH OBJECTIVES

The objectives of this research were to describe transit priority techniques implemented in Zürich and how Zürich was able to implement its program. It is hoped that other cities can learn from Zürich's experience and use these techniques and implementation tools to improve their transit systems.

Zürich is famous for the quality and popularity of its transit system. Service is fast, reliable, inexpensive, and safe. One reason Zürich's transit service is so good is the systematic implementation of a comprehensive transit priority program over the past nearly 30 years. According to Professor Robert Cervero, "The results of this program have been nothing short of exceptional. Zürich has one of the highest rates of transit usage today, about five hundred sixty transit trips per resident per year, almost twice as many as Europe's largest cities." [8]

TRANSIT PRIORITY

Transit priority improvements can be defined as a wide range of techniques designed to speed up public transit service. Speeding up transit is critical. Customers use travel time as a critical factor in choosing a means of transportation. The fastest transportation mode will be the top choice. Furthermore, by speeding up transit, more service can be operated with the same resources.

Transit priority techniques can range from simple engineering improvements in a single location to construction of major infrastructure improvements such as busways. In addition to physical improvements, operating changes can be applied at the network level to provide transit priority for the entire transit system.

Zürich has taken a unique approach to providing transit priority. The city has implemented relatively simple techniques throughout its transit network and has designed and implemented more complex techniques to improve overall network operations (for example, a citywide traffic signal control system).

Many techniques implemented in Zürich are not complicated and are relatively inexpensive, but other cities have not implemented them to the same extent. One reason is that providing priority to transit vehicles can mean taking road

space or traffic signal time from other vehicles. While this is often an efficient way to allocate resources based on the number of passengers carried by transit, it does not mean that other users will be happy. Ironically, cities where streets are congested and people argue that there is no room to give transit special treatment are exactly the places where providing transit with priority will have the most benefits.

This report describes Zürich's transit priority improvements, explains how Zürich has been able to implement transit priority improvements, and presents lessons from Zürich that can be used by other cities to implement transit priority programs. Zürich faces many of the same urban problems as other large cities, including decentralization and increasing automobile use, and therefore these lessons should be relevant to other cities.

REPORT ORGANIZATION

"Transit Priority" briefly outlines transit priority techniques and describes the range of transit priority improvements from single isolated changes to systemwide programs or major capital investments. Since transit priority techniques are well described in the literature, the intent of this chapter is simply to provide an introduction to the techniques.

"Zürich Context" provides an introduction to Zürich, describes Zürich's transportation characteristics, and summarizes the Swiss system of government. The Swiss system of direct democracy (public initiatives) was a key factor in the history of Zürich's transit priority program.

"History: Zürich's Transit Priority Program" presents a brief history of public transit planning and implementation in Zürich. It describes proposals for new transit systems defeated by the voters in 1962 and 1973, the 1973 citizen's initiative that called for implementation of the transit priority program, and how city departments implemented the transit priority program.

"Zürich's Transit Priority Program" describes how Zürich implemented specific transit priority improvements. It includes examples of specific projects and describes the process of developing Zürich's citywide traffic signal control system.

"Complementary Transportation Programs" outlines complementary improvements made to reduce traffic in the city and to improve the regional

transit system that further supported Zürich's transit system. Transportation measures in Zürich's citywide transportation policy that have contributed to the success of the transit priority program include traffic calming and parking restrictions. It has been critical to Zürich's success to have a well-operating regional transit system. As a result, people traveling to and from the sprawling city of Zürich can use transit rather than drive their cars into or out of the city.

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TRANSIT PRIORITY

INTRODUCTION

Transit priority improvements are generally defined as a range of techniques designed to speed up public transit service. They consist of physical improvements, operating changes, and regulatory changes designed to increase the speed of transit vehicles and improve the system's overall efficiency. By reducing conflicts with private traffic, transit priority improvements also can reduce accidents and driver stress.

Transit priority techniques are generally relatively low-cost improvements; however, specific techniques vary from small, simple street improvements in particular locations to introduction of major capital improvements and changes to the entire transit network.

There are two ways to characterize transit priority programs: in terms of the types of improvements and in terms of the degree of their implementation in the transit network. The following sections summarize four types of transit priority techniques defined for this research, implementation levels of transit priority techniques, and more detailed descriptions of each transit priority improvement category.

TRANSIT PRIORITY TECHNIQUES

There is significant literature that describes transit priority techniques. Two especially recommended sources are the City of Portland's *Transit Preferential Streets Program Sourcebook* and *Program Report*.[9] The first document presents a description and guidelines for implementing a series of transit preferential techniques. The second document presents a report on the potential to implement specific techniques on five Portland transit corridors.

Roadway Improvement—Traffic Regulations

The simplest category of transit priority improvements consists of changes to the roadway that improve the operation and speed of transit vehicles. Roadway changes are traffic regulations, minor physical improvements, and changes to transit stops. Specific examples include:

- *Parking Restrictions*—One main cause of delays to transit vehicles is waiting while private vehicles maneuver in and out of parking spaces. Parking restrictions and controls can be implemented to reduce the impact of parking movements on transit vehicles and to provide space needed for exclusive transit lanes.
- *Turn Restrictions*—Turning vehicles are another significant source of delay for transit vehicles. Implementing turn restrictions carefully can significantly reduce these delays.
- *Transit Exemption from Turning Requirements*—In some cases, restrictions to turning movements can lengthen and delay transit routes. In these cases, it can be beneficial to exempt transit from the turning movement restriction.
- *Loading Restrictions*—Historically, vehicle loading on public streets has been a problem in cities throughout history. In ancient Rome, goods delivery was banned during the day because of congestion. Careful design of loading areas can improve transit priority by reducing interference with transit vehicles.
- *Transit Stop Location*—The location of transit stops has a large impact on transit speed. Transit travel times can be improved significantly by relocating stops to places with better traffic conditions (for example, to the near or far side of an intersection, as appropriate). Eliminating or consolidating stops reduces travel time but at a cost to accessibility, so this must be carefully evaluated; however, many transit routes probably have more stops than really necessary.
- *Transit Boarding Islands*—Boarding islands enable transit vehicles to pick up passengers without moving into the curb lane. This keeps them in a moving travel lane and out of an intersection right turn lane—especially critical where right-turning traffic is delayed by pedestrian crossings.
- *Curb Extensions*—Curb extensions at transit stops, known as bus bulbs, are similar to boarding islands in that they allow transit vehicles to pick up passengers without moving into the curb lane. However, they can interfere with right-turning vehicles when located on the near side of an intersection. Therefore, their location must be carefully planned to maximize their effectiveness.

The role of good traffic engineering in successful implementation of roadway improvements and traffic regulations cannot be overemphasized. Roadways serve many different types of users, and transit priority improvements should

not penalize those other users. Sophisticated traffic engineering techniques must be used to accomplish transit priority and minimize the impact on other users. Transit planners must have good relationships with traffic engineers and be able to work cooperatively on improvement projects.

Traffic regulations and roadway changes often are controversial to drivers and adjoining property owners. Public support is critical to implementation of transit preferential programs. Roadway improvements must be designed to meet conditions in public areas and minimize unnecessary negative impacts.

Another effective method of attaining public support is to work with the community to design transit priority improvements as part of a comprehensive program designed to improve transit service and neighborhood livability. If a transit priority improvement can be designed to retain access to local businesses and creates a more pleasant pedestrian environment, it will be easier to implement than if such factors are ignored in the design process.

Traffic Signal Priority

Delay at traffic signals causes nearly 50 percent of the delay experienced by transit vehicles.[10] Traffic signal priority for transit means that traffic signals are designed to provide a green light to transit vehicles whenever possible. There are three approaches to providing transit with priority at traffic signals: passive, active, and unconditional. Zürich has developed a unique form of active traffic signal priority. The three standard approaches and Zürich's approach are outlined below.[11]

Passive Priority

In passive priority systems, predetermined timing plans are used to provide some benefits to the transit movements but do not require the presence of the transit vehicle to be active. The following are specific types of passive priority techniques:

- *Cycle Length Adjustment*—Reducing traffic signal cycle lengths so that transit vehicles wait less time at intersections.
- *Splitting Phases*—Splitting a traffic signal's priority phase movement into multiple phases and repeating it within a cycle can reduce transit delays without necessarily reducing the cycle length.

- *Areawide Timing Plan*—An areawide timing plan provides preferential progression to transit vehicles by designing traffic signal cycle offsets using transit travel times rather than automobile travel times.
- *Metering Vehicles*—Metering consists of allowing transit vehicles to bypass metered signals with special reserved bus lanes, special phases, or by rerouting transit vehicles to nonmetered signals. Two examples of this technique are known as "queue-jump" and "queue-bypass."

The passive approach is the simplest form of providing transit priority at traffic signals since it simply sets cycle times or phases to reflect the average speed of transit vehicles, rather than mixed traffic. Generally, this is not very effective; however, in cases when multiple transit vehicles use a street, such as San Francisco's Market Street, it can create significant benefits. Furthermore, using traffic signals to meter vehicles can be an effective technique when combined with roadway improvements.

Active Priority

An active priority system provides priority only when a transit vehicle is present. In the United States and Europe, active systems have been used since the early 1970s.[12] Signal preemption is an active system and a complicated type of traffic signal priority program. In these systems, the transit vehicle trips a switch (physical or electronic) or the operator pushes a button on the dashboard that causes an individual traffic signal to interrupt its cycle and give a green signal to the transit vehicle. Interrupts are activated within the signal's minimum safety parameters, such as minimum pedestrian walk times. This approach is used in many cities, especially in conjunction with new light rail transit lines.

The following are specific types of active priority techniques:

- *Phase Extension*—The traffic signal phase is extended to enable the transit vehicle to travel through the intersection before the traffic signal changes to red.
- *Early Start*—The traffic signal phase for the transit vehicle direction is started early when a transit vehicle arrives at the intersection during the red phase.
- *Special Phase*—A special transit-only phase is inserted into the signal cycle's normal phase sequence to allow the transit vehicle to travel through the intersection with minimal delay.

- *Phase Suppression*—A traffic signal cycle phase with low demand is suppressed from the normal cycle to enable the appropriate phase for the transit vehicle to occur sooner, thus reducing the amount of transit vehicle delay.

A major design issue in active preemption systems is the additional delay caused to other vehicles when changing the traffic signal cycle times to provide priority for transit. Traffic engineering literature cautions that traffic signal preemption should be used only where intersections are "operating at less than saturation capacity, where occasional timing or phasing changes will not significantly degrade the level of service."[13]

Unconditional Priority

In unconditional priority systems, transit vehicles are priority no matter what phase the current cycle is in, by finishing the required clearance intervals and then providing the phase appropriate for the transit vehicle. This is rarely done for transit vehicles, but it is used for emergency vehicles.

Zürich's Approach

Zürich developed a unique approach that applies the active approach to all the traffic signals in its network. Zürich's system estimates the arrival time of a transit vehicle at an intersection. Next, it optimizes the traffic signal phasing and timing to provide a green signal for transit when the transit vehicle arrives at the intersection based on a "dynamic" approach to the traffic signal network design. Zürich provides transit priority without significantly impacting traffic conditions by carefully determining the right cycle, phasing, and providing green time only when required by a transit vehicle. Research completed in the United States for the Federal Transit Administration supports this type of approach to transit signal priority systems.

According to the report, "Ideally, a really smart signal control system should exploit real-time information about transit operations and general traffic conditions and adapt as efficiently as possible to changing conditions while minimizing disruptions in networks with coordinated signals. In the process of continually revising signal timings it should consider in real time such factors as:

1. Traffic volumes at all approaches to intersections.

2. Queue lengths and potential spill-backs that might block lanes or intersections.
3. Expected arrival times of transit vehicles at signalized intersections.
4. Expected passenger occupancies of transit vehicles and other vehicles.
5. Deviations from schedule.
6. Deviations from proper service headways with respect to preceding and following transit vehicles.
7. Expected demand and wait times at downstream transit stations.
8. Expected arrival times of connecting transit vehicles at downstream transfer stations.
9. Expected delays to transit riders, motorists, pedestrians, and other users that are attributable to signal control decisions.
10. Expected vehicle operating costs attributable to signal control decisions.
11. Expected energy consumption and air quality impacts of signal control decisions.
12. Policy-based priorities that may be specified to create mode choice incentives, such as encouraging transit use." [14]

The type of signal control system described in this quotation is considerably more high-tech than Zürich's, although Zürich's system addresses the same problems by combining its traffic signal program with other low-tech transit priority techniques. For example, exclusive transit lanes and traffic improvements mean that transit vehicles seldom deviate significantly from schedule, so the traffic signal system does not consider this factor in deciding how to give priority to transit vehicles.

The chapter on "Zürich's Transit Priority Program" presents a detailed description of Zürich's approach to traffic signal transit priority.

Transit System Changes

Three specific system-level changes that impact transit speed are operations center, proof of payment, and improved vehicle design. Transit system operations improvements are physical and institutional changes made to the entire transit system to help speed up transit. They can be difficult to implement, because they face many policy and institutional questions and

because they need to be implemented over the entire network. However, they can be effective if considered when developing a long-term plan for transit.

Operations Center

The operations center monitors the position of transit vehicles and maintains schedules and reliable headways. When transit headway becomes irregular, vehicles begin to bunch together, causing significant delays and poor service quality. The problem is caused because when transit vehicles become delayed, more people are waiting to board the first vehicle at downstream stops, which further delays the first vehicle, enabling the following vehicle to catch up with the first vehicle.

An effective operations center can provide assistance to transit vehicles operating behind schedule by providing information and direction to operators. Operations centers can reroute vehicles around incidents and place standby vehicles into service.[15]

Operations centers include:

- Communications systems—Provide information and instructions to drivers and passengers.
- Vehicle tracking systems—Provide information on the location of all vehicles in the system.
- Plans for addressing system disturbances—Includes spare vehicles to put into service when needed.

Operations centers enable transit management to improve service by making real-time changes to routing and runs. Both are most effective when the transit system operates in a generally stable condition. It is hard to improve transit service significantly using these techniques when schedules are on the verge of breakdown due to traffic congestion. This is another reason transit priority improvements are most effective when they are implemented in a coordinated and comprehensive manner throughout the transit network.

Proof of Payment (Self-Service Fare Collection - SSFC)

Proof of payment (SSFC) frees the transit driver from collecting fares and enables all vehicle doors to be used for boarding and alighting. This significantly reduces the amount of time that a transit vehicle spends stopped at

stations. Most new light rail transit systems in the United States use proof-of-payment systems, while in much of the rest of the world proof of payment is used for all forms of public transit.

Introduction of a proof-of-payment system is complicated and raises fare evasion questions, but experience in Europe shows that these problems can be solved and that proof of payment leads to significant transit travel time savings. Experience with proof of payment in the Portland bus system showed that problems outweighed benefits. As a result, Portland discontinued the trial program. Currently, Portland's light rail system uses proof of payment.[16]

Improved Vehicle Design

Specific design improvements include low-floor vehicles, improved interior circulation spaces, and multiple wide doors. Where low-floor vehicles are unavailable, the same benefit can be attained by constructing platforms at the level of the transit vehicle floor as has been done with Curitiba's (Brazil) express bus system. Used in combination with proof-of-payment systems, these vehicle improvements significantly reduce the time a vehicle needs to spend at transit stops. These improvements also make vehicles more comfortable and accessible for all passengers.[17]

Separate Right of Way: Exclusive Transit Lanes

The key question facing all transit system designers is how to make their system fast. Often, speed requires using a right of way for transit only. In most rapid transit systems, this exclusive right of way is an expensive subway or aerial structure. In contrast, the transit priority approach generally consists of redistributing existing street space to provide an exclusive transit lane. Short sections of exclusive right of way also are built in transit priority programs.

This section describes three different types of separate right-of-way improvement: redistributing space on existing roadways for transit, transit malls, and building new transit right of way.

Redistributing Existing Roadway Space for Transit Use

The most common way of creating a separate right of way for transit is to take an existing lane of mixed-flow traffic and designate it for transit use only. These exclusive transit lanes are areas of roadway that can be used only by public transit vehicles. Transit lanes vary from long stretches of roadway to

short sections just before intersections. There are numerous variations in the operation and design of these roadways.

In terms of operations, some cities allow taxicabs to use transit lanes (for example, San Francisco and Paris). Often, exclusive transit lanes are only exclusive during certain times of day (for example, peak periods); afterward, they revert to mixed flow or parking lanes. In many cases, private vehicles making turning movements can use exclusive transit lanes. Clearly, this reduces the lane's transit reliability, especially in areas with high numbers of pedestrians, whose crossing movements will delay turning vehicles. Portland's guidelines assume exclusive lanes are shared with turning movements. A condition for application of this technique is that the turn lane must be less congested than the through lanes.[18]

In physical terms, there are many different ways of designing an exclusive transit lane to meet the particular needs and specific roadway conditions at the site. The most straightforward type of transit-exclusive lane is simply a stretch of roadway that is set off in some way for use by transit vehicles only. For example, a transit lane can be a contraflow lane in the underutilized roadway direction.

A second type of improvement combines roadway changes with traffic signal technology to enable transit vehicles to be the first to enter a stretch of uncongested roadway. Two common methods are queue bypass and queue jump. Queue bypasses are short sections of exclusive roadway located near an intersection that enable transit vehicles to bypass congestion at the intersection. Queue jumps are queue bypass physical improvements with the addition of a change in traffic signal timing that enables transit vehicles to start ahead of private vehicles—essentially jumping ahead of them. Several interesting Zürich examples of these techniques are described in "Zürich's Transit Priority Program."

A critical aspect in the design of exclusive transit lanes is traffic lane separation. Building a new exclusive separate right of way is the ideal solution. However, an exclusive transit lane can be created by painted lines. A major difference between these is the level and type of enforcement necessary to keep them exclusive. Physical separation has higher capital costs, but is generally self-enforcing. Reliance on painted lines or signs requires much greater enforcement in order to be effective.

Relaxation in the control and enforcement of bus-only lanes has been identified as a key element in the gradual discontinuance of bus priority improvements implemented in the 1970s.[19] It is interesting to consider whether it is easier politically to get an exclusive transit lane for light rail than for bus projects.

A key implementation issue for exclusive transit lanes is how much they are used by transit. If a transit lane is not well used, motorists may perceive it as wasted space and complain to elected officials. Given the importance of support for implementation of these improvements, it is critical that planners consider introducing exclusive transit lanes only where they will be heavily used. This requires creative techniques to bypass only congested areas and considering rerouting other transit routes so that several use the same stretch of exclusive right of way.

Special Case: Transit Malls

Transit malls are sections of street, generally located in a city center, where many different transit lanes operate with little or very limited private traffic. While transit malls are often thought of in terms of their contribution to urban livability, they also serve two important transit priority functions: They speed service by reducing interference with private traffic, and they provide a good opportunity to implement systems-level transit priority improvements.

Transit malls provide a good opportunity to implement system operations improvements because they can serve as linear transit interchange stations providing patrons with a convenient place to change from one route to another, thus speeding their trip. This is especially true when the transit system operates on a pulse-type schedule, that is, where several different transit routes are scheduled to arrive at the transit mall simultaneously, allowing passengers to transfer between the routes efficiently.

Furthermore, transit malls encourage such improvements as better marketing. Malls make transit more visible to the public and provide better passenger information, introduction of passenger amenities at transit stops, and innovative fare programs (for example, fare-free zones).

Transit malls must be carefully planned and designed. There are many excellent examples of transit malls in the United States, but also several failures that resulted when the factors needed to make a transit mall successful were not fully understood.

Transit malls are constructed as elements in new light rail transit systems. New, well-designed transit malls, including those in San Jose, Portland, and Denver, are good examples of high-quality urban design and transportation planning.

Building Separate Right of Way for Transit

Building a separate right of way (for example, a busway) is a costly transit priority improvement, especially if it serves as the catalyst for implementing other transit priority improvements. Furthermore, even given their high cost, these improvements can be less expensive than traditional transit capital solutions like building entirely new light rail or Metro systems.

Building a separate right of way for transit is most like a transit priority improvement when it is designed to speed up service in a particular geographic area. As a result, it can be used by several different transit routes and when a comprehensive transit priority program is implemented on the surface sections of the transit routes (for example, a subway in a downtown area).

The best examples of these types of improvements are bus rapid transit systems and light rail systems that share major capital facilities. Bus rapid transit systems are attractive and considered less expensive to build than rail. Boston and San Francisco have benefited greatly by placing the downtown sections of their light rail networks underground.

IMPLEMENTATION OF TRANSIT PRIORITY TECHNIQUES

The effectiveness of a transit priority program often depends more on the degree or extent to which transit priority techniques are implemented than on the specific improvements that are implemented. This section outlines four different levels of implementation and describes the special case of how building a bus rapid transit system can serve as the catalyst for implementation of a transit priority program.

Transit Priority Program Implementation Levels

This research defines four different implementation levels for a transit priority program, ranging from limited application of individual improvements to comprehensive application of a full range of improvement types throughout the network. The four levels are shown in Table 1.

Table 1: Levels of Implementation for Transit Priority

Level	*Improvements*
Limited	Specific Locations
Route Level	Entire Route
Areawide	Specific Points
Comprehensive	All Network & System Routes

The limited level consists of implementing transit priority techniques individually in various locations in the transit network. Generally, these consist of individual roadway improvements or changes to traffic regulations to help speed up transit service. Since most individual improvements cause only a small reduction in transit vehicle delay, eliminating single significant sources of transit delay can be helpful to particular route operations. Implementing transit priority on a limited level is not as effective.

In route-level implementation, a segment improves along the entire route. Good examples include building exclusive transit lanes and providing priority at traffic signals along a route or segment. Most new light rail systems have implemented these types of transit priority techniques. Several cities, including San Francisco[20] and Portland,[21] have implemented these techniques to existing route segments.

Areawide implementation of transit priority consists of implementing improvements in a particular area. Examples include construction of transit malls and introducing neighborhood traffic calming to improve transit service. Transit malls have been an effective part of many recent light rail projects, including those in San Jose, Portland, Denver, and Sacramento.

Traffic calming is becoming increasingly popular as cities attempt to make communities more livable. One lesson from Zürich is that combining these types of livability improvements with transit priority improvements in a coordinated areawide program can increase support for both programs. San Francisco also has successfully combined implementation of transportation demand management (TDM) programs with implementation of their transit priority program.[22]

Comprehensive implementation of transit priority has two aspects: implementing the basic transit priority improvements, such as transit lanes and traffic engineering, to all parts of the transit network, and implementing improvements and operating changes that make transit faster or more efficient at the network level (systems-level changes). Systems-level improvements include citywide traffic signal control programs, transit operations and dispatching centers, operating procedures (for example, proof of payment), transit vehicle design, and system coordination.

The comprehensive approach is the most effective way to implement a transit priority program. Zürich used this approach and today, after almost 30 years of implementation, most of the network operates with transit priority.

Transit Priority Implementation Problems

Many cities, including Zürich, implemented transit priority improvements in the early 1970s. While Zürich has continued to expand its program over the last 30 years, many U.S. cities have neglected and not expanded their transit priority programs. Examples of neglect include lack of enforcement, opening bus lanes to other traffic, and reduced interest in implementation of new programs.[23]

The difficulty in implementing transit priority improvements is ironic, because most transit priority techniques are relatively simple and inexpensive. It is critical, however, to design and implement these improvements carefully to ensure that they do not provoke opposition to the concept of transit priority and thus reduce the ability to further implement the program.

Implementing transit priority improvements is always difficult, because most urban roadways have a fixed amount of space available for their right of way, and generally it is all in use. These roads cannot be expanded to provide space for an exclusive transit lane. Therefore, either a travel lane or parking lane must be taken from other users. In either case there will be complaints, and it will be difficult for the government to change the existing situation to provide transit priority.

An interesting problem with transit priority is the difference in efficiency between transit vehicles and private cars. The problem is that a single exclusive transit lane with one fully loaded bus or tram every two minutes carries many more people than a lane completely filled with cars—but the transit lane looks empty compared to the auto lane. This generally enrages

those in the congested auto lane, and they argue that the transit lane is inefficiently used. This example indicates the importance of educating the public regarding the benefits of transit priority and designing a transit priority system that minimizes perceived inefficiency.

Another aspect of implementing transit priority techniques is that, while they are simple in concept, they often require careful engineering to ensure that they work well and do not unnecessarily impact other traffic. A well-designed transit priority improvement involves taking a comprehensive view of the traffic network rather than simply putting a single improvement in one place. Careful traffic engineering and strategic thinking is one way to address the public relations problems outlined above (or rather, not being careful is a good way to enrage the public against the program).

Transit priority techniques generally involve several different departments that often do not share the same goals. For example, the goal of many traffic engineering departments is simply to move traffic, but the goal of transit agencies is to move transit vehicles. Both groups must learn to work together to achieve a common goal of using the street space most efficiently. The problem of conflicting goals becomes even more acute when other goals, such as neighborhood livability, are factored in. Cities must develop ways for competing departments to work together in order to implement transit priority techniques successfully.

In summary, the key reasons it is difficult to implement transit priority techniques include:

- Low technical competence and lack of expertise on transit priority techniques and implementation.
- Lack of support or direct opposition by different agencies or departments.
- Difficulties of coordination between agencies and departments.
- Pressures by automobile users.
- Poor public understanding of the benefits of transit priority.
- Opposition to changes by businesses and residents.

The difficulty of overcoming these obstacles has led to skepticism and a defeatist attitude in transit agencies and planning departments about implementing transit priority improvements.[24] The goal of this research is to

describe some of the techniques used in Zürich to overcome these obstacles and implement a comprehensive transit priority program.

Implementing a Transit Priority Program with Bus Rapid Transit

There is a great deal of interest in bus rapid transit since these systems are generally less expensive and can be built more quickly than new heavy or light rail transit systems. While bus rapid transit could be attractive to many cities, it remains an underutilized form of transit service.[25]

Two good examples of bus rapid transit programs are Curitiba, Brazil, and Ottawa, Canada.[26] Both cities made substantial capital investments in providing more and faster bus service rather than constructing Metro or light rail systems. Focusing on bus rapid transit enabled them to build more extensive bus-based transit networks more quickly and less expensively than light rail alternatives.[27] Both of these bus rapid transit systems are outlined below. From the perspective of this research, what is interesting about these examples is how they integrated other transit priority techniques into their networks with construction of the major improvement.

Bus rapid transit provides an excellent opportunity to implement a comprehensive transit priority program, as the most successful bus rapid transit systems embody many transit priority improvements.[28]

Ottawa

In Ottawa, a bus-only transit-way system 31 kilometers long was constructed with stations along the routes. Buses operate on neighborhood streets and then enter the busway for the trip downtown. In the downtown area, they operate on a transit mall. The Ottawa system has been successful in terms of passengers attracted and operating efficiency, and by encouraging higher-density development near transit stations in the Ottawa region.[29]

Ottawa's approach involves implementation of all the transit priority techniques described in this research, including exclusive lanes, traffic regulations, system operating changes, and transit malls. Like Zürich, Ottawa implemented these changes in conjunction with planning improvements designed to improve overall operation of the system and livability of the region.

Curitiba

Curitiba has generated significant excitement in the transit industry because its busway combines many transit preferential techniques with excellent land use planning.[30] Curitiba created its busway by redistributing road space from mixed-flow to transit-only use. Curitiba made a relatively significant capital investment in building the system, including high-level stations and special buses. The cost were far less than rail alternatives or building a new right of way for buses.

Importantly, Curitiba was able to build an entire network rather than a single line. Curitiba's radial network of five rapid bus corridors perform much like light rail lines by providing high-frequency service on an exclusive right of way to stations using specially designed double articulated buses. An extensive feeder bus network connects these stations to neighborhoods.

Key aspects of Curitiba's system include the following:

- *Exclusive Transit Lanes*—The rapid bus corridors in Curitiba consist of transit-only lanes in the center of a street with local traffic on the outside lanes. A low curb separates bus lanes from mixed traffic lanes. The buses do not get stuck in traffic congestion, and therefore can make fast trips. Private vehicles are not ignored in the Curitiba system. The two parallel streets on either side of the bus street are one-way arteries for this traffic; thus the three streets act as a single system providing multimodal transportation in the corridor.
- *Level Boarding*—Passengers in Curitiba enter a tube-shaped waiting area at the height of the bus floor. When the bus arrives, it positions its doors at the doors of the tube and small drawbridges provide a path between the tube and the bus. The buses and tubes have four double doors, so the bus dwell time is short. Low-floor transit vehicles can provide similar advantages without having elevated floor stations.
- *Fare Prepayment*—Passengers in Curitiba pay their fare when entering the tube, so the bus is not delayed while passengers pay their fare. Again, this reduces bus dwell times at stations. (Note that instituting a proof-of-payment system for fare collection can provide similar advantages.)
- *Feeder Service*—The Curitiba bus corridors include stations where people can transfer easily between the fast, high-frequency buses that serve the rapid bus corridor and feeder buses that circulate through the

neighborhoods. These stations include newsstands and protection from the weather, similar to rail stations.

- *Land-Use Changes*—The city of Curitiba encouraged higher-density development along the rapid bus corridors by upzoning land on these corridors. High-density development on these corridors has increased ridership on the transit system and reduced the spread of lower-density development around the outskirts of the city.

In Curitiba, another goal was to integrate many of the transit priority techniques outlined in this research with a major capital investment to create a high-quality, cost-effective transit system—the same approach taken in Ottawa and Zürich. The success of these systems should encourage more cities to consider this approach as a cost-effective transit system improvement.

ZÜRICH CONTEXT

INTRODUCTION

The City of Zürich is the historic, administrative, and cultural center of northeast Switzerland, located at the north end of Zürich Lake. The city's medieval old town and central business district spread along the banks of the Rivers Limmat and Sihl where they enter the lake.

Zürich is a truly livable city with a wealth of recreational and cultural opportunities. The city's motto, "Little Big City," is intended to communicate that it is comfortable to live in, but has the cultural opportunities of a large European city. The city's transportation system plays an important role in creating Zürich's dynamic and livable environment.

This chapter provides a context for the report by outlining Zürich's population and economic statistics, transportation system statistics, and the Swiss system of government.

ZÜRICH POPULATION AND EMPLOYMENT

Zürich is the largest city in Switzerland, with a population of approximately 335,900. Approximately 928,000 live in what has been defined as the Zürich agglomeration (the commute-shed area for the city). Approximately 1,178,400 live in the 171 towns that make up the Canton of Zürich. The total population of Switzerland is about 7,097,000 in 26 cantons. The capital of Switzerland is Bern.

The populations of Zürich city, agglomeration, and canton are presented in Table 2. Like many central cities, during the last several decades Zürich's city population has fallen while the population of the surrounding area has increased. Zürich is about the size of a small to medium U.S. city such as Portland, Oregon, or St. Louis, Missouri. .

The city is 92 square kilometers (approximately 36.8 square miles) and the canton is 1,728 square kilometers (approximately 691 square miles). In 1997, the population density was approximately 3,860 persons per square kilometer for the city of Zürich (9,130 per square mile), 680 persons per square kilometer in the Canton of Zürich (1,705 per square mile), and 170 persons per square kilometer in Switzerland.

Table 2: Zürich Population

Year	*City*	*Agglomeration*	*City%*	*Canton*
1900	176,900	NA	NA	431,000
1941	359,700	NA	NA	674,500
1950	390,000	605,800	64%	777,000
1960	440,200	754,500	585	952,300
1970	422,600	884,800	48%	1,107,800
1980	369,500	898,900	41%	1,122,900
1990	365,000	940,200	39%	1,179,000
1995	342,000	926,200	37%	1,173,000
1997	335,900	928,000	36%	1,178,400

Source: *Statistisches Jahrbuch des Kantons Zürich.*

Employment and Income Data

While Zürich's resident population has been falling, the number of people working in Zürich has increased (see Table 3). Employment in the city rose from approximately 315,000 in 1975 to 351,600 in 1991, but fell significantly in the economic recession that Switzerland experienced from 1992 until 1998. Recently, employment has been increasing although it is still short of its historic high.

Table 3: Employment Statistics

Year	*City*	*Canton*	*City%*
1985	NA	687,100	47.4%
1991	351,600	742,200	47.4%
1995	323,500	695,400	46.5%
1998	313,900	693,200	45.3%
2000	327,800	716,300	45.8%

Source: *Statistisches Jahrbuch des Kantons Zürich 1997, 1999 - p. 486*

Similar to many older cities in high-income countries, Zürich is losing much of its manufacturing industry while growth is occurring in the professional and service sectors. Employment in the service sector increased from 71 percent to 81 percent between 1975 and 1991. This trend has extended to the canton as well, with employment in services increasing from 65 percent to 73 percent between 1985 and 1995.

The Canton of Zürich has the third-highest income per capita of Swiss cantons. In 1995, per capita income was approximately 57,100 Swiss Francs (SFr) per year ($35,700) versus approximately 45,000 SFr for Switzerland as a whole.

TRANSIT SERVICE QUALITY

Zürich, like many European cities, provides a high level of transit service to its citizens. In Zürich, this high level of service encompasses all the factors that matter to public transit customers: frequency, coverage, speed, reliability, safety, and quality. The most important aspect of Zürich's public transit system is that it is an excellent network. Passengers can get from anywhere to anywhere almost anytime of the day throughout the year.

Providing high-quality transit service is a prerequisite for successfully implementing a transit priority program. In the words of many of those interviewed for this research, Zürich has always had good public transit service; the transit priority program improvements were simply needed to improve the quality of transit service, given the increase in private traffic during the years following World War II. Transit priority improvements enabled Zürich to increase the speed of transit vehicles, allowing the city to operate more transit service for the same amount of money. It also made service more reliable for customers.

This section outlines characteristics of transit service supply in Zürich that have helped make the transit priority program a success.

Service Frequency

Transit service in Zürich is offered on a frequent basis throughout the day with a limited night bus system operating on weekends. Most lines operate seven days a week, with service every 7 to 8 minutes between about 7 A.M. and 8 P.M., and approximately every 12 minutes during the early morning and evenings until about midnight. As many streets have several transit lines operating on them, the effective frequency of vehicles is even higher.

Passenger Comfort and Safety

Zürich's streetcars and buses are invariably clean and comfortable. The vehicles enable easy access through multiple doors. The system uses proof of payment and vehicles are designed with plenty of space around the back door for easy movement and storage of such items as baby carriages. Service is operated frequently enough that it is generally easy to get a seat. The Zürich transit system, like the rest of the city, is safe. One measure of its safety is the large number of young children using the system independently.

Transit Service Network Coverage

Both the City of Zürich and the canton have strong transit service requirements. According to Ott, "The Canton's Public Transport Act of 1988 and the relevant Transportation Supply Order call for the provision of good public transportation services for all contiguous built-up areas with at least 300 inhabitants, jobs or trainees/students. 'Good' means that there must be a bus or tram stop in the catchment area within a distance of 400 meters of the built-up area or a train stop in a catchment area within a distance of 750 meters with at least one service per hour."[31]

The City of Zürich provides an extremely high level of transit service. The city's public transportation company, Verkehrsbetriebe der Stadt Zürich (VBZ), operates a network of almost 450 kilometers, out of a roadway network of 800 kilometers. This network consists of approximately 109 kilometers of streetcar line, 54 kilometers of trolley-bus line, 130 kilometers of motor bus, and 181 kilometers of regional buses. The network has increased by approximately 31 percent since 1970. Zürich streetcar and bus stops offering better than 10-minute frequency service are located within 300 meters of almost all built-up areas of the city. This means that almost all residents and employees have easy access to transit.[32] At the regional level, the commuter rail system (S-Bahn) covers a network of approximately 508 kilometers, of which 457 kilometers are part of the national rail network and 51 kilometers are privately owned rail lines.

There are almost twice as many S-Bahn stations per square kilometer within the City of Zürich as in similar cities with S-Bahn systems.[33] The canton's regional transportation agency, the Züricher Verkehrsverbund (ZVV), started operation in 1990. The ZVV is responsible for coordination and financing of all 262 lines (covering 2,300 kilometers) of the Canton's 42 different public transit operators, including the Zürich city network and the regional S-Bahn

service. The transit operators who constitute the ZVV have 1,228 vehicles, including buses, S-Bahn trains, streetcars, and ferries.[34] The ZVV is described in more detail in "Complementary Transportation Programs."

TRANSPORTATION STATISTICS

This section outlines transportation statistics from Zürich, including transit ridership modes, split data, and auto ownership.

Transit Ridership

One of the most interesting things about Zürich, from a transportation planner's perspective, is that it has an extremely high degree of transit use for a relatively small city. According to Cervero, "Zürich boasts one of the highest rates of transit usage anywhere today—about 560 transit trips per resident per year. This is almost twice as many transit trips per capita as in Europe's largest cities—London, Paris, and Berlin—made all the more remarkable in that Zürich is one of Europe's wealthiest cities and unlike these places, has no downtown metro circulator." [35]

Table 4 summarizes annual transit ridership data over time for Zürich's city transit network of trams and buses.

Table 4: Annual Transit Ridership Data Over Time

Year	*Population*	*Annual Transit Trips (000's)*	*Avg. Transit Trips per Resident*
1941	185,536	85,536	
1950	390,000	158,768	407
1960	440,200	196,442	446
1970	422,600	202,295	479
1980	369,500	217,183	588
1990	365,000	273,000	NA(1)
1995	342,000	283,000	NA
1997	335,900	268,000	NA

Source: *Population and Transit Trip Data: Statistisches Jahrbuch des Kantons Zürich.*
1. Trip data from 1990 on is boardings not linked trips, so "Average trips" is not calculated.

Transit ridership in the Zürich area is changing as a direct result of changing spatial patterns. Specifically, ridership on the regional S-Bahn system is increasing while ridership on the city network (VBZ buses and trams) is falling slightly. Two reasons for the falling absolute transit ridership may be the decrease in the city's population and the economic downturn in the 1990s. Table 5 summarizes recent average weekday transit ridership data for Zürich's city network and S-Bahn trips at the border of Zürich.

Table 5: Average Weekday Transit Ridership

Mode	*1989*	*1990*	*1995*	*1997*
Zürich Border S-Bahn	170,700	208,300	232,200	233,700
Zürich–City Network	434,000	430,000	433,500	411,200

Source: *Statistisches Jahrbuch des Kantons Zürich 1999* - p. 184.

Mode Split

Zürich has a high mode split for journeys to work via transit. This is clearly a reflection of the fact that transit service is excellent and it is expensive (mostly due to parking costs) to commute with a private automobile in the city. As with the transit ridership data, mode split data confirms the increase in regional trips over intracity trips caused by growing development outside the center city. Details are presented in Tables 6 through 8.

Table 6: Mode Split for Zürich City Residents Working in City

Residents	*1970*	*1980*	*1990*
Walk	19%	14%	16%
Bike	6%	5%	6%
Public Transit	49%	55%	61%
Private Car	26%	26%	17%
Total	100%	100%	100%

Source: Ott (1992 OECD) & *Der ZVV in Kurze* 95

Tables 7 and 8 show that for regional commuter trips, the opening of the S-Bahn in 1990 caused many people to switch from private cars to public transit.

Table 7: Mode Split for Commuters into the City

Residents	*1970*	*1980*	*1990*
Public Transit	51%	47%	58%
Public Transit	51%	47%	58%
Private Car	49%	53%	42%
Total	100%	100%	100%
Source: *Ott (1992 OECD) & Der ZVV in Kurze 95*			

Table 8: Mode Split for Commuters out of the City

Residents	*1970*	*1980*	*1990*
Public Transit	37%	345	42%
Private Car	63%	66%	58%
Total	100%	100%	100%
Source: *Ott (1992 OECD) & Der ZVV in Kurze 95*			

In terms of trips for people living and working within the city, the number of people driving private vehicles decreased substantially as transit priority and traffic restrictions were implemented during the early 1980s.

Vehicle Ownership Rates

The City of Zürich has a significantly lower auto ownership rate than the rest of the canton and Switzerland (see Table 9). The city's auto ownership rate has hovered between 39 percent and 36 percent during the period between 1992 and 1997.

Table 9: Residence and Private Vehicle Ownership Rate

Residence	*Private Vehicle Ownership Rate*
Switzerland	47%
Canton of Zürich	46%
City of Zürich	36%
Source: Switzerland and Canton: *Federal Census 1999*; City: *Canton Yearbook 1999*.	

SWISS SYSTEM OF GOVERNMENT

This section outlines Switzerland's system of government as context for understanding adoption and implementation of Zürich's transit priority program. The nation's system of direct democracy was a key reason for implementation of the transit priority program. The federal, cantonal, and local levels of government are described to provide additional context for understanding implementation of the program.

Federal Government

Switzerland was founded about 700 years ago when three cantons banded together to form a confederation. The Confederation Helvetica, as Switzerland is officially known, grew to include 22 cantons and four half-cantons.

Switzerland has a national parliament similar to the U.S. Congress in that it consists of two parts: the Nationalrat, a population-based chamber, and the Standerat, a chamber with two votes for every canton. The Nationalrat has 200 members (the Canton of Zürich has 34 seats) while the Standerat has 48 members.

The Nationalrat and Standerat are both part-time legislatures. All legislators are elected using a proportional-based party voting system that is quite complex. There are four major parties and many smaller ones. For a law to pass, it must be approved by both chambers of the Parliament. Similar to the U.S. Senate, this gives the smaller cantons effective veto power over the larger cantons.

While Switzerland's Parliament is similar to that of the United States, the executive branch is quite different. The Bundersat carries out executive functions, including day-to-day business. The Bundesrat is a group of seven people elected by the Nationalrat and Standerat together. Since 1959, the composition of the Bundesrat has been designated as two members from three political parties with the seventh member from a fourth party.

Canton Government

Cantons are the political equivalent to U.S. states with functions such as vehicle registration, but are generally about the same size as small- to medium-sized U.S. counties. In Switzerland, cantons are the strongest level of

government. Similar to counties, cantons directly impact citizens. Switzerland's constitution preserves the power of cantons and the people.

Each canton has a legislature (Kantonsrat) and an executive branch (Regierungsrat). In Zürich, the Kantonsrat consists of 180 people who meet to provide policy direction. The group also forms subcommittees to investigate particular issues and make recommendations to the full Kantonsrat. This relatively large body helps bring government closer to the people, since most citizens actually know members of the Kantonsrat and see them on the streetcars or in neighborhood cafes.

In Zürich Canton, the Regierungsrat consists of seven full-time elected officials who are responsible for managing particular portfolios of agencies, similar to the commissioner form of local government in the United States. For example, one member of the Regierungsrat is responsible for transportation. This person serves as department manager and represents the department in the legislative meetings.

Local Government

In Switzerland, the basic unit of local government is the Gemeinde. The Gemeinde government has the same basic organization as the canton. The Gemeinderat is the legislative branch (parliament) and the Stadtrat is the executive branch. In Zürich, the Gemeinderat consists of 125 people elected from 12 districts (Kreise).

Zürich's Stadtrat consists of nine full-time elected officials, who are each responsible for a specific department. The Zürich Gemeinderat meets almost weekly and sets policy for the city. The Stadtrat carries out policies. The Gemeinderat has committees to study issues and present ideas before the entire body. The Stadtrat answer for their departments at the meetings.

In the Appenzeller half-cantons, policy direction for the Gemeinden is still given directly by the people in Landesgemeinde meetings. Annual meetings are held each April. Similar to New England town meetings, annual meetings include the entire voting population.

Direct Democracy

Direct democracy is the most interesting aspect of Swiss government, especially as it relates to capital projects and policy setting. The Swiss people

go to the polls seven or eight times per year to decide upon a variety of issues at the local, canton, and federal levels. Some issues must be voted on by the people, while others may be placed on the ballot.

Under direct democracy, the Swiss people decide many of the most critical issues facing the nation. For example, the decisions to not join the European Union, not to disband the army, and not to build a national high-speed rail system have all been decided in referenda. The people also have decided how much money to spend on the national rail system's Bahn 2000 program and the AlpTransit project in referenda.

One measure of the cantons' strength is the fact that federal measures must be approved by a majority of the national population and receive a majority vote in a majority of the cantons. One key aspect of direct democracy is that all major capital expenditures must be voted on and approved by those who will pay for them. For example, citizens in the City of Zürich must vote on any capital expenditure over 10 million Swiss Francs (approximately $7 million). The direct impact on government is to reduce the level of expenditures and therefore make programs less ambitious. One result of this requirement is that Switzerland has one of the lowest tax rates in Europe.

The United States is similar to Switzerland in that many cities rely on votes of the public to fund major capital improvements such as building and revitalizing transit systems. In fact, many major transit projects underway in the United States today are based on new taxes approved by voters for the specific purpose of well-defined transit improvements.

Several Western states allow open ballot initiatives. Interestingly, some U.S. political scientists question the benefit of the initiative process due to the widespread influence of money in developing and approving initiatives, and also in terms of the quality of the laws that come out of the process.

The Swiss citizens' initiative process is similar to the U.S. processes. Citizens draft a measure, collect a required number of valid signatures, and then the measure is placed on the ballot. One significant difference is the long time between when the measure is turned in and when it is voted on. Time gives the government plenty of leverage. In the interim time, the government can consider and develop counterinitiatives that might be more equitable to the voters and more in keeping with the government's approach.

The People's Initiative for the Promotion of Public Transportation of 1973 was the key factor in implementing Zürich's transit priority program. The initiative was discussed for a significant time in the government before being placed on the ballot. However, the Gemindesrat eventually took a position against the measure. Interestingly, it took a strategic approach in the sense that it outlined a basic approach and left it up to city departments to develop the detailed implementation plan. For more information, see the discussion by Zürich transportation planner Ernst Joos on strategic issues versus short-term benefits in *Economy and Ecology Are Not Contradictions*.[36]

The initiative and how it influenced Zürich's public transit system is described in the following chapter.

HISTORY: ZÜRICH'S TRANSIT PRIORITY PROGRAM

INTRODUCTION

The story of Zürich's transit priority program begins in years following World War II when significant population and economic growth, combined with increasing use of private cars, caused major transportation problems. As early as 1948, a description of Zürich said "It is easier to put a camel through a needle than to drive a car through a main street or find a parking place."[37] From public transit's perspective, the biggest problem was the impact of increasing traffic congestion on operation of the city's tram and bus network.

Zürich's approach to solving its growing transportation problems mirrored that of most other cities. In the 1950s and 1960s, plans were made for freeways and major new transit systems. In the 1970s, a backlash developed against these capital improvement solutions and many plans went unrealized. Arguably it is harder to build large projects in Zürich than in other cities, because Switzerland requires voter approval for major capital investments.

During the 1960s and 1970s, Zürich voters rejected two major public transit improvement plans and several roadway plans. Citizen rejection and then approval of a transit priority measure was the single most important factor in Zürich's choosing to adopt the transit priority program. Instead of simply saying "No" to the major transit improvement schemes, citizens developed an alternative "fix the existing system" approach. The latter approach focused on implementing a comprehensive transit priority program. This chapter outlines the history of that effort.

TIEFBAHN PLAN

During the 1950s, the accepted solution to solving transportation problems was to rebuild the entire transportation system with new facilities that could be constructed quickly and meet the entire transportation demand. This meant large, unexpected, and complicated building projects such as freeways and new rail transit lines. In hindsight, it is not so surprising that in many cities these plans were not built, but rather that they were built in any city.

Zürich was no exception in its belief that transportation problems could be solved with these massive construction projects. The city worked through the

1950s developing plans for a major freeway system and a project that would place the existing streetcar network underground in the center city.

Zürich's public transit company prepared the Tiefbahn underground train plan. The Tiefbahn Plan proposed to reduce the impacts of congestion on operation of the streetcar network. The goals of the Tiefbahn Plan were to speed up the streetcars and free space on the surface for private vehicle traffic. The plan would have placed Zürich's existing streetcars underground in the central city. The proposal would have cost 543.7 million Swiss Francs (1962 estimate). Because it was a major capital project, citizens of the City of Zürich needed to vote on the Tiefbahn Plan.

On April 1, 1962, voter turnout at the election was high, at almost 72 percent.[38] The plan was placed before the voters and defeated by a vote of:

- YES - 34,307 - (38.9%)
- NO - 53,893 - (61.1%)

The defeat of the Tiefbahn plan was unexpected. The general consensus was that the transit system needed to be improved. All the elected officials supported the plan, but two different groups opposed the plan. Tram enthusiasts believed that the existing system could be improved quickly and efficiently. [39]

The second group wanted to build a modern Metro-type rail system similar to other European cities rather than simply placing the existing streetcars underground. Blanc speculates they never would have voted No if they had known that 30 years later the same streetcars they wanted to replace would still be running on the surface streets.[40] The plan also was defeated because of its high cost, need for destruction of many parts of the city to build the new tunnels, and what newspapers called groups of "chronic naggers and no-sayers." [41]

Concurrent with the defeat of the Tiefbahn Plan, Zürich's freeway planning was criticized. Three major national freeways were planned to meet at the center of the city where they would form a "Y." The route of such a massive and ugly construction would negatively impact the city's economy and a major part of the system was going to be built in the generally accepted area for expansion in the city's central business district.

Furthermore, only 25 percent of the traffic on the system originates or ends in the center city. According to Blanc, the Tiefbahn Plan's surprising defeat and the rising concerns about freeway system planning signaled the failure of the 1950s concept for solving transportation problems and led to a comprehensive reexamination of the approach to transportation planning in Zürich, away from the megaproject approach of the 1950s.[42]

The recognition of the need for a new type of transportation planning was not unique to Zürich. Many criticisms of the 1950s style of transportation planning were published in the 1960s, including Jane Jacobs' *The Death and Life of Great American Cities* in the United States and the *Buchanan Report* in Britain. Citizen protests against freeway projects, the most famous being in San Francisco and Boston, were causing many cities to rethink their plans for urban freeways.

TRANSPORTATION PLANNING REALISM

Following rejection of the Tiefbahn Plan and the advent of major criticism of freeway plans, Zürich took the advice of professional transportation planners and the newspapers. Traditionally, the City Engineer performed transportation planning duties. However, Zürich formed a professional city planning department and gave it responsibility for transportation planning. Formerly, separate departments on the neighborhood level planned, focusing on building inspection and detailed zoning rather than citywide issues. It was difficult for Zürich to find a qualified person to serve as director of the newly created Planning Department. Eventually Hans Marti, a former member of the Zürich Geminderat (city legislature) and a professional planner, was hired.

Marti's selection was especially interesting since he was a vocal critic of some previous transportation plans when he was in the government. In 1964, after analyzing the transportation situation, Marti presented his ideas to the Geminderat. His overriding belief was that transportation should serve the greater interest of city planning, not the other way around. His analysis was direct and not encouraging to the elected officials. He believed that a city adapted to automobiles is neither wanted nor possible for financial reasons; furthermore, the public transit system must have priority.[43]

Approval of providing transit with priority in the center city was growing. For example, a public survey in Munich proved people thought transit priority made sense.[44] A simple reason for supporting transit priority in Zürich was to ensure that the public transit system could continue to work while constructing

a new underground system. Marti believed that it could take decades before a new U-Bahn (subway) could take over the tasks of the tram network in the center city.[45]

An impetus for implementing some transit priority improvements came in the late 1960s when Zürich started replacing some of its streetcars with longer articulated models. Since these vehicles required longer boarding platforms, the stops in the center city were redesigned and traffic was limited on the main streets by channeling it to other streets that were made one-way. Although these measures were effective at keeping traffic moving, owners of major stores did not support them.[46]

A EUROPEAN METROPOLE?

During the 1960s and 1970s, Zürich experienced something of an identity crisis. The business community wanted Zürich to become a European Metropole while the citizens gradually grew tired of the development's negative impacts on their quality of life. This is a theme that Zürich has in common with many other older cities experiencing rapid economic growth (for example, San Francisco).

In the early 1960s, Zürich was headed in the direction of more development. The strongest supporters for the Metropole idea were associations of stores and banks. These groups lobbied for increased development and presented recommendations on a variety of topics including transportation. One group, called Stadt Vereinigungen (City Association) published a list of 33 theses for quick improvement of the transportation system. Their ideas, not surprisingly, focused on measures to provide fast, efficient access to the center city by automobile.[47]

That the Zürich region would continue to grow seems to have been unquestioned by civic leaders and the government. In 1971, Zürich released a transportation plan for the Zürich region. This plan, based on a population of 2.1 million for the Canton of Zürich, projected saturation conditions for the transportation system. The plan recommended implementing measures to preserve future transportation corridors. Government planners seemed to believe that the public would approve the new transportation projects necessary to serve this development and did not really work with the public to develop their plans. They had forgotten about defeat of the Tiefbahn Plan in 1962.[48]

Public support for continued development began to decline in the late 1960s and early 1970s as the results of economic development started to become visible. The main problems were that people were displaced by businesses moving into the city and construction of major infrastructure projects. Many people questioned the need for economic growth in Zürich. In 1969, citizens overwhelmingly rejected a proposal to bring the 1976 Olympics to Zürich because of the infrastructure needs that this would have entailed, but during the same year several roadway projects were approved.

There was significant debate in Zürich over urban freeways and the impacts of transportation projects. The Stadtrat recognized this in a statement made in 1972: "Though the use of the car is obvious, it must be established that there is a growing resistance to the car and building of streets."[49] City leaders seemed to miss the growing resistance to the environmental impacts of continued growth, an omission that had significant impacts on plans for constructing a U-Bahn/S-Bahn system.

1973 U-Bahn/S-Bahn Proposal

In 1973, the underlying public unease with Zürich's continued development made itself felt at the ballot box when citizens defeated a proposal to construct a major new transit system in the city. One of the main arguments against the U-Bahn/S-Bahn proposal was that making the existing surface system more efficient would be a better solution to transportation problems. This section describes the U-Bahn/S-Bahn proposal and campaign.

U-Bahn/S-Bahn Plan

Zürich planners had started working on the U-Bahn project following defeat of the Tiefbahn Plan in 1962. The group that opposed the Tiefbahn Plan because they wanted to replace the existing streetcars prevailed in the decision of what type of transit system to build following the Tiefbahn Plan election. In the new plan, instead of placing the existing streetcars underground, a new underground heavy-rail (U-Bahn) system would be built to replace some of the main streetcar lines operating in the inner city. This is similar to Metro systems being built in many cities at this time.

In parallel with the city's efforts, planners from the Swiss national railroad (Schweizerische Bundesbahnen or SBB) were developing a plan to address problems with Zürich's existing suburban fast-rail network (S-Bahn). Both

projects, the heavy-rail U-Bahn and the S-Bahn, were combined into a single ballot measure costing approximately 1.2 billion Swiss Francs (SFr).

The U-Bahn/S-Bahn plan would have created a three-level transit system for Zürich similar to that in many large cities. In such a system, surface transit (trams and buses) handles the short trips, a subway or elevated heavy-rail system (U-Bahn) handles the medium-distance trips, and a fast suburban train (S-Bahn) handles regional trips.

Initial Optimism

During the 1960s and early 1970s, it was hard to find anyone opposed to the U-Bahn/S-Bahn project. A public opinion survey taken in 1972 showed increased support for public transit over a similar survey completed in 1968. In 1972, people believed that public transit should receive greater support than private transportation, while in 1968 they thought that public and private transportation should be supported equally. The 1972 survey demonstrated a clear majority of voters supported the U-Bahn/S-Bahn project.[50] Interestingly, most of those surveyed believed that others would benefit from the system rather than themselves, but a majority believed that everyone would benefit from the system's construction.

This survey proved higher support for the U-Bahn system than the S-Bahn system. Therefore, the government made the decision to bundle both proposals together. The government could have placed two separate measures on the ballot, but placed only one on because of the strong support for the U-Bahn.

Another reason for optimism was that construction of some pieces of the U-Bahn system had started. An underground station was built for the U-Bahn in front of the city's main train station and a 2-kilometer tunnel was constructed under a section of freeway leading out of the city.[51] Both were constructed as part of larger projects and would have been much more expensive and disruptive to construct later, after a vote on the entire U-Bahn system.

Amid this general optimism, the U-Bahn/S-Bahn proposal was placed on the ballot for a May 1973 election. The government clearly believed that the voters would approve the plan. However, early in 1973 a backlash against the U-Bahn/S-Bahn proposal started with the liberal parties (Social Democrats) and labor unions, then spread through the more center parties.

Opposition to the U-Bahn/S-Bahn Proposal

Economic Issues

The main argument against the U-Bahn/S-Bahn was that it would cause continued economic development in Zürich and that this would push people out of the city as offices replaced apartments and rents were increased. The liberal parties characterized the U-Bahn/S-Bahn project as a class conflict between the landowners who would profit from higher rents and companies who could raise prices against people living in the city. Furthermore, the opposition argued, why should so much money would be spent on a disadvantaged project?[52] These arguments are illustrated in campaign posters.

The parallels in this argument with those going on in San Francisco at the same time are amazing. In San Francisco, residents of the Richmond District opposed construction of the Gear Boulevard Bay Area Rapid Transit (BART) line due to the development it was expected to generate, and the line was never built. Similar local opposition led to downzoning of areas around BART stations on the lines that were built. Very interestingly, Zürich's liberal parties used the same word to describe their development fears as that used in San Francisco: "Manhattanization."[53]

Transportation Issues

In addition to the opposition that focused on the impact of continued development, a second sophisticated argument was made. The option of "cleaning-up" the existing surface transit system would be a more efficient and better transportation option than the proposed U-Bahn/S-Bahn. These arguments appeared in a guest article in the weekend edition of the Zürich *Tages Anzeiger* magazine.[54]

The transportation argument focused on the fact that the plan would not shorten most trips in the city, because the new system would lead to a time improvement on long trips but lengthen short intracity trips. The proposed U-Bahn/S-Bahn system would have reoriented Zürich's existing streetcars and buses to feed passengers into the new system. This would have required many people to transfer from surface transit into the underground system. In Zürich, where most trips are short, the new system could have been less convenient for intracity riders.[55]

Ecology

Another argument was ecological. Opponents believed that once the U-Bahn was built, many of the city's existing streetcar lines would be abandoned and their track space given over to automobiles. This had happened in some German cities that had built U-Bahn systems (for example, Munich). Once there were more cars on the streets, there would be demand for more parking and additional road building.[56]

Cost

Finally, there was the cost. The proposed U-Bahn/S-Bahn system would have cost more than 1 billion Swiss Francs, and opponents provided data showing that similar systems in other cities had cost significantly more to construct.[57] They also argued that public transit could be improved for much less money.[58]

Campaign and Election

A strong campaign was run in favor of the U-Bahn/S-Bahn proposal. It was well funded and had strong support from business and industry. Most of the political parties supported it.

The Yes Campaign responded to the opponents' arguments in several ways. The city government attempted to address concerns regarding the impacts of the project on property rents and development, but were only able to come up with vague and nonbinding methods that did not satisfy the opposition.[59] The Yes Campaign also argued that the U-Bahn/S-Bahn was needed to keep the economy healthy, but that argument seems not to have resonated with the voters since the economy was strong at the time.

The Yes Campaign responded to the alternative proposal for improving the existing system in a follow-up article by their press spokesperson in the *Tages Anzeiger* magazine. This article for the most part outlined technical problems with the opponents' alternative proposal in an attempt to discredit it.[60]

In contrast to the Yes Campaign, the No Campaign had little money but was able to mobilize many volunteers for leafleting and tabling. Volunteers from the Social Democrats and Progressive Organization of Switzerland and many students were involved in the campaign. The opponents mobilized many people because of the clear impacts of development on life quality.

The Social Democrat Party was a big part of the No Campaign; however, it was divided in its opposition to the U-Bahn/S-Bahn proposal. The younger progressive members opposed the proposal while the older leaders supported it. Ultimately, the members voted against their leadership to oppose the U-Bahn/S-Bahn.

Since the No Campaign had a small budget, a critical part of the campaign were the articles in *Tages Anzeiger*. These provided the opportunity to reach a wide number of voters and to present thoughtful arguments against the new system. Another critical part of the No Campaign was development of a people's initiative to improve the existing surface transit system rather than building the U-Bahn. This initiative was developed by a group of transportation professionals and students and put forward by the Social Democrat Party as a progressive alternative.[61]

On election day, May 20, 1973, Canton of Zürich voters went to the polls in the third-highest turnout election in 10 years (64 percent) and rejected the U-Bahn/ S-Bahn proposal by a vote of:

- YES - 177,362 - (43%)
- NO - 234,230 - (57%)

The results were even more negative in the City of Zürich, where the proposal was rejected by almost 60% of the voters.[62] These results were a surprise. Even given the opponents' strong arguments against the proposal, most people expected it to be approved by the voters.[63]

Some observers speculate that the U-Bahn/S-Bahn proposal was a victim of timing. They believe that it would have passed had it been on the ballot two years before, when there was less concern about the impacts of economic growth, or two years later when people were worried about economic recession. They believe that the U-Bahn/S-Bahn proposal itself became completely intertwined with the impacts of economic development on quality of life and those concerns reached a high point in 1973. [64]

Conversely, opponents of the U-Bahn/S-Bahn proposal believe that it would not have passed had it been on the ballot on a later date.[65] They point out that changing perspectives on urban planning away from megaprojects and redevelopment started to gain momentum in the early 1970s. Furthermore, the growing political power of environmental groups would have made itself felt

in later elections. This point of view seems to be borne out with the results of later transportation ballot measures in Zürich.

The defeat of the U-Bahn/S-Bahn proposal was a significant blow to the city's plans for improving its public transit system. It was a real surprise, because for many years it seemed that everyone had been in favor of the U-Bahn/S-Bahn system. Since the U-Bahn/S-Bahn was a fundamental part of the city's overall transportation plan, Zürich's entire transportation policy had to be revised. The centerpiece of Zürich's new transit policy became the alternative ideas put forward by the Social Democrats for improving the existing public transit network.

PEOPLE'S INITIATIVE FOR THE PROMOTION OF PUBLIC TRANSPORT

In the campaign against the U-Bahn/S-Bahn proposal, the Social Democrats had said that the existing transit system could be improved for far less than the 1.2 billion Swiss Francs the U-Bahn/S-Bahn system would cost. During the campaign, the Social Democrats put forward an alternative proposal, developed by a group of transportation professionals and students, called The People's Initiative for the Promotion of Public Transport, to implement a comprehensive transit priority program in the city.

There were two main reasons why the Social Democrats developed the transit priority initiative. First, improving public transportation is a fundamental part of the progressive program. A progressive party cannot seriously argue against a public transit proposal without having, or being willing to develop, its own proposal. In fact, they were clear in their campaign material that they were not against public transit, but against this particular proposal.[66] The second reason had to do with progressive politics. At the time there was also a power struggle going on in the progressive community and the Social Democrats wanted to be viewed as leaders in transportation policy. Therefore, the party liked the idea of developing and passing an initiative. [67]

Transit Priority Program Initiative Development

In the early 1970s, there was a great deal of interest in transit priority techniques. In Switzerland, the city of Bern already had implemented transit priority techniques and was viewed as a leader in progressive public transit thinking.[68] Transportation planners in Zürich were considering transit priority ideas and how they might be implemented in the city's system.

In 1971, Zürich's City Planning Department prepared a report titled "Tram Route #10: Journey-Time Measurements and Measures to Increase its Speed Study."[69] This study analyzed the causes of delays on a specific tram line and made more than 105 specific recommendations for improving service on the route.[70]

The report's main recommendation was to reduce interference of private traffic with the public system through introduction of transit-only lanes, priority for public transit at traffic signals, and traffic improvements. The original objective of the report was to recommend improvements for the existing transit system while the new U-Bahn/S-Bahn system was being built and for the new system's feeder network.

Many of the Tram Line #10 Study ideas were outlined in the April 1973 *Tages Anzeiger* magazine article by Schweingruber and Romann as an alternative to the proposed U-Bahn/S-Bahn system. The package of improvements was called "cleaning" the tram system (in addition to improving the existing tram network, they proposed a different version of the S-Bahn for regional trips). In the article, they set forth a six-stage program of transit priority improvements that consisted of the following elements:

1. Absolute Priority for Trams and Buses —Changes to traffic regulations
2. Exclusive Transit Lanes and Traffic Signal Priority
3. Higher-Frequency Transit—Changes that would allow more frequent transit headways
4. Extensions and Additions to the Transit Network
5. Improvements of Interchange Points—Main stations served by multiple tram lines
6. Improvements to Stops and Stations—For example, raising the curb to make it easier to board trams and buses

Some of these measures had been implemented in particular places. Most were easy, but Schweingruber and Romann called for implementing them throughout the entire city transit network without regard to their impact on the automobile network. They estimated the cost for these improvements in Stages 1 to 4 at between 160 and 210 million Swiss Francs and projected that they could be implemented in 10 years.[71]

The People's Initiative for the Promotion of Public Transport was drafted in this environment by a small group of transportation professionals and students. It called for implementing the program outlined by Schweingruber and Romann in their article in *Tages Anzeiger*, which essentially crystallized many of the transit priority ideas in the air at the time. The text of that measure was:

> At the expense of the investments fund, a credit of 200 million francs will be approved to permit, in the course of the ten years following the referendum, at a rate of 15 to at most 25 million francs per year, the financing of structural additions and improvements to the network of the transportation company of the City of Zürich, which will serve exclusively and substantially to eliminate all interference by private traffic and internal problems within the companies, so that the vehicles of the VBZ (Zürich transport company) can travel along their lanes or tracks virtually as fast as is technically possible.
>
> The credit will be reduced by an amount corresponding to any contributions by the Canton, which the latter makes on the basis of the regional transport law for the same purposes during the ten-year period. Where they are beyond the competence of the City Council, regulations for implementing this resolution are the responsibility of the municipal parliament and are subject only to the optional referendum in the meaning of Clause 11, letter c, of the Municipal Regulation. Such directives cover the provision of separate tram and bus lanes, the construction and conversion of traffic light operating systems remote controlled by the public transport, the conversion of the important traffic junctions entirely to meet the requirements of the VBZ and the pedestrians.[72]

The initiative was turned in to the government on June 18, 1973, about one month after defeat of the U-Bahn/S-Bahn proposal.[73] It was discussed in the government for more than three years before it was finally placed on the ballot in March 1977.

Transit Priority Program Initiative Campaign

The Swiss system of direct democracy allows the government to take a long time before it places an initiative developed by the people on the ballot. In the case of the People's Initiative for the Promotion of Public Transport, the government analyzed the measure and eventually took a position opposing it. The government could have placed a competing measure on the ballot, but choose not to.

Since the government had already started implementing transit priority measures, it believed the initiative was not necessary. The newspaper *Neue Züricher Zeitung* agreed and said, "Nobody today disputes the idea that promoting public transit is sensible and appropriate. Even without the initiative the city is moving in this direction." [74]

Conservative political parties and city business interests opposed the initiative. These groups opposed the measure because it would reduce automobile capacity and was a political contest with the Social Democrats.[75] Ironically, given the high cost of the U-Bahn/S-Bahn proposal the initiative was designed to replace, one argument against the People's Initiative focused on the high cost of the transit priority program.The initiative was supported by the Social Democrats—who both supported the idea of improving public transportation and wanted to develop political muscle in Zürich—and by all the progressive and environmental groups in Zürich.

The campaign for the Transit Priority Initiative was not as big or interesting as the U-Bahn/S-Bahn campaign, which had been a watershed election. In the U-Bahn/S-Bahn campaign, people really believed that construction of the system would negatively impact their lives, while the transit priority program was not as critical to their day-to-day lives.[76]

Campaign issues focused on whether the improvements could really work in Zürich and the general ideological belief against reducing the ability to travel by automobile. To address the feasibility question, Schweingruber wrote a second article in *Tages Anzeiger* (1975) that described results of a detailed travel-time measurement study. He and several others had compared a tram route in Zürich with a tram route in Bern that had transit priority. The article clearly described the speed advantages of transit priority and asked why the same measures could not be taken in Zürich.[77]

On March 13, 1977, the voters narrowly approved the People's Initiative for the Promotion of Public Transport by a vote of:

- YES - 61,599 - (51.25%)
- NO - 58,588 - (48.75%) [78]

During the same election, Zürich citizens voted on an initiative submitted by progressive organizations regarding construction of the "Y" freeway in the city (Ypsilon). This measure would have asked that the freeway be reconsidered. It

was defeated in the canton, but city voters approved it. This marked a change in transportation politics—previously canton and city voters generally had agreed on transportation measures, now they were split. Zürich voters, who would bear the impacts of the new freeways, opposed them, while suburban voters, who would use them to get to the city and through it, wanted them. [79]

Political Analysis

The fact that the initiative passed is quite interesting. According to one of those who was involved in developing it, "the initiative was probably the first and perhaps only time in the history of direct democracy when people asked, with their signature and later on with their vote at the polls, that the government spend such a large amount of money for any purpose, and were successful against the will of the government and the intentions of the majority parties." [80]

One reason for passage of the initiative had to do with the growing political power of environmental organizations and the overall support for ecological causes during the 1970s. Some of those involved in fighting the U-Bahn/ S-Bahn proposal and drafting the People's Initiative also started a group that fought for more environmentally friendly forms of transportation with less impacts on cities. The group, called Verkehrs Club Schweitz (VCS), grew to have more than 20,000 members with more than 8,000 in Zürich city alone (out of a total population of approximately 340,000). The VCS and other environmentally oriented groups had a significant amount of influence on Zürich's city politics, especially because of Switzerland's parliamentary system of government.

An interesting aspect of the concept of improving the existing system rather than building a brand-new system is that this approach embodies the concept Small is Beautiful,[81] which was popular at this time.[82]

The People's Initiative presented the voters with a much more economical and environmentally friendly solution to transportation problems than the U-Bahn/ S-Bahn proposal. Today, Zürich's transit priority program can be viewed as an extremely successful example of the Small is Beautiful concept. The city's public transit system is extremely efficient and effective at moving people around and did not have a social or economic cost.

Today, city departments are implementing it enthusiastically and most feel it was a good approach to solving the city's transportation problems.

IMPLEMENTING THE TRANSIT PRIORITY PROGRAM

Passage of the People's Initiative in 1977 was the single most important factor leading to implementation of Zürich's transit priority program. Zürich's transportation planners and elected officials embraced many of the principles embodied in the initiative. The planners began implementing them before passing the initiative. The initiative provided the political support and funding necessary to implement the transit priority program in a bolder and more comprehensive manner than would have been possible otherwise.

This is a critical point: The importance of the People's Initiative is that it forced the government to act more boldly than it otherwise would have done. Following passage of the initiative, the government could no longer say that they did not have the money or that people would object to taking automobile space for public transit. Passage of the initiative was not sufficient—advocates still had to put pressure on the city government to implement the program boldly—but it was a necessary condition for implementing the transit priority program.

Implementation Difficulty

Zürich's city government, like many governments, had difficulty implementing transit priority techniques for all the typical reasons. Car drivers would oppose them, it was technically impossible in such a large system, and businesses would object. Interestingly, the governments of two smaller Swiss cities had passed their own transit priority measures before Zürich and had been implementing transit priority improvements for some time. The government of Basel approved transit priority in 1971 and the government of Bern approved it in 1973.[83] Both cities were significantly ahead of Zürich in transit priority in the early 1970s.[84]

The importance of transit priority had been recognized in Zürich since the 1950s and 1960s, but implementation of improvements had been timid. The Planning Department also had compiled a detailed set of recommendations for transit priority improvements in its 1971 Tram Route #10 Study.

Before the People's Initiative, transit priority was intended as a short-term action until a new underground system could be built and for implementation on the underground system's feeder routes. After the People's Initiative, transit priority took the center role. While the many specific transit priority improvements were identified in the Tram Route #10 Study, their

implementation proved to be difficult. Therefore, in March 1973, the Zürich Geminderat (city legislature) passed a resolution stating that "A special organization will be formed under the Police Commissioner with the task of establishing priority for public transport based on a tram and bus network."[85]

In response to this resolution, the Police Commissioner created two groups—a political-level Executive Council to Promote Public Transportation and a staff-level Working Party for the Development of Projects and Project Management. These task forces are discussed beginning on page 68. The objective of these groups was to develop and implement transit priority projects.

In August 1975, the government passed a resolution directing the city to issue a policy to departments indicating that public transport generally should be encouraged, taking into account the needs of both pedestrians and the environment. This policy stated:

> "In accordance with the city council's repeatedly stated wish to give priority to public transport when weighing up various transport interests, the city departments are hereby instructed in principle to give preferential treatment to public transport. Moreover, reasonable provision must be made for the needs of pedestrians, disabled people, cyclists and delivery vehicles. The environment, the quality of life in the city's residential areas and the townscape must also be taken into account." [86]

Although organizing the task forces and passing the transit priority policies indicate a degree of support for transit priority, the city government still did not endorse the People's Initiative when they placed it on the ballot. As with many governments, they did not want their hands to be tied when it came to annual budgeting. Furthermore, although transit priority was accepted city policy, actual implementation in cases where there were potential conflicts with automobiles was lacking. [87]

Government Acceptance of Transit Priority

Once the People's Initiative passed, the city began to more actively implement the transit priority program. According to citizens active in progressive transportation issues, however, even after passage of the initiative they needed to be quite active in lobbying and advocating for stronger implementation of transit priority measures.[88]

The activists' efforts slowly began to pay off as the government began to embrace the concept of transit priority more fully. For example, the government passed a resolution in October 1979 giving priority to public transit in any conflict with private transportation. The word "conflict" in this case was not assumed to mean solely physical conflicts; public transit was also to be given priority in funding decisions and in other administrative areas.[89] Many of Zürich's professional transportation planners had supported the concept of transit priority for years. Planners were involved in the campaigns against the U-Bahn/S-Bahn and for the People's Initiative. However, there was a reluctance to implement the program. Today, as older employees have retired and younger staffs have taken leadership roles, the departments are more fully committed to the transit priority program.

A similar transition occurred with Zürich's elected officials. Today, many officials have come to embrace the concept of transit priority. They see that it has helped improve the city's quality of life and some of them now understand that you can never build enough capacity for automobiles in congested urban situations. Many of the officials who supported the U-Bahn/S-Bahn proposal now realize that the transit priority program has created a more livable city and more efficient transportation system.

While the city government in Zürich generally supports the transit priority measures, although not to the extent that activists believe that they should, the Cantonal government is not as supportive. This is a problem because the canton controls many of the larger roads through Zürich and will not allow the city to reduce automobile capacity to provide a higher level of transit priority. As with many of these types of arguments, it is not that the canton does not realize the importance of transit priority, but, they argue, they need to consider all forms of transportation. Thus, the fight to implement transit priority continues.

People's Initiative Capital Improvements

The capital improvements called for in the People's Initiative were constructed during the late 1970s and into the 1980s. The transit priority improvements were implemented incrementally throughout the city in conjunction with transit system rehabilitation projects and neighborhood traffic calming projects. Constructing all these improvements together reduced costs and disruption of the program; however, costs were carefully separated between those improvements necessary for the speed-up program and rehabilitation.[90]

By 1985, most elements of the transit priority program had been fully implemented, including the operations center and the full traffic signal prioritization program.[91] Drafters of the People's Initiative were not entirely satisfied with the way funds were spent on the program but think that the measure was a success nevertheless and are happy with the results. They were unhappy that a large share of the 200 million SFr paid for converting a tunnel originally built for the U-Bahn system for use by trams. This is a direct conflict with the initiative's goal of keeping the trams on the surface.[92]

In 1991, Zürich voters passed a second initiative—this one sponsored by the city—that provided funding for an additional series of transit priority improvements. This initiative was put forward by the city's transit system, which produced a detailed public report describing the results of the transit priority program so far and a detailed analysis of what improvements would be constructed with the additional funding.[93]

One reason for Zürich's success in implementing transit priority improvements is that the city implemented a series of urban livability improvements concurrently with the transit priority improvements. These traffic calming measures were designed to stabilize traffic volumes and channel traffic out of residential areas. Implementing both types of improvements helped increase public support for the overall transportation program.[94] Details of Zürich's traffic calming program development are outlined beginning on page 70.

City Task Forces for Transit Priority

As outlined above, Zürich's government realized that it would be difficult to implement the transit priority program and so organized two task forces to facilitate the process in March 1973. The political-level task force was the Executive Council and the department-level task force was the Working Party. One reason for Zürich's success in implementing the transit priority program was the structure and operation of these task forces.

The Executive Council consists of the three elected officials and four city department heads with transportation responsibilities. The elected officials are the three Stadtrat (city executive branch) members responsible for the departments charged with transportation planning and implementation. They are the Police Commissioner, the Building Works/City Planning Department Commissioner, and the Industrial Department Commissioner (the Industrial Department operates the city's public transit company). The department heads are professional managers of four transportation departments. The department

managers are the Chief of the Traffic Police, the City Engineer, the City Planner, and the public transit company (VBZ) Director.

The Executive Council provides the political power necessary to implement improvements both within the city departments and at the Geminderat level. It is responsible for setting policy and making decisions necessary to establish priority for public transport.

The Working Party is led by the VBZ Manager and consists of middle-level managers of the Traffic Police, Public Works Department, City Planning Department, and VBZ. Those attending meetings include people working on specific projects under development, so the group membership varies over time. The group's main task is to develop specific projects for implementation. One way the Working Party does this is by organizing task forces to address various different problems. Four main task forces have been organized to develop improvement implementation programs for

- promoting public transit,
- improving pedestrian conditions,
- traffic calming,
- improving bicycle conditions.

An interesting and beneficial result of the Working Party approach is that by working together, the departments have learned to change their institutional culture towards the goals espoused in Zürich's transportation principles. While initially departments had differing goals, over the years all the departments have embraced the goals set forth in Zürich's transportation principles.[95]

An example is that the Traffic Police may have been more concerned with moving traffic than providing priority for transit. According to participants in the process, it has taken time and working together on implementation of specific projects, reaching project goals, for the different departments to learn to work together. Today, the departments trust each other and work well together.

IMPLEMENTATION OF COMPLEMENTARY MEASURES—TRAFFIC CALMING

In 1974, Zürich's Transportation Plan was revised to incorporate the new ideas such as transit priority, traffic regulation to improve life quality, and environmental concerns that were becoming popular in transportation planning literature. The new plan was a significant departure from standard official transportation planning documents in that it included the following sentence:

> "Free use of private autos is not possible in the future for life quality, there must be constraints, doing nothing means that conditions will get worse." [96]

The 1974 plan also listed the following three main principles for planning transportation in the city:

1. Kanalisiernug (Channelization)—Motor traffic should be moved out of neighborhood residential areas and focused on main streets.
2. Plafonierung—Traffic volumes in the city should be stabilized.
3. Verkehrsentmischung—Public transit should be separated from private traffic.[97]

While these principles do not appear radical today, in 1974 they were on the cutting edge of transportation policy. It is interesting that Zürich would include such principles in their official transportation plan. The impetus for these principles was growing discontent with the negative impacts that traffic and development were having on life quality in the city.

Many of those who worked on the campaign against the U-Bahn/S-Bahn proposal and for the People's Initiative were also active in encouraging the city to begin adopting these types of transportation livability improvements.

As outlined in the "Zürich Context" chapter, Zürich has a form of government in which the executive branch (Stadtrat) consists of nine elected officials, each of whom acts as director for a specific department. This is similar to the Commissioner form of government in the United States. During the late 1970s and early 1980s, those involved in drafting the People's Initiative met regularly with the Stadtrat responsible for transportation improvements in the city. Reudi Aeschbacher became one of Switzerland's strongest proponents of transit priority, traffic calming, and alternative transportation.[98]

Although almost everyone agreed with the concept of protecting living areas and encouraging public transit, specific measures were hard to implement.[99] Under Aeschbacher's direction, the city made significant progress in implementing the transit priority program, traffic calming, and alternative transportation, although implementation of these improvements was never easy. The city also issued two interesting publications, titled *Verkehrspolitik der Stadt Zürich* (transportation politics of the city of Zürich) while Aeschbacher was in office, the first in 1983 and the second in 1994.[100]

The first document describes three transportation problems: growing regional commuting to jobs in the city, growing parking problems, and transportation impacts on living areas in the city. It presented three solutions from the Transportation Plan: encouraging the use of public transit, channeling traffic out of neighborhoods; and reducing the number of parking spaces for commuters.

The interesting aspect of this publication is that it was an official city document, but took a proactive approach to advocating relatively controversial techniques. The 1994 document was more of a report on the many successes experienced by Zürich in the past decade, but still advocated progressive solutions to transportation problems.

In the mid-1980s, growing concerns over environmental quality caused the Swiss federal government to pass a series of laws designed to improve air quality and reduce noise. Since one of the biggest contributors to both noise and air pollution is motor traffic, this provided Zürich with the incentive to further strengthen its transit program and reduce traffic volumes. In 1987, the Geminderat passed a resolution approving the following five transportation principles:

1. Public transportation must be promoted.
2. Motor traffic must be reduced.
3. Motor traffic must be channeled—living areas must be kept peaceful.
4. Parking places must not be increased, but rather decreased.
5. Environmentally friendly modes of transportation should be supported.[101]

The main result of these principles was to strengthen the transit priority program and the traffic-calming program. However, specific measures still proved to be quite difficult to implement quickly.

IMPORTANCE OF PUBLIC SUPPORT

A major theme of this research is that strong public support is required to implement controversial transportation programs such as transit priority. In Zürich, support was realized in two major ways:

- Elections, most importantly the People's Initiative.
- Continued advocacy by activists pushing for bold implementation of these controversial transportation programs.

Public support, as evidenced in elections, is critical to keeping elected official support for the program; and elected officials are necessary because in the long term, they ensure that government programs are implemented. Advocacy by activists keeps pressure on elected officials to implement the programs. One way activist groups place pressure on elected officials is through their endorsement process.

In summary, the vote for the People's Initiative provided the government with the mandate for implementing the transit priority program and the continued advocacy of activists provided the backbone necessary to boldly implement the program.

ZÜRICH'S TRANSIT PRIORITY PROGRAM

INTRODUCTION

"Transit Priority" refers to the following four basic types of transit improvements:

- Roadway Improvements and Traffic Regulations
- Traffic Signal Priority
- Transit System Operations
- Separate Right of Way (for example, exclusive transit lanes)

One of the most critical factors in the success of a transit priority program is the careful planning and design of particular improvements. Zürich has had more than 30 years of experience implementing its transit priority program. The purpose of this chapter is to outline how these improvements were implemented in Zürich and present some interesting implementation examples.

It should be emphasized that one of the ways Zürich maximized the effectiveness of its transit priority program was by implementing a series of complementary transportation and city planning efforts in addition to the transit priority program. These efforts included controlling traffic volumes by introducing traffic calming, reducing commuter parking, and significantly improving the regional transit system. These complementary efforts are described in the next chapter.

ROADWAY IMPROVEMENTS AND TRAFFIC REGULATIONS

As outlined in "Transit Priority," roadway improvements and traffic regulations are changes to the street or the regulations that govern traffic operations designed to provide priority to public transit vehicles, specifically, the following types of improvements:

- Traffic islands/channelization
- Turn restrictions
- Parking/standing restrictions

These types of improvements were identified in the Tram Line #10 Study and recommended for implementation on the entire transit network. Since most applications of these improvements are small and must be designed for specific locations, they can be difficult to implement for several reasons.

First, since the impact of individual traffic engineering improvements is small, many improvements must be made to improve operation of a particular route significantly. For example, the Tram Route #10 Study identified more than 100 specific improvements to speed up the transit route that would "only" save 10 to 15 percent of travel time.[102] Most single improvements would only yield a few seconds of travel time savings, but taken together they yield far greater benefits, a few minutes on the route, and, as the Tram Route #10 Study emphasized, a more reliable schedule.

Second, since the impact of individual improvements is small, there is not a big political payoff in implementing any particular improvement, although there could be significant negative political impacts. This means that the improvements must be carefully designed, working with the community. In many cases, this provides an opportunity to implement additional improvements that help control traffic volumes to improve a neighborhood's livability. Zürich's program is outlined in the next chapter.

Finally, since providing transit priority consists of so many small actions, carried out by many different city departments as part of many different types of projects, it is necessary to develop a strong interdepartment understanding of transit priority. It is critical that all departments that could impact transit performance negatively through implementation of their projects (for example, sewer construction) understand the transit priority program and believe in it. This way these departments can design their own projects with transit priority in mind, or at least so as to not negatively impact the program inadvertently.

In Zürich these problems were addressed in the following ways:

- Transit priority improvements were implemented in a comprehensive manner on line segments to maximize their benefits. These were often done in conjunction with rehabilitation projects to minimize construction impacts and costs.
- Sophisticated traffic engineering techniques often were implemented to reduce the impact of transit priority technique implementation on private vehicle traffic.

- Improvements designed to reduce traffic flow in neighborhoods and improve alternative transportation (for example, bicycles and pedestrians) were implemented simultaneously with transit priority techniques (see next chapter).
- Zürich formed an interdepartmental working group (the Working Party) to prepare projects for implementation. This also helped to create an understanding of transit priority program that created a culture that further assisted in the implementation and effectiveness of the transit priority program.

These techniques helped Zürich to implement the fine-grained transit priority roadway improvements and regulations necessary to make the transit priority program a success.

ZÜRICH'S TRAFFIC SIGNAL TRANSIT PRIORITY PROGRAM

Providing priority for public transit vehicles at traffic signals in Zürich had been under serious consideration since the early 1970s. The Tram Route #10 Study identified stopping at traffic signals as a major cause of delay, and the People's Initiative of 1973 called for providing transit priority at traffic signals.

The chapter on "Transit Priority" outlines several approaches to providing transit priority at traffic signals. Ultimately, Zürich decided to develop its own custom system, since standard systems could not provide the level of priority that the city wanted. While Zürich's system is designed to provide transit priority, it also enables private vehicle traffic to flow relatively smoothly throughout the city.

The story of the traffic signal system's development provides illumination on Zürich's overall success in implementing transit priority techniques and describes an interesting approach to citywide traffic controls. Zürich's approach to developing the new traffic signal system is described below.[103]

Initial Approach: Static Traffic Signal Control

Zürich initially attempted a traditional method to provide transit priority at traffic signals: Transit operators/drivers controlled traffic signal operation by pushing a button when their vehicle approached a traffic signal to turn the traffic signal green. This was not effective at providing transit priority. When it failed, it created traffic flow problems.

The planners could not understand why this method was not effective at providing transit priority. At first they thought that the transit operators were not cooperating or were "too dumb" to operate the system. The department director and several system developers learned to drive buses and trams to research the problem. As they drove the transit vehicles, they learned the real reason the system was not working—it is hard enough to drive a public transit vehicle and there is little time to do anything else. The planners then decided that they had to create a system that did not require operator input.

The method's second problem, creating traffic flow problems, was more understandable; in fact, a great deal of traffic engineering literature is devoted to discussing the problems of transit priority at traffic signals. To understand why, a short description of traffic signal progression systems is necessary.

Traffic Signal Progression

Traffic signal progression is the process whereby a vehicle can go (progress) through a series of traffic signals without stopping. When this type of system is in place, the traffic signals are said to be coordinated. In the most basic type of coordination system, traffic signals are set to turn green as a platoon of vehicles moves at constant speed through the series of intersections without stopping. This is called a "static" system because it is based on repeating patterns of signal cycles at a series of connected traffic signals.

When a transit vehicle is allowed to interrupt the regular pattern of traffic signal cycles in a static system, a queue will build up at the impacted intersection and traffic signals downstream will have wasted green time. This also means that there will be a larger number of vehicles at the impacted intersection that must be processed in the next cycle; this number, when added to the next platoon of vehicles, may be too great for the cycle to accommodate, and then the system will be overloaded.

Introducing random events (like transit priority) to a static traffic signal progression system on a street with relatively high traffic volumes will throw the whole system into chaos. Therefore, many traffic engineers recommend against it. (Note that this is also one reason why much of the traffic engineering literature on transit priority at traffic signals addresses analytical techniques to estimate the delay to vehicles on the rest of the system. The literature recommends against providing transit priority in cases where it would cause extensive delays on the whole system.[104])

Zürich's Approach: Dynamic Traffic Signal Control

In the late 1970s, Zürich's traffic police decided to take a new approach to traffic signal control to address the problems of too many transit operator responsibilities and traffic flow disruption caused by transit priority. Their goal was to provide transit priority at traffic signals without significantly impacting traffic flow. In order to create this new system, the Traffic Police reconsidered the entire philosophy behind the operation of traffic signal systems. One benefit of this was that transit priority was included as a basic requirement of the new system, not as an add-on.

The starting point for Zürich's new approach was an idea taken from industrial production, namely, to maximize the efficiency of a production line, one should have intermediate storage for semiprocessed materials. One reason for taking this approach was that those responsible for traffic signal operations were trained in operations research rather than traffic engineering.

Thinking of a traffic signal system as an assembly line was useful. In an assembly line, if there is an interruption in production at one machine, machines downstream can still be used efficiently. In a traffic signal system, this means creating places where queues of vehicles are allowed to develop so that green time at downstream intersections is fully utilized. In a standard "green wave" (static) type of traffic signal coordination, traffic signals are set to turn green as a platoon of vehicles moves along the street from one signal to the next. In contrast, Zürich's system provides a green wave in a small group of traffic signals and then the platoon is stopped.

Although this sounds inefficient, for networks with many discontinuities of traffic flow it actually enables more efficient use of the overall system by ensuring that green time at intersections downstream from discontinuity is not wasted. The new system was designed from that theoretical benchmark. Interestingly, research in Zürich also shows that many people only travel on major arterials for a few intersections, so they do not take advantage of the standard (long set of intersections) green wave system.[105]

In the Zürich system, specific traffic signal timing for individual intersections and sets of intersections is controlled by computer programs designed based on the geometry of the intersection and on real-time traffic data collected from sensors in the roadway. The sensors communicate traffic volume information to the system's central computers, where it is combined with data from the rest

of the network to determine the most efficient traffic signal operation at all system intersections—in real time.

This type of system can be termed a "dynamic" system because it does not rely on a constantly repeating cycle at each intersection. When Zürich's signal system developers looked at providing transit priority in this dynamic system, they realized that transit priority would have little impact on the network's overall operation because even a transit vehicle arriving every several minutes could be considered a random event from a probability standpoint, and that these random events could be accommodated easily within this system. In a static system, interrupting one intersection has cascading impacts for all the downstream and upstream intersections; in a dynamic system, interrupting an intersection would simply be dealt with the same way as any other discontinuity.

Another way of thinking about Zürich's approach is that providing transit vehicles priority in a dynamic system only adds five to eight seconds (the time it takes the vehicle to get through the intersection) of green time to a cycle if the green time can be added at the right point in the cycle.

The dynamic nature of traffic signal timing in Zürich enables the green time to be added to signal cycles at maximum efficiency, thus reducing impact on other users of the roadway system. This is done by adjusting the cycle pattern in addition to timing.

Intersection traffic volumes under Zürich's dynamic system with provision of transit priority are similar to what they were before introduction of the system. This means that the dynamic system has created additional capacity and given it to transit vehicles; therefore, private vehicles have not been hurt, but transit has been helped.[106]

Once a dynamic traffic signal control system is in place, it is relatively easy to see how transit vehicles can be provided with priority. Information relating to the position of individual transit vehicles is relayed to the system's central computers, which then incorporate expected transit vehicle arrival data into their calculations for optimal traffic signal timing and cycle at the appropriate traffic signal. One of this system's most critical aspects is that it provides continuous information on location of the transit vehicles so that it does not waste green time. For the system to operate efficiently, it needs to know exactly when the vehicle will arrive within 1 second.

One of the system's most basic objectives is to not waste green time. The obvious reason for this is to keep the overall traffic network operating efficiently. The less obvious reason is public relations. People complain when they see wasted green time, for example, if the light turns green and 30 seconds later the transit vehicle goes through the intersection. In contrast, when they see a traffic signal change, a transit vehicle immediately go through, and then see the signal change again, people are more willing to support the program. The Chief of Zürich's traffic police believes that most people do not even realize that transit vehicles have priority over private vehicles because the system works so well for private vehicles.

Since an almost infinite number of different signal patterns can be computer programmed, traffic signal timing can be designed to meet transit priority, other transportation, and nontransportation requirements. For example, the system can provide a cycle enabling pedestrians to cross the street to transit boarding islands in street medians, thus helping to prevent people from running out in front of traffic when a transit vehicle is approaching. Furthermore, as described below, the system is also used to control traffic flows into the city, which keeps the overall transportation network from becoming saturated.

Additional Control System Benefits

The dynamic traffic signal control system is an extremely flexible approach to traffic signal system planning. In addition to providing an elegant solution to providing transit vehicle priority, it enables Zürich to control traffic conditions in the city. Specifically, the traffic signal control system is used to maintain below-capacity traffic volumes on center city streets by adjusting signal cycles and phases to meter traffic volumes entering various parts of the city based on congestion levels.

Maintaining below-capacity traffic volumes is used to keep traffic flowing within the city. This addresses the well-understood fact that transportation systems operate much more efficiently slightly below capacity than at capacity. Ernst Joos compares limiting traffic volumes to operation of a washing machine, saying that everyone knows that a washing machine will not work well if it is completely filled; the same logic applies to the urban road network.[107]

Some might argue that keeping overall traffic moving is not a pro-transit policy. Even in Zürich, however, where significant progress has been made in providing transit with priority treatments, there are still many places where

transit and private vehicles interact; therefore, keeping traffic moving helps keep transit moving. Furthermore, reducing center city gridlock improves livability in the immediate area.

In addition to keeping traffic moving, the traffic signal system can be used to encourage drivers to use public transportation by creating controlled traffic jams in places that can accommodate the traffic jam without creating negative livability impacts. These traffic jams are created in locations that meet other objectives, for example, in places that could encourage people to use transit, such as in front of a transit station.

In summary, Zürich's citywide dynamic traffic signal control system has succeeded in providing excellent transit priority without impacting traffic volumes. The system also controls traffic volumes in the city to maintain flowing conditions that assist all system users and improves livability in the center city.

System Hardware and Software

The traffic signal control system itself consists of hardware on the streets, transit vehicles, and main computers in the central control center. The street hardware consists of transmitters on all transit vehicles and detectors in the street.

The transmitters send a signal that is recognized by detectors in the street, generally located about 300 meters before the intersection, 100 meters before the intersection, and just after the stop line in the intersection. The first detector is used by the traffic computer to develop an initial estimate of the time that the vehicle will arrive at the intersection; the second detector revises the estimated time; and the third tells when the vehicle has passed through the intersection. The specific location for detectors depends upon the physical layout of the intersection and stop location. There are more than 3,000 SESAM* detectors in the system.[108]

The central control center has 16 computers to control the system, two for each traffic control zone, and two to provide overall coordination for the system. The system requires fast computers able to store significant amounts of information relating to the operation of signals as well as traffic volume data for use in later analysis.

The system's computer software is the key to the dynamic signal system operation. It consists of custom-designed programs governing the operation of the following four levels of the system:

- Individual traffic signals.
- Microcells, small groups of approximately four to eight traffic signals over several intersections that are operated together.
- Zones, consisting of all the microcells in one of seven city zones.
- Citywide coordination between zones.

At the intersection level, traffic signal timing is determined in a central computer based on the intersection geometry, predetermined safety parameters (such as minimum pedestrian times), real-time traffic volume data provided by detectors, and transit vehicle location information provided by the transit vehicle detectors. In addition, intersection-specific similar information from the other intersections in the microcell is used to determine a coordinated pattern for the group. Further information at the zone and interzone level is used to help determine operation of each particular intersection.

The street segments at the boundaries between microcells are used as storage areas to make the dynamic system work efficiently. While an individual vehicle can make it through the series of traffic signals within a microcell without stopping, they often stop at the start of a new microcell in order for the system to achieve its overall objectives.

The system employs six full-time computer programmers to adjust and refine operations. Most of the equipment is custom-designed for Zürich. Even with such a unique system, when all costs are included it is not more expensive than normal traffic control equipment and computers. One way to think about it is that instead of a computer at each intersection controlling operations, there are 16 larger computers in a central location.[109]

As this description indicates, the computer programming used to control operation of Zürich's traffic signal system has a strong theoretical basis and has been highly developed for the specific conditions of the intersections, streets, and community objectives in Zürich. Because the system is unique, it is hard for the system's planners to even talk about it with colleagues in other cities.

TRANSIT SYSTEM OPERATIONS

As described in "Transit Priority," transit system operations improvements are changes made to the entire transit system to help speed up transit. "Transit Priority" lists three different types of system-level improvement:

- Operations Center
- Proof-of-Payment (self-service fare collection)
- Improved vehicle design

In Zürich, the improvement most closely associated with the transit priority program is construction of the Transit Operations Center. This center helped the city's transit system improve its effectiveness and efficiency. The operations center is described in more detail below.

Zürich also has implemented the other two system-level improvements. Zürich's transit system operates with a proof-of-payment fare collection. Passengers buy tickets before boarding the vehicle and are subject to random checks by fare inspectors. The proof-of-payment system was in operation before the transit priority program began. The region's transit operators also use buses and trams that are well designed for making transit faster. Vehicles have lots of space around the doors, new vehicles are low floor, and there are three wide double-doors in most of the standard 40-foot buses.

Operations Center

A critical systemwide improvement implemented as part of Zürich's transit priority program was the construction and operation of a transit operations center. The center is the focal point of a sophisticated system that provides communications and control for the city's entire public transit network.

One role of an operations center is to monitor the position of transit vehicles and assist them in maintaining schedules and especially keeping reliable headways. When transit headways become irregular, service quality suffers. Reliable service is one of the passenger's strongest desires, often rating higher than speed.

Zürich's transit operations center provides the following four main functions:

- Communications for operators and passengers

- Vehicle location
- Emergency intervention
- Data collection and analysis

Each of these functions is outlined below.

Communications

Zürich's transit operations center is linked with a sophisticated communications system to all vehicles in the system. A radio system is used to speak to individual operators and enables them to speak with the operations center. This link is also used to speak to passengers and selected sets of operators. The operations center can choose to speak to operators, passengers (or both), on individual vehicles, all the vehicles on a line, all the vehicles in an area, or all the vehicles in the system at any given time.

The communications system is used to give operators directions and information as well as to give passenger updates on system status. Announcements are clear and easy to understand. In addition to speakers in vehicles, more than 50 major transit stops have loudspeakers to provide waiting passengers with information. The system also is used to make general announcements about system promotions and special services. As VBZ Deputy Director Ernst Joos said, "It is important to remember that you are not moving potatoes but people, and people want to be informed about their trip." [110]

The communications system is so well organized that it has been used as a lost-and-found service. When someone leaves something on a vehicle they can simply tell the operator of the next vehicle, who will relay the message through the operations center to the first vehicle operator. This is a remarkable level of customer service.

Vehicle Location

For purposes of transit priority, it is the operations center's ability to locate all public transit vehicles (within 10 meters) at all times that is most useful. This feature provides real-time schedule adherence data that can be used to help direct operators and data for long-term schedule analysis. Interestingly, this system was put in place before the advent of advanced geographic positioning systems (GPS) that are more common today. Also, this is a different system than that used by the traffic signal priority program.

The vehicle location system continuously sends real-time schedule adherence data to each vehicle. This tells operators whether they are early or late at all times and enables them to adjust their driving to better meet the schedule. The VBZ has done studies comparing operators who have this information with those who do not. These studies indicate that schedule adherence is much improved by providing the schedule information to operators—essentially giving them the information they need to do a good job.[111]

In addition to real-time schedule adherence, the schedule data is stored and used by the VBZ to help refine schedules and identify potential problems on routes. Once a potential problem is identified—for example, a segment of route that exhibits widely varying travel times—more detailed observations of segment operations can be made and improvements can be planned. This approach is to document the need for many transit priority improvements. One implementation lesson from Zürich is that it is easier to design and sell transit priority improvements when you have detailed data available to justify the improvements.

Originally, transit operators opposed it because they feared it would be used to observe and potentially discipline operators. Therefore, management made a promise that the system would not be used for these purposes and has kept that promise. If the system indicates problems with a line, someone will observe line operation and these observations could be used to discuss problems with operators.

Today operators are generally happy with the system. It provides them benefits, including an assurance that they will not have to work beyond their scheduled shift. The benefits include enabling management to send replacement operators if delays are expected and providing real-time schedule data.

Emergency Intervention

Emergencies and unplanned disturbances impact every transit system's reliability. Zürich's control center acts proactively to intervene and reduce the impact of these disturbances. The basic elements of the intervention system are the vehicle location system, the communications system, and plans for addressing potential problems.

These plans for addressing problems are one of the more innovative strategies used by the VBZ. The VBZ divided the entire network into sections and

prepared a detailed plan for each section describing exactly what to do if there is a disruption. The plan covers everything from rerouting vehicles to the wording of public announcements that should be made on the vehicles. The basic philosophy is to isolate problems and not let them impact the rest of the network.

One significant investment in the system's reliability is that the control center has five spare buses and two spare trams distributed through the network to place in service when problems occur during peak periods. One tram and one bus are available during off-peak hours. These vehicles help ensure that delayed vehicles will not be overloaded and further slowed down.

Having spare vehicles distributed throughout the system for use in emergencies is expensive, but the VBZ believes that reliability is one of a transit system's most essential qualities, so this is a good use of money. When there are problems that can not be handled by the standby vehicles, additional vehicles can be put into service using the control staff as operators. A team of 90 people who check passengers for valid tickets are also qualified tram and bus drivers.

One reason it has been possible to use the Transit Operations Center effectively to actively manage transit vehicle operations is that the transit priority improvements empower overall transit systems to limit the number and extent of serious problems the system faces. The public transit system is not approaching total breakdown on a daily basis by having vehicles stuck in congestion and traffic accidents, so the operations center staff have the time and tools available to focus on specific problems as they arise.

Data Collection and Analysis

As outlined above, schedule data from the vehicle location system is stored for use in developing schedule revisions and in identifying route segments that need transit priority improvements. Several interviews pointed out that one reason the transit vehicles were so reliable is that planners really know how long it will take to make a trip and they use this knowledge to set the schedule.

Such a system could be abused by selecting long travel times for schedules, but it works quite well in combination with the detailed route analysis. Also, it speeds up improvements by enabling realistic schedules to be developed by the planners and achieved by the operators.

Operations Center Description

The operations center consists of five workstations, each with three different computer displays, radio system controls, telephones, and hard copies of route schedules and emergency plans. The computer displays present real-time schedule adherence data in a variety of formats. For example, one format presents information on all the vehicles operating on a particular line such as the run number, location, deviation from scheduled time, and amount of turnaround time expected at the terminal station.

Calculations are based on the vehicle's actual location and travel time to the terminal. This last element of information enables controllers to determine if the vehicle will be late starting its next run. The operations center also includes additional computer equipment designed to collect and store data for analysis and refining schedules. The center has almost six years worth of data on hand, with earlier data stored off site.

Separate Right of Way

The fourth and final type of transit priority improvement described in this chapter is separate right of way for transit vehicles. The most common examples are exclusive transit lanes. As outlined in "Transit Priority," exclusive transit lanes are designed to speed up public transit by providing it with a way to bypass congestion. That chapter also describes the difference between building new separate rights of way for transit and redistributing street space to provide separate rights of way.

Redistributing Roadway Space for Transit

One measure of Zürich's transit priority program's success has been its ability to redistribute a large amount of road space to construct a significant network of exclusive transit lanes. Currently, the majority of transit route miles in Zürich are on exclusive transitways, and the majority of these were built by redistributing space rather than building new rights of way. According to Joos, by early in 1990 approximately 21 kilometers of transit lanes had been created by redistributing road space and 8.5 kilometers of exclusive right of way had been created in several tram extension projects.[112]

An essential aspect of Zürich's overall approach to transit is that it should be easy for people to transfer between different routes and modes. Consequently, there are many major transfer points in the city served by several different

modes. Often these transfer points are located exactly where large amounts of private vehicle traffic occur. An example is the Central and Bellevue Squares, where seven or eight different tram lines intersect with multiple bus lines in addition to being major private vehicle traffic intersections. Providing transit priority by redistributing road space in these situations means taking a sophisticated and well-organized approach to traffic engineering, not simply taking space from private vehicles and giving it to transit. This is critical because space dedicated to transit priority that is not well used will be viewed as inefficient by drivers and will make implementation of further transit priority techniques difficult.

Zürich's major transit transfer points are excellent examples of careful traffic engineering. These squares provide both transit priority and for the relatively good flow of private traffic. Specific techniques used include channelization, careful placement and coordination of multiple traffic signals, and roundabout routing for private vehicles. The distance is slightly longer for private vehicles; often there is less delay because vehicles can share traffic signal phases with the transit vehicles given priority. Many of these traffic engineering techniques are implemented well before the transfer point to control the flow of vehicles into the square.

In these situations, traffic engineers work closely with transit system planners to ensure that transit stops are located in the right places, sufficient space is allowed for passengers to wait and transfer, and the operation of transit vehicles into and out of the square is considered. An important step in the process of improving transit speed is thinking about how the transit vehicles travel through the square as well; this was one of the first types of improvements implemented in Zürich.

One critical aspect of exclusive transit lanes is enforcement. In many cases, it is impractical to construct physical barriers between the transit lanes and the traffic lanes. In these cases, a strict program of enforcement must be carried out to keep private vehicles out of the transit lanes. In Zürich, enforcement for the transit lanes was recognized as a specific need and police staff was assigned to ensure that priority was maintained. The police department's budget was increased to meet this assignment.[113]

Zürich has implemented several refinements to the system of providing exclusive transit lanes. First, many exclusive transit lanes are shared between different modes of transit and by different transit operators The Zürich region has 42 different operators, several of which operate on city streets. Second,

many exclusive transit lanes are short sections strategically located to optimize transit operations, reducing the amount of roadway needed to provide transit priority.

Finally, in some situations, traffic signals are used to meter access to shared lanes, again reducing the amount of exclusive transit lanes without reducing their effectiveness. Three particularly imaginative ways of creating exclusive right of way for transit are outlined below.

Langstrasse Transit Bypass

Langstrasse is a major north-south crosstown route across Zürich. It is one of the few streets to go under the large number of railroad tracks serving the city's main train station. One of the VBZ's trolley bus routes (#32) uses Langstrasse to connect several radial tram routes serving the center city. Langstrasse is a two-lane street with commercial uses and relatively heavy pedestrian traffic.

This was a difficult location in which to create an exclusive transit lane. Transit priority was needed in both directions and there was not enough right of way possible to widen the street. Zürich planners therefore made an approximately 300-meter-long section of Langstrasse one-way southbound for private vehicle traffic. The northbound lane was converted into a two-way exclusive bus lane by adding traffic signal controls at both ends of the section. Bicycles can use the transit lane for travel in the northbound direction too.

This arrangement enables a bus traveling south to bypass private vehicles and cut back in front of the traffic just before the intersection of Langstrasse with Miltarstrasse at the end of the exclusive transit section. An intermediate traffic signal stops southbound private vehicles approximately 20 meters before the intersection to provide the bus with the space necessary to cut in. In the northbound direction, the lane operates as an exclusive transit lane. Bus operators in the northbound direction can choose whether to use the bypass, depending on if they need to improve travel time or if a northbound bus is using the lane.[114]

Limmatquai Sidewalk Widening

The Limmatquai is a major roadway along the east bank of the Limmat River through Zürich's old town between the main train station and Zürich Lake. Originally, this street was four lanes wide. An early transit priority

improvement was designating two lanes as exclusive transit lanes and two lanes for private traffic.

Subsequently, the city wanted to improve the pedestrian environment along the river in the old town. This is a vibrant commercial area with many sidewalk cafes and also provides beautiful scenic vistas to the other side of the river and down toward Zürich Lake and the Alps in the distance.

To improve the pedestrian environment, the central section of the roadway was converted to a two-lane road where transit and private vehicles shared the lanes. The north and south sections kept the original four-lane design. However, transit still has priority on this section by means of a traffic signal for the private traffic located at the point where the private traffic lane merges with the transit lane. When a streetcar approaches the merge point, the traffic signal turns red for the private traffic and the streetcar can proceed ahead of the other traffic on the rest of the roadway segment.

Sidewalk cafes and shops expanded their outdoor sales areas once the road was redesigned. It created a more lively and exciting urban space. This is an example of how the overall goal of urban livability was achieved, but through careful design, transit still was provided with priority. Zürich citizens voted in 1999 to make the Limmatquai private-traffic free, further improving livability.

Wollishofen Tram #7 Station

Redesign of the Wollishofen tram station is another example of improving pedestrian conditions in a neighborhood. Originally, the roadway at the Wollishofen tram station was four lanes wide, with two traffic lanes and two streetcar lanes in the median. The station consisted of two island platforms between the streetcar and traffic lanes.

The station was reconstructed by narrowing the road to two lanes for shared use by both streetcars and private traffic and widening the sidewalks to essentially create bus bulbs. The project's purpose was to improve the environment for people waiting for streetcars and to improve safety for people crossing the street. There is no traffic signal controlling vehicle movements; a simple Yield to Trams sign is provided and is respected by motorists.

According to the station's designer, transportation engineer Willi Hüsler, this station is safer than the previous design, even though it has more inherent

conflicts. The critical thing is that the conflicts are visible and understood by all and therefore addressed in the behavior of users.[115]

Summary: Second-Generation Exclusive Transit Lanes

These examples illustrate relatively sophisticated ways of providing priority for transit; in fact, in the second two examples, exclusive lanes were removed and transit still has priority treatment. In a sense, these can be thought of as second-generation exclusive transit lanes. In the first generation, one of two traffic lanes was taken for transit. In the second generation, traffic was mixed again, but transit was given priority through traffic control devices—a traffic signal—and the roadway was narrowed to improve urban livability.

The VBZ seems to have adopted the approach of mixing transit priority with urban livability. Specifically, there are no set rules on whether new streetcar lines will have exclusive rights of way or some combination of exclusive and mixed. Peter Stirnemann, the VBZ's Chief Transit Planner, believed that successful streetcars are designed to fit within the neighborhood qualities and do not need to impose their requirements on the area's urbanity.[116] This is an innovative approach to transit system planning.

Transit Malls

This research has treated transit malls as a special case of exclusive transit right of way. In Zürich, the main downtown shopping street, the Bahnhofstrasse, has been made into a transit mall. The Tram Line #10 Study called for implementation of the Bahnhofstrasse transit mall as one of its transit priority recommendations.[117]

The Bahnhofstrasse transit mall is approximately 1,200 meters long between Zürich's main train station at the north end and Zürich Lake at the south. Seven separate streetcar lines use the Bahnhofstrasse transit mall, yet only six use it for part of its distance turning on or off at the Paradeplatz station. Additional streetcar and bus lines intersect the mall at the north and south ends. The Bahnhofstrasse is one of the world's most fashionable shopping streets, lined with sidewalk cafes and shops. Physically, most of the street is level with painted markings indicating the streetcar lanes. The street has mature trees providing shade in summer and many pedestrian amenities such as benches. Most of the street allows transit, taxis and delivery trucks only.

Zürich's old city lies to the east of the Bahnhofstrasse and many streets in this area have been converted to a pedestrian-only network. This area also has many shops, restaurants, and hotels, and is one of the city's most desirable residential neighborhoods.

Economic Impact

The Bahnhofstrasse transit mall has been an economic and transportation success. Proof lies in the fact that rents along the mall are some of the highest in the world, transit operates efficiently through the center city, and the city has supported expanding the use of transit malls and pedestrian zones. The most recent example of support was in June 1999, when Zürich citizens and some merchants voted to remove private traffic from the Limmatquai and create a transit mall.

Separate Right of Way for Transit

As outlined in "Transit Priority," the second way of providing exclusive right of way for transit is to construct a new facility. While Zürich relied on redistributing roadway space to obtain exclusive transit right of way in most cases, the city did build a short section of streetcar subway in the Milchbuck area. This section is approximately 2,200 meters long, has three underground stations, and is used by two different streetcar routes for maximum efficiency. This subway originally was built to serve as part of the U-Bahn network, but when the proposal for a U-Bahn was defeated, it was converted into a streetcar subway.[118]

As described in the following chapter, the Canton of Zürich made a major capital investment in its S-Bahn system by constructing a new commuter rail subway through the center city.

COMPLEMENTARY TRANSPORTATION PROGRAMS

INTRODUCTION

An important lesson from Zürich is that the city implemented several complementary transportation programs that increased public support for the transit priority program. Specifically, it implemented transportation programs to increase livability and made a significant improvement to its regional transportation system. Implementing transportation livability improvements in the downtown and neighborhoods helped Zürich maintain public support for the transit priority program.

Public support was strengthened by combining improvements the public wanted (for example, less traffic in neighborhoods) with those that they might not like (for example, reducing parking to provide an exclusive transit lane). Many livability improvements also provided transit priority (for example, closing access to a major transit street from a minor neighborhood street).

Improving the regional transit system was critical for suburban commuters. The City of Zürich's transit program would have failed and downtown Zürich would have been overwhelmed by commuter traffic without an effective regional transit system.

This chapter outlines these two complementary transportation programs and their impact on Zürich's transit priority program.

LIVABILITY IMPROVEMENTS

There are many ways to improve a city's livability. Good urban design, adding amenities to neighborhoods, supporting alternatives to automobile transportation, and controlling traffic volumes were used in Zürich. This research focuses on some of the ways Zürich used to control traffic that assisted implementation of the transit priority program.

Historically, Zürich developed measures designed to actively reduce private motor traffic in the city.[119] Zürich's approach has evolved from channeling traffic away from residential neighborhoods (traffic calming) and speeding up transit in the 1970s to more explicit programs designed to help improve air quality. Zürich used three main approaches to control the vehicle traffic in the city: traffic calming, reduction of roadway capacity, and parking controls. As

with other programs, Zürich has taken a comprehensive and thoughtful approach to controlling vehicle traffic.

The three main approaches Zürich implemented to help restrain traffic are outlined below, after a discussion on the importance of alternatives.

The Importance of Alternatives

In describing ways that Zürich used to control traffic in the city, it is critical to understand that it is not impossible to drive a car in Zürich.[120] The goal has not been to keep all private motor vehicle traffic out of the city, but rather to encourage people to use other forms of transportation whenever possible. This policy recognizes the fact that in some cases the private vehicle is the most logical and efficient means to make a particular trip.

The most interesting way Zürich encouraged people not to drive was to make the transit system extremely convenient for almost all trips. Zürich made transit reliable, inexpensive, and frequent, and designed vehicles to encourage multiple types of trips. For example, there is space on vehicles to stow baby carriages and to carry moderately sized parcels home from department stores, safely and comfortable. The transit priority program was one specific program that Zürich implemented to achieve this goal.

Zürich also developed significant programs to promote bicycling and walking as alternatives to automobile traffic. The city implemented a significant bicycle promotion effort, including construction of a bicycle network throughout the city. It also improved pedestrian conditions by implementing a traffic calming program and creating an extensive pedestrian network in the old city and downtown areas. These programs were often carried out together with the transit priority program, but it should be understood that they played mutually supporting roles in reducing automobile traffic in the city and creating a more livable city.

Traffic Calming

Zürich adopted a policy to introduce traffic calming to neighborhoods and the historic city center in the 1974 transportation plan.[121] This was before the term "traffic calming" was in widespread use, so in Zürich the principle was known as "channel traffic out of residential areas to keep them peaceful." Since adopting this policy, Zürich has systematically implemented traffic calming improvements to channel traffic out of residential areas throughout the city.

Traffic Calming Improvements

Today, traffic calming improvements are visible in all Zürich residential and commercial neighborhoods. A wide variety of different improvements, including sidewalk wider streets, pedestrian zones, speed bumps, one-way streets, and prohibition of night traffic on certain streets, have been implemented throughout the city.

In scope and implementation, traffic calming improvements are analogous to Transit Priority improvements. Both programs consist of small, carefully tailored improvements that add up to an improved system. Since the improvements are small they are often difficult to implement, as individual improvements have limited specific positive benefits and can have strongly perceived specific negative impacts. Their real benefit comes from implementing them comprehensively. These similarities make it logical to combine implementation of both programs together in a given area.

This is one implementation lesson from Zürich: Coordinating the transit priority and traffic calming programs provided needed public support for both programs and allowed a larger and more comprehensive program to be implemented. Support for transit improvements on the local level came from improving neighborhood livability by implementing traffic calming improvements, while support for traffic calming on the city level came from implementing the transit priority improvements. The traffic engineering improvements for both programs could be codeveloped. Both require detailed analysis and designs carefully tailored to a specific neighborhood and street network. The formation of the Working Party of departments assisted in the design and implementation of these integrated improvement projects.

In addition to helping generate support for the transit priority program, the traffic calming improvements themselves helped improve the transit system. One reason is that some of these improvements served transit priority as well. For example, eliminating cross traffic on a transit route by creating a cul-de-sac on a minor neighborhood street both reduces conflicts for transit and makes a more livable neighborhood street. Another example is that traffic calming has made it more comfortable to walk to transit stops and made the transit stops themselves more attractive for waiting passengers. Finally, traffic calming has made it slightly more difficult to drive in the city and therefore has encouraged transit use.

Reduction of Roadway Capacity

While traffic calming can be targeted to improving neighborhood livability, reducing roadway capacity[122] often is intended to serve more general environmental goals, such as regional air quality and citywide transport conditions. Zürich's approach, however, linked the two programs closely by using traffic calming to channel traffic to arterial streets and then focused on reducing capacity on those arterials.[123]

The most obvious way of reducing a roadway's capacity is to reduce the number of lanes available for private motor traffic. This has been done in Zürich at many locations where roadway space was redistributed to provide exclusive lanes for transit, and in other locations to construct better facilities for pedestrians (wider sidewalks) and bicyclists (bike lanes).

In Zürich, these improvements have not been implemented simply to reduce traffic but rather to achieve other goals such as the transit priority program. This puts into practice the idea recommended by Jane Jacobs in *The Death and Life of Great American Cities*, that roadway space should be taken from automobiles only where pedestrians can really use it as a "gain for city life." [124]

Balancing Roadway System Capacity

In addition to actively reducing roadway capacity, Zürich has not pursued programs designed to increase roadway system capacity. In fact, when two major new federally subsidized roadways opened in 1985 as part of the national road system, capacity lessened on alternative routes to keep the overall traffic capacity approximately the same.

Finally, as has been outlined above, Zürich uses its traffic signal system to regulate the amount of traffic entering the city and traveling between city zones to keep the roadway network from becoming overloaded.

According to Ott, results of a large-scale test of strict traffic restraint measures did give a decrease of 15 to 25 percent in kilometers traveled during the rush hour; the reduction was 5 to 10 percent over a 24-hour period.[125]

Parking Controls

"Because there is no place to park in Zürich" is a popular answer to why Zürich's public transportation is so successful. Zürich has actively pursued a

program of reducing parking in the city since the 1970s, when programs were designed to encourage commuters to use public transportation. Similar to reducing roadway capacity, parking been removed as part of programs that provide exclusive transit lanes and improved pedestrian/bicycle facilities on roadways.[126]

The city adopted programs to control on-street and private parking. Private parking makes up approximately 80 percent of the parking supply. Both types are outlined below.

In the 1970's, Zürich began an ongoing program to reduce the number of on-street parking spaces available to commuters. The city reduced the number of public parking spaces from approximately 61,200 in 1970 to 51,500 by 1980 and to 48,267 by 1999.[127]

During the 1980's, controls were imposed on street parking spaces. Controls placed time limits on parking spaces or designated them for neighborhood use. Today, approximately 30,000 of the on-street spaces are regulated. Most of the city is in a neighborhood parking program whereby residents are allowed all-day parking. Visitors can park only for an average of one to two hours. The remaining spaces are time-restricted and more than half have parking meters. As a result of these programs, there are few free places to park. The price for parking at a meter is fairly low—generally about 2 SFr per hour ($1.33 U.S.) and fines for exceeding time limits are 30 SFr ($20 US).

Off-Street and Private Parking

It has been more difficult for the city to limit private parking spaces. In fact, the number of spaces increased by 5.3 percent from 1989 to 1999.[128] However, given the increase in economic activity during this time, Zürich is probably doing a good job at limiting the growth in private parking.

Zürich's program to limit private parking is based on parking controls for new development that govern the maximum allowable amount of parking. The regulations are tailored to each individual area's public transportation alternatives and the capacity of its roadway network.[129]

The city also is negotiating progressive agreements with developers of new employment centers that further limit the amount of parking and set performance goals for the number of vehicle trips that can be generated by the facilities. Should the ambitious goals not be met, the developers and owners

will be responsible for paying a monetary penalty and developing measures to bring the traffic generation into compliance with the agreements.[130]

IMPROVING REGIONAL TRANSPORTATION PROGRAMS

History and Introduction

Zürich's economic growth since World War II led to a development pattern of decentralization similar to other cities. In 1950, almost 200,000 people lived and worked in Zürich, while 25,000 commuted into the city to work. By 1980, the number of people living and working in Zürich decreased to about 175,000 and the number of commuters increased to almost 125,000.[131] Jobs in the suburbs increased significantly as well.

The increasing decentralization created a strong need for improved transit coordination and regional transit improvements. One of the most innovative implementation lessons from Zürich is that the region used the need for a large capital investment in the regional commuter rail network to leverage institutional change in the region's 42 different transit operators.

In essence, the Canton of Zürich forced the region's transit operators to coordinate their fares and schedules in exchange for building the major improvement. This approach is interesting given the need for institutional change, such as improved transit operator coordination, in many cities and the difficulty experienced in bringing about this change. A good example is San Francisco Bay Area's long struggle to improve coordination between regional transit operators.

Commuter Rail System

Improving regional transportation by investing in the commuter rail system and carefully coordinating transit service was critical to the success of the city's transit priority program. Without an excellent regional system, commuters would have needed to drive into the city, thereby reducing the amount of space available for Zürich's transit priority and livability improvements. With the excellent system, the city can argue that public transit is a better alternative than driving and reject demands for increasing space for private vehicles.

The following two sections describe the regional rail system and the coordination program it brought about.

S-Bahn Regional Rail System

As described in "History: Zürich's Transit Priority Program," Zürich voters defeated a proposal for a combined U-Bahn/S-Bahn system in 1973. It was clear to those who analyzed election results that the measure had been defeated because of the U-Bahn, not the S-Bahn. Many people believed that there was a need for significantly better regional transportation, but were skeptical about constructing a new urban underground system.

Following the defeat of the combined plan, the Canton of Zürich took charge of developing an S-Bahn plan needed to serve regional transportation needs.[132] Up to this point the canton had not been significantly involved in providing transit service, leaving this to the federal government and individual cities.

S-Bahn Planning

The 1973 S-Bahn improvement plan had been developed by the Swiss national railroad's (SBB) planners to address problems with the existing system. The existing system was inefficient and offered poor connectivity for passengers, because all the lines operated into and out of Zürich's main station, a traditional terminal design station. This design meant that all trains needed to pull into the station and then reverse direction to pull out, an operation that takes several minutes. In addition to being an inefficient use of station capacity, it meant extensive delays and transfers for people not traveling to the downtown area. The inefficiencies of terminal design and other system capacity constraints limited S-Bahn service to 1-hour frequencies.[133]

The 1973 plan was to build a system that allowed at least half-hour-frequency service on 12 different S-Bahn lines. The construction included building an underground through station at Zürich's main station, a 12-kilometer tunnel under the city and Zürichberg Mountain, and a series of capacity improvements on the mainlines in and around Zürich. These improvements were designed to enable approximately 450 kilometers of the national railroad network to be used efficiently for the S-Bahn service. The original plan was reevaluated following the 1973 election in an 8-year public planning process, and was placed on the ballot in a 1981 election.

Swiss Rail System Planning

An underappreciated aspect of Switzerland's rail infrastructure is that it is extremely efficient. Before making any new capital investment, rail system

planners prepare a detailed operational analysis. This analysis begins with development of a desired service schedule; this schedule is then used to determine precisely the location, type, and extent of physical improvements required to meet that schedule.[134] This reduces the cost of projects by eliminating overbuilding. In the case of the S-Bahn, the desire was to offer half-hour service on a series of existing and new routes made possible by the improvement program.

One reason for keeping costs as low as possible is that voters must approve funding for all major capital improvement projects. To be successful at the ballot box, project proponents must clearly describe the project's benefits and ensure voters that they are not wasting money. A significant part of the S-Bahn campaign was preparation of detailed train schedules. The schedules were taken to the cities to show how much service could be improved for the particular city with the proposed improvements. [135]

Campaign and Election

The Canton placed the S-Bahn proposal on the ballot in the Fall of 1981. There was a great deal of support for the plan; however, it was opposed by some of the most progressive groups, because there was not a strong mechanism in place to prevent property values from increasing around S-Bahn stations.[136] They feared, similar to the 1973 U-Bahn/S-Bahn election, that rising prices around stations would displace residents in favor of businesses. This opposition was not enough to defeat the proposal. The voters approved the S-Bahn plan on November 29, 1981 by a vote of:

- YES - 209,177 - (74%)
- NO - 74,467 - (26%) [137]

The vote approving construction of the S-Bahn specified that the Canton would provide 523 million Swiss Francs (SFr) for the project (80 percent) and the Swiss National Railway (SBB) would provide 130 million SFr (20 percent). This funding paid for the central project (main station, center city tunnel, Stadelhofen Station, and Zürichberg tunnel).

Construction

The S-Bahn improvements were constructed as a result of a contract between the SBB and the Canton of Zürich. That contract stated who would pay what

share for the project and how the new system would be operated. Construction of the S-Bahn improvements started with the groundbreaking on March 17, 1983.

Eventually, nearly 2 billion SFr was spent on additional railroad system capacity improvements, station improvements, and new rolling stock. For example, the canton and SBB shared 50/50 the cost of a 440 million SFr set of capital investments made following the start of operations in 1990 (the canton also voted to approve these improvements).

The SBB purchased 50 new trains for use on the S-Bahn at a cost of 500 million SFr before the system opened, and added 66 trains at a cost of 660 million SFr during the early 1990s. The trains consist of four cars: one locomotive/baggage car and three double-deck passenger cars, one of which has a control cab. The passenger capacity of each train is approximately 450 seated. The train units can be linked to a maximum of three trains. Before deciding on the two-level design for the S-Bahn trains, planners borrowed two-level trains from France to see how Zürich passengers would react.[138]

S-Bahn Operation

The S-Bahn trains are operated under contract by the SBB over a network of tracks owned by the SBB, and the canton is billed for the service costs. The S-Bahn connects all parts of the region and is used for the long-distance parts of most public transit journeys. Rail service is provided on 16 different lines on a half-hour frequency (more often during peak periods) from 6 A.M. until midnight. Several lines share the same tracks in the central area so that effective frequency in the central area is even better than every half-hour.

One extremely attractive quality of the S-Bahn service is that it has been designed with the capacity to provide express service. This means that certain S-Bahn lines provide limited service and therefore operate with very short travel times, in fact, much shorter from many locations than driving. The S-Bahn schedule has been designed to enable connecting transit service to take advantage of these express train routes. This type of service provides much better service to passengers than metro-type transit that must stop at all stations.

Private S-Bahn

In addition to the S-Bahn system that operates on the SBB's national rail system, two private railroad operators provide S-Bahn service in Zürich. These lines are the Sihltal-Zürich-Uetliberg (SZU) Bahn, which operates underground along the Sihl River into its own underground station at Zürich's main station, and the Forch Bahn, which operates in the city over streetcar tracks into Zürich's Stadelhofen Station then out of the city on its own right of way. Both systems are fully coordinated with the other S-Bahn lines and local transit operators along their routes.

The SZU Bahn completed its own large (105 million SFr) project, constructing approximately 1 kilometer of underground track along the river, a new terminal in the main station, and a new underground station at Selnau.[139] This service opened approximately at the same time as the rest of the S-Bahn. Interestingly, the SZU Bahn terminal occupies the space that had been planned for the U-Bahn station at the Zürich's main train station.[140]

S-Bahn Success

In terms of its operation, Zürich's S-Bahn has been a resounding success. It is the backbone of the region's public transit system and serves as the means of coordinating public transit services in the suburban communities (see below). Since opening, S-Bahn ridership has increased by approximately 50 percent and increased even during Switzerland's economic recession between 1992 and 1997 when employment fell by approximately 10 percent.

Table 10 illustrates growing S-Bahn ridership. As shown in the table, the biggest single jump occurred when the new system was opened in 1990, but ridership has increased consistently since then.

Table 10: Zürich S-Bahn Ridership

Year	*Daily Ridership*	*Increase Over '89-'90 Ridership*
1989-90	159,300	100%
1990-91	197,700	124%

Ridership measured at the Zürich city border.
Source: *Der ZVV in Kürze; Juni 2001.*

Table 10: Zürich S-Bahn Ridership (Continued)

Year	*Daily Ridership*	*Increase Over'89-'90 Ridership*
1991-92	206,600	130%
1992-93	212,700	134%
1993-94	215,500	135%
1994-95	217,800	137%
1995-96	216,100	136%
1996-97	220,600	138%
1997-98	220,000	138%
1998-99	227,300	143%
1999-2000	242,300	152%

Ridership measured at the Zürich city border.
Source: *Der ZVV in Kürze; Juni 2001.*

The ridership data presented in Table 10 do not include trips made on the S-Bahn totally within the city of Zürich. Data from the VBZ (the city transit operator) reveals that average passenger trip length on surface trains and buses has dropped by approximately 12 percent since the S-Bahn opened. Boardings have remained constant, supporting the conclusion that many of the longer intracity trips are now being made on the S-Bahn system.

Use of the S-Bahn for intracity trips is an important aspect of Zürich's overall transit program. Many cities have what can be termed three-level transit systems: a local level (generally buses and trams operating on surface streets), an intermediate level (generally a grade-separated heavy rail system), and a longer-distance level (generally a suburban train or commuter rail system). Zürich has no intermediate-level system; instead, the city has increased the speed and efficiency of the local level and the region has increased the number of stations for the longer-distance system in the city. Basically, the shorter middle-distance trips can be made easily by surface transit and the longer middle-distance trips can be made using the S-Bahn. The ridership and trip length data from Zürich show that this strategy has succeeded.

S-Bahn Failure

One argument in favor of the S-Bahn was that it would be a means of taking cars off the road rather than a way to move more people into the city. Therefore, its construction would enable the City of Zürich to reduce vehicle capacity on main roads entering the city. Unfortunately, the Cantonal government would not allow the city to implement these measures and city traffic volumes remained relatively constant after construction of the S-Bahn system. The 1994 proposal for improvements to the Central Plats transit center is a specific example. This proposal would have improved transit priority at the square but would also have reduced automobile capacity and therefore was vetoed by the Kantonsrat.[141] The S-Bahn is successful in many ways; however, the canton's government did not allow it to be used as a means to strengthen Zürich's transit priority program.

Planning for the Future

The success of the S-Bahn system and Swiss national railroad system has created increased demand for train service to the point where the existing S-Bahn network and stations are operating at capacity. Therefore, the SBB and the Canton of Zürich are once again working together to develop long-range plans for improvements to the system. Some of these improvements will be completed as part of the on-going national "Bahn 2000" program, and others are being developed for the next capital improvement program.[142]

The most significant improvement being planned is an additional underground through station on the south side of the main station. This station would serve the S-Bahn lines that still use the main station's surface tracks as well as some national trains.[143] The SBB started working closely with other government agencies and the public early in the planning process for this project, as opposed to the original S-Bahn planning process which was completed almost exclusively by the SBB itself.[144]

Regional Transit Coordination: The Züricher Verkehrsverbund (ZVV)

More important than the S-Bahn's physical improvements are the institutional changes from construction of the system. As described, the Canton of Zürich used its investment as leverage to force the region's different transit operators to better coordinate their services. This was done because one line in the S-Bahn ballot measure said that it was the intention of the parties to implement a coordinated ticket system for the entire canton.[145]

In order to put that provision into place, the canton formed the Züricher Verkehrsverbund (ZVV) following approval of the ballot measure.[146] In German, "Verbena" means federation and "Verkehrsverbund" means transit federation. The Züricher Verkehrsverbund is the Canton of Zürich's agency for coordinating, managing, and improving service quality of the region's 42 different transit operators. Since its formation, the ZVV has evolved into a powerful agency for management of the region's public transit service.

Only 10 years have passed since the systems became fully coordinated; however, visitors to Zürich marvel at how coordinated its different transit systems are. The coordination required the Canton of Zürich to study many different organizational structures for the regional transit coordination agency. After examples of other regional transportation agencies were evaluated, the canton combined the best features from all the agencies to create the Züricher Verkehrsverbund (ZVV).[147]

The next section describes operation of the ZVV and some of the techniques it has used to coordinate schedules, fares, and marketing in the Zürich region.

Operation of the ZVV

There are many organizations like the ZVV; however, few have had the same success in creating an efficient and effective regional transit network. Perhaps the most interesting aspect of the ZVV and one secret of its success is how it operates: The ZVV acts as a broker and purchases a level of service from each of the 42 transit operators. For example, the ZVV annually contracts with the city of Zürich's transit operator (the VBZ) to operate a given level of service and pays the VBZ an agreed amount for the service.[148] In turn, all the ticket revenues are paid to the ZVV. The ZVV receives a subsidy from the cities in the Canton to make up the difference between what is collected in fares and what is paid to transit agencies to operate the service.

The key to this approach is that the ZVV must be able to analyze the cost structure for each of the transit operators and determine whether the price offered by the transit operator is reasonable. It took several years for the ZVV to develop the expertise necessary to analyze costs effectively, but today it has that ability and works, through the contracting process, to reduce unnecessary expenses at transit agencies. The ZVV is allowed to contract out poor quality and/or inefficient service to other public or private operators, although this has been challenged and the ZVV has agreed not to contract out any more service until 2002.

Table 11: Transit Cost and Subsidy

Year	*Cost*	*Fares*	*Subsidy*	*Subsidy %*
1991	522.6	277.5	245.1	47%
1992	563.6	286.9	276.7	49%
1993	583.2	292.8	290.4	50%
1994	600.7	294.4	306.3	51%
1995	605.4	298.1	307.3	51%
1996	639.2	298.8	340.4	53%
1997	660.2	300.0	360.2	55%

Figures in millions of Swiss Francs.
Source: ***Statistisches Jahrbuch des Kantons Zürich 1999 - Page 190.***

The important point about how the ZVV operates is the region's fresh approach to the issue of the business of public transit in the region.[149] The canton formed a new agency with power to require individual transit operators to improve quality, efficiency, and coordination, and did it using a simple, business-like approach.

Schedule Coordination

There are two basic types of schedule coordination operating in the Zürich area today: pulse scheduling at suburban rail stations and "brute-force scheduling" in the City of Zürich itself. With pulse scheduling, several different transit routes meet at a specific point at approximately the same time, passengers can transfer among the vehicles, then all the vehicles leave; the pattern repeats, for example, every half-hour. The "brute-force" method is not really coordinating schedules, but operating so much service that people do not need to wait long to transfer between vehicles or systems.

In terms of the suburban pulse system, the crucial element for schedule coordination is the S-Bahn's all-day-long half-hour frequency. The S-Bahn stations serve as the focal points for local public transportation networks; these networks are designed to feed people into the S-Bahn, but this station-based system also improves service and connections for people who are only using the local system. This works because requiring a local transit system to be

coordinated with the S-Bahn arrivals and departures means that the local system's vehicles also will be coordinated with themselves.

It is amazing to visit some of the suburban S-Bahn stations and see buses and trains arriving at a station in a five-minute period, passengers interchanging among all the vehicles, and then all the vehicles leaving. The station is quiet for 25 minutes, then the whole process repeats itself.

In the City of Zürich, transit service is so frequent throughout the day (approximately every seven minutes on all lines in all directions) that it is not necessary to have a highly coordinated system for most of the day.

Finally, the SBB operates a pulse-type coordination system for its entire network in Switzerland. Thus, it is possible to travel from one city to another, transfer to another train, and travel to your ultimate destination with only a short transfer time (under 10 minutes). The SBB uses this pulse scheduling as a critical element in its capital improvement planning.[150]

Fare Coordination

There are two key parts of fare coordination: how it works for passengers and how it works for transit operators. The best type of coordination from a passenger's perspective is to pay one fare for the entire trip regardless of what transit operator they use to make the trip. Transit operators, on the other hand, are worried about maximizing their fare-box revenue.

In order to bring about coordination, regional transit operators must agree to some type of system. The need to maximize revenue has made it difficult for operators to coordinate fares since they need to develop some agreement on how to split ticket revenues. In many places, this has led to development of complex, capital-intensive fare collection systems, and agreements between operators and coordinating agencies. The approach in Zürich is simpler but required looking at the problem in a new way.

From the transit operator's perspective, the fact that the ZVV contracts for a given level of service from all operators takes away the need to negotiate formulas and procedures for splitting ticket revenues. This allows transit operators to focus on the service and efficiency.

Fare coordination is critical to passengers. A simple and efficient system will make them more willing to take public transit. A system that makes them pay a

new exact change fare several times on their trip is a significant disincentive to using public transit. In addition to being inconvenient for passengers, this type of complex system delays transit vehicles and presents a level of uncertainty for potential passengers that further dissuades them from using transit.

From the passenger perspective, the ZVV developed a simple, efficient tariff system. The Zürich Canton is divided into 45 fare zones. The City of Zürich is a single-fare zone, and tickets are purchased for traveling from one fare zone to another. Tickets are purchased at train stations, newsstands, and through a common type of ticket-vending machine at all stops and stations. Suburban operators' tickets are purchased from drivers. Single-ride tickets are easy to purchase; however, most people in Zürich use monthly or yearly tickets, which provide significant discounts and simplify accounting.

Transit Marketing and Ticketing

Marketing is a critical and often neglected part of transit operation. During the 1980s, Zürich started an aggressive marketing program designed to encourage people to use transit. These programs include printed brochures mailed to households and businesses, fare promotions such as youth discounts, and activities linked to the VBZ, including free public transportation. These programs continue today with such innovative programs as special Christmas season trams for children and joint ticketing with many of Zürich's concerts and cultural activities.

One successful marketing program was implementation of the discounted monthly ticket. In 1985 the VBZ introduced the monthly Rainbow Ticket, which allows unlimited rides on public transportation within the city zone and is transferable. The ticket was based on success of a similar ticketing system adopted in Basal, Switzerland, in 1984 and marketed as an environmental protection ticket.[151] The cost of this monthly ticket is 78 SFr (about $50), while a single 24-hour ticket is 7.2 SFr.

These tickets are extremely popular. In 1990 more people purchased these monthly tickets than owned cars in Zürich. According to Pharaoh, "the success (of these tickets) ... has clearly shown that a tariff system must above all have two features: simplicity and good value."[152] In 1997, approximately 27 percent of ZVV passengers used annual tickets, 26 percent used monthly tickets, and 47 percent used single or multi-ride tickets.[153] In May 2000, about a quarter of the entire active population of the Zürich Canton, about 260,000 people, had monthly or annual tickets.[154] In addition to the monthly ticket, several shorter-

time tickets are priced to encourage people to use the system. For example, a 24-hour ticket is offered for the same price as two single rides. The VBZ also offers six 24-hour-period tickets for the price of five. Both tariffs provide a significant incentive for people to use the system.

Another aspect of marketing is advertising your service. In Zürich, one way of advertising the service is using the transit vehicles themselves as moving advertisements—not as moving billboards with text and pictures, but just the basic paint scheme of the vehicles themselves.

Surface transit has a strong advantage over underground transit in this way especially when service is as frequent as Zürich's. Zürich's blue-and-white streetcars and buses are ubiquitous on the city's streets and squares. The city's streetcars are so popular that Zürich transportation consultant Willi Hüsler has completed an informal survey and found that nearly 50 percent of the tourist postcards in Zürich have one of Zürich's trams in the picture.[155]

PUBLIC SUPPORT FOR TRANSIT IMPROVEMENTS

INTRODUCTION

Public support is necessary to mobilize government to take any significant action. Implementing a transit priority program is no different, and in some ways it requires stronger and more explicit support, since elected officials often do not accurately understand the strength of public support for transit priority improvements.

In Zürich, elected officials supported construction of the U-Bahn/S-Bahn plan in 1973, while citizens proposed an alternative based on transit priority. It took defeat of the U-Bahn/S-Bahn plan and approval of the citizens' initiative to implement Zürich's transit priority program. Several years after implementation of the transit priority program began, the Zürich government commissioned a survey to assess elected official views on transit priority and improvements. It found that elected officials underestimated public support for transit priority. In order to test this finding in another situation, a similar survey of public leaders was made in Santa Clara County, California, as part of this research project. This chapter outlines findings of that survey and describes how these findings impact implementation of transit priority programs.

IMPORTANCE OF PUBLIC SUPPORT

Building substantial public support is the primary task in the design, passage, and implementation of transit system improvements. Community interests are varied and reflect individual, group, and societal preferences. For example, a voter faced with an expensive transportation initiative must weigh his or her own transportation needs and preferences, the economic need to reduce congestion, and the quality-of-life impacts of transportation systems on the community. Paying for transportation requires long-term commitments of resources that will not be available for other worthwhile societal purposes.

Community leaders must choose wisely among transportation alternatives. They must anticipate the preferences of their constituencies and weigh them against what is best for the larger society. Most important, they must plan based on existing conditions; new initiatives must be considered in the context of existing systems.

When urban transportation systems need improvement, community leaders must find alternatives that are workable and that can be sold to voters. The problem of obtaining public support for transit improvements is particularly acute in California, where financial expenditures require a two-thirds majority. Voter cynicism can seem almost insurmountable. A strong political will and an indefatigable commitment to community education are therefore indispensable to gaining voter approval. Many recently completed major transit investments are testimony to the hard work of community leaders and civic consciousness of their constituencies. The Tasmania and Guadeloupe light rail extensions in Santa Clara County are clear examples of collaborative efforts.

The 1993 study *Mobililitat in Zürich: Einschatzungen* (*Mobility in Zürich: An Assessment*)[156] presents results of a survey of community leaders and voters. This survey revealed a considerable disparity between the expressed views of the two groups and their perceptions of the view of the other.

The two samples were asked their view on automobile-based initiatives versus alternatives such as light rail systems and pedestrian-only streets. Remarkably, the two groups had virtually the same opinion. Both favored nonautomobile solutions—91 percent of citizens and 94 percent of leaders. However, each group was cynical about the priorities of the other. Citizens believed that opinion leaders would only favor nonautomobile solutions by a margin of 56 percent. Community leaders viewed citizen support for nonautomobile solutions as being around 49 percent.

A closer analysis of the survey results revealed an even weaker support for automobile-based solutions. Each respondent had the opportunity to vote three times, and they could vote more than once for a given alternative. Only 9 percent of the respondents voted twice or more for automobiles. The strongest support for automobile-based solutions was among men who commuted to work by car.

Drawing on the European example, the author questioned whether the same misappropriations of constituent priorities might exist among opinion leaders in Santa Clara County. Since political leaders' perceptions of their constituents' priorities drive the design of improvement proposals and presentation of marketing materials aimed at soliciting constituent support, this is an important question. To answer this and other related questions, a survey was conducted of policy makers who participated in planning and campaigning for Santa Clara County's most recent light rail extensions.

SANTA CLARA COUNTY SURVEY BACKGROUND

The survey consisted of asking a group of elected officials and high-level staff members to complete a questionnaire consisting of three demographic items and ten open-ended questions. The questionnaire asked participants to answer the following questions:

1. What are the transportation priorities of public officials in the Santa Clara County?
2. Do they prefer roadway or mass transit solutions?
3. What do officials believe to be the priorities of their constituents?
4. What percentage of their constituents do they estimate would regularly utilize light rail if it were made available?
5. What do officials believe is the potential effectiveness of light rail for alleviating traffic congestion?
6. What do officials perceive to be the motivations of voters who support light rail (access or to get others off the road)?
7. What do officials see as pitfalls to planning new systems and getting them built?
8. What do officials perceive to be the relative importance of political and technical issues in formulating transportation policy?
9. What should be the relative emphasis placed on access versus congestion in campaigns for voter support mass transit systems?
10. What do officials believe to be the most effective campaign strategies (media-based or community outreach)?
11. How do the officials rank transportation planning in the greater context of overall public policy?

Fifty elected and appointed officials from the Santa Clara County Board of Supervisors and the cities of Cupertino, Milpitas, Mountain View, Santa Clara, San Jose, and Sunnyvale were asked to participate in open-ended, in-depth interviews. Career transportation officials from the Santa Clara Valley Transportation Authority (the public transportation system operator) were also invited to participate. All the targeted officials have busy schedules and many could not be scheduled for face-to-face interviews.

In-person interviews lasting from 30 to 45 minutes were conducted with 27 respondents. Seven additional questionnaires were mailed in for a total response of 34 officials. The combined response rate was 68 percent. Table 12 summarizes the make-up of the respondents.

Table 12: Survey Respondents

Organization/Office	*Number*
Santa Clara County Board of Supervisors	3
City of San Jose City Council Members	7
San Jose City Manager	1
Milpitas City Council Members	3
Milpitas City Manager	1
Mountain View City Council Members	6
Mountain View City Manager	1
City of Santa Clara Council Members	4
Sunnyvale City Council Members	4
Cupertino City Council Members	2
VTA Career Transportation Specialists	2
Total	**34**

The experience of the elected respondents ranged from a low of six months to a high of 14 years. The mean number of years in their current positions was 4.3 years. The modal response was four years. The city managers had experience ranging from less than six months to 10 years. The two transportation specialists had been in their current positions for more than five years.

The open-ended responses were coded into standard numeric format using content analysis. For example, officials expressing a preference for mass transit were coded 1. Those expressing a priority for new roads and highways were coded 2. Those who preferred a mixed solution of mass transit and roadways were coded as 3.

The data was analyzed using the statistical package in Microsoft's Excel. The responses of the transportation specialists differed sufficiently to warrant a

separate analysis. The frequency tables reported below, therefore, include only elected and appointed officials. Where appropriate, the views of the transportation professionals are noted in the text.

SANTA CLARA COUNTY SURVEY RESULTS

This section outlines results of the Santa Clara County survey. The first two survey questions were designed to provide information similar to that included in the Zürich report. Several questions provide information on how County leaders view light rail effectiveness and developing transportation plans for public approval at the ballot box.

It is interesting to note that the final survey question addressed the relative importance of transportation as a public policy challenge in the minds of Santa Clara County officials. The survey respondents were unanimous in the opinion that transportation is one of the top three problems they will face for the foreseeable future. The other two top problems were affordable housing and air quality.

With respect to transit priority program implementation, results of the survey indicate that public officials in Santa Clara County are skeptical that citizens support public transit over roadways. This finding will be discussed further in the Conclusions section.

Support and Perception of Support for Transportation Improvements

Table 13 presents the level of support by Santa Clara County leaders and their perception of public support for transit, roadway or multimodal transportation solutions based on survey questions 1 and 2.

As shown in Table 13, when asked their own transportation preferences, 58 percent of the officials expressed a preference for transit solutions, 22 percent expressed a preference for roadways, and the remainder did not express a preference, saying instead that both were part of the solution. This latter group expressed the view that Santa Clara County needs comprehensive transportation planning that integrates rail and bus systems with roadways.

Table 13: Support and Perception of Support for Transportation Improvements by Public Leaders in Santa Clara County

Transportation Improvement	*Leader Support for Improvement*	*Public Perception*
Transit	58%	22%
Roadway	225	50%
Multimode (both)	20%	28%
Source: *Santa Clara Transportation Leaders Survey, 2000.*		

The Zürich disconnect between the preferences of public officials and their perception of their constituents' preferences also occurs in the Santa Clara County. Fifty percent of officials in the Santa Clara County survey believed that their constituents would prefer roadway solutions. Only 28 percent credited their constituents with a multimodal view that recognized the need for integrated transportation systems and only 22 percent believed that they wanted transit-only solutions.

The differences between the officials' personal preferences and their perceptions of their constituents were substantial. The t-test of the correlation was statistically significant and negative. On the positive side, Santa Clara County officials' perceptions regarding their constituents' preferences is much less negative than are those of their European counterparts. These results are presented in Table 14.

Table 14: Statistical Differences Between Officials and Their Perceptions of Constituents in Santa Clara County

Measure	*Official's Variable*	*Constituent Variable*
Mean	1.625	2.0625
Variance	0.629032	0.512097
Pearson	Correlation	0.55
T-Statistic	-3.458414	
N	32	32
Source: *Santa Clara Transportation Leaders Survey, 2000*		

LIGHT RAIL TRANSIT EFFECTIVENESS

Survey questions 3 and 4 asked the transportation leaders for their perceptions on what percentage of travelers would use light rail if it were built and how effective they think it could be in reducing traffic congestion. The survey focused on light rail because Santa Clara County made a significant investment in this mode of transit. Plans are being made to construct a large network throughout the county.

In terms of light rail transit use, the Santa Clara County transportation professionals surveyed reported that where light rail is available, its use runs at a steady 3 percent. However, as shown in Table 15, Santa Clara County public officials were much more optimistic regarding the potential use of light rail.

Table 15: Officials' Perception of Light Rail Use

Amount Constituents Expected to Use Light Rail	*Percentage*
Light Use—<10% of time	59%
Moderate Use—Between 11% and 20% of time	38%
Strong Use—Between 21% and 30% of the time	3%
Source: *Santa Clara Transportation Leaders Survey, 2000.*	

Fifty-nine percent of Santa Clara officials believed usage of light rail would be light, while 38 percent believed moderate use was possible, and 3 percent believed the potential use to be greater than 20 percent. Clearly, local officials view light rail as a key component in addressing transportation needs in the county. It is interesting to note that a large number (41 percent) of the officials expected more than 11 percent light rail usage, while actual utilization runs at about 3 percent when it is available. Thus, officials are more optimistic about light rail than perhaps is warranted.

Survey question 4 asked respondents to assess the overall potential effectiveness of light rail for alleviating traffic congestion. These data are reported in Table 16.

Table 16: Officials' Perception of Light Rail Transit's Effectiveness in Reducing Congestion

Perception of Light Rail Impact on Traffic	*Congestion %*
Not effective	22%
Somewhat effective	50%
Very effective	28%
Source: *Santa Clara Transportation Leaders Survey, 2000.*	

According to the survey, 50 percent of Santa Clara County officials expressed the view that light rail could be somewhat effective, 22 percent judged light rail as not effective, and 28 percent believe it to be potentially very effective.

When those who believed that light rail would not be effective at impacting traffic congestion were asked why, they blamed population and economic growth rather than light rail itself. All believed that the county's population would continue to grow, increasing pressure on an already overloaded transportation system. Thus, as one of those having a lowly view of light rail said, "Nevertheless, we have no choice but to continue to build it, otherwise things will come to a standstill."

Another expressed the view that light rail would be more effective if it were faster. Commuters, rightly or wrongly, view light rail as slower than traveling by car. In the words of one respondent: "It is a quality of life issue. Home time is vital to commuters who want to minimize travel time." This official, therefore, expressed the need for easy access to the light rail system to cut commute time. Interestingly, this argues for implementation of programs like transit priority and improved regional transit similar to those implemented in Zürich.

Voter Motivation and Campaign Strategies

Today, citizens must approve most major transit improvement projects in an election. Most of the time this takes the form of approving a new tax or bond issue to pay for the project's construction. Both Zürich and Santa Clara County have long histories of going before the voters with transportation plans and funding proposals. Questions 5 through 9 addressed officials' perceptions of voter motivation for supporting transportation plans and campaign strategies that could be used to obtain voter support. Since voter approval is critical to

implementing transit projects, understanding what motivates voters and campaign strategies is critical to the success of these projects.

Voter Motivation

Question 5 asked officials what they believed was the motivation of voters who supported light rail transit, whether it was to get access themselves to the new system, or to ease congestion by getting others off the road. Question 5 results are in Table 17.

Table 17: Officials' Perception of Voter Motivation in Supporting Transit Systems

Perception of Voter	*Motivation %*
To gain access to the new transit system	6%
To ease congestion	58%
Recognize need for transportation alternatives	35%

Source: *Santa Clara Transportation Leaders Survey, 2000.*

Fully 58 percent of Santa Clara officials expressed the view that voters support mass transit systems in order to get others off the road; 6 percent said voters support transit systems because they would use them. This rather cynical view of voter motivation is consistent with Santa Clara County officials' belief that voters prefer roadway solutions to transportation problems. It is also consistent with other surveys done on transit projects. On a more positive note, 35 percent of respondents credited supportive voters with an understanding of the transportation problem and the need for balanced multimodal solutions.

Obstacles to Transit Plans

Santa Clara County officials were asked to identify the principal obstacle to implementing a transit improvement plan. As shown in Table 18, educating constituents was overwhelmingly viewed as the most significant problem, with 59 percent believing it to be the primary obstacle.

Table 18: Officials' Perception of the Primary Obstacles to Transit Plans

Type of Obstacle	*Percentage*
Educating Constituents	59%
Funding	22%
Political Process	11%
Nonexisting Support	11%
Other	7%

Source: *Santa Clara Transportation Leaders Survey, 2000.*

Other obstacles included obtaining funding (22 percent) and the pitfalls inherent in the political process (11 percent). Eleven percent believed that significant obstacles no longer exist, that is, the support and political will are already in place for mass transit improvements.

Political Versus Technical Issues

Survey question 7 asked respondents to weigh the relative importance of political and technical issues in formulating transportation plans. Not surprisingly, as shown in Table 19, the Santa Clara County officials surveyed emphasized the importance of politics over technical issues.

Table 19: Officials' Perception of the Relative Importance of Political versus Technical Issues in Formulating Transportation Plans

Type of Obstacle	*Percentage*
Political	53%
Technical	22%
Both	23%

Source: *Santa Clara Transportation Leaders Survey, 2000.*

According to the survey 53 percent of the leaders interviewed emphasized the importance of politics, 22 percent emphasized the importance of technical issues, and 23 percent said both were important. A review of the original questionnaires revealed that the more senior political officials most often spoke of the need for balance between technical and political sides. As one explained:

"We have to develop a comprehensive technically feasible plan in order to sell it to the people."

Both of the transportation professionals surveyed expressed a need for both factors. One expressed the belief that the current knowledge level of political leaders makes it possible for him to focus on technical issues. In the absence of such sophistication, he believes that educating the politicians would be the priority. Once the political leaders are on board, the population will follow.

The second transportation professional believed that a balance is necessary. He believed that, technically, transportation planners must "determine the best transportation alternative for the corridor. Residents are always political." He explained that the political community along the corridor is critical to a successful campaign for implementation of a particular improvement.

Campaign Emphasis

Survey question 8 asked officials what they believed should be emphasized in campaigns: access to transit services, traffic congestion relief, or both. Answers are presented in Table 20.

Table 20: Officials' Perception of What Transportation Improvement Political Campaigns Should Emphasize

Campaign Emphasis	*Percentage*
Access to transit system	21%
Reduce congestion	69%
Both	7%
Other	3%

Source: *Santa Clara Transportation Leaders Survey, 2000.*

The campaign preferences of the officials are consistent with their perceptions of their constituents' preference for automobile use: 69 percent emphasized reduction of traffic congestion, 21 percent made access to transit the priority, and only 7 percent mentioned both. It is not surprising that most officials think that campaigns should emphasize the fact that transit systems reduce congestion, given their belief that this is what motivates voters to support transit.

One transportation planner pointed out that campaigns must be careful to market improvements in the context of the overall plan. He worried that an oversell of one factor could damage others. For example, an overemphasis on light rail could be to the detriment of bus services and/or new roadways. Similarly, overselling an element as a panacea for congestion, once built, could backfire when population growth offsets the initial congestion relief provided by the project.

Effective Marketing

In the final campaign-related question, survey respondents were asked their perceptions of the most effective approach for marketing a transportation proposal. Their priorities reflect sophistication born of experience, as Santa Clara County has been a leader in going before the voters for funding and approval of major transportation plans.

Table 21: Officials' Perception of Successful Campaign Strategies

Campaign Strategy	*Percentage*
Community	19%
Comprehensive	50%
Media	31%

Source: *Santa Clara Transportation Leaders Survey, 2000.*

As shown in Table 21, 50 percent of respondents expressed the view that to be successful, the campaign must be comprehensive; 31 percent emphasized the need for media-based campaigns to reach the maximum number of voters; 19 percent spoke to the need for campaigns that were community- or neighborhood-based. While only 19 percent said that community was the most important strategy, everyone surveyed believed addressing neighborhood concerns was important. One respondent in the 19 percent said, "You have to get out there and win support a neighborhood at a time."

Those advocating a comprehensive campaign also spoke of the neighborhood approach while recognizing the need for media-based get-out-the-vote approach. Officials expressed the need for neighborhood support to stem the growth of opposition groups based on Not In My Backyard (NIMBY). NIMBY was the most frequently mentioned campaign obstacle. Neighborhood

opposition can mushroom into organized community opposition that can join with anti-tax interests to defeat worthy projects.

The transportation professionals recognized the need for neighborhood support, especially along transportation corridors. One noted the additional effectiveness of mail-based campaigns.

Although Santa Clara County officials recognized the need for community support for transit proposals, their definitions of which communities were most important differed, as shown in Table 22.

Table 22: Importance of Community Group Support for Transit Improvements

Group	*Percentage*
General Community	78%
Business Community	11%
Political Leadership	3%
Special Interest	7%

Source: *Santa Clara Transportation Leaders Survey, 2000.*

According to the survey, 78 percent of leaders mentioned the community at large as most important. 11 percent thought that the business community should be a priority. Special interest groups such as environmentalists were named by 7 percent of the respondents. Three percent expressed the view that gaining the support of political leaders was most important.

CONCLUSIONS

Results of the Santa Clara County Transportation Leader Survey clearly show that transportation is one public policy challenge upon which a substantial consensus has formed among public officials. All surveyed recognize that job and population growth have combined to impact Bay Area transportation systems. They believe that transportation problems will continue until people are able to secure suitable housing near their jobs.

Optimism among Santa Clara County officials regarding the ability to keep pace with transportation demand is variable. Most believe that mass transit

usage in the Santa Clara County will remain below 10 percent. Others are hopeful for increased ridership. All agree, however, that there is no alternative to pursuing mass transit solutions to transportation problems.

Santa Clara County survey respondents demonstrated a remarkable consistency among several highly interrelated topics. There is a substantial consensus that constituents would prefer roadway solutions. Respondents, therefore, believe that voters support mass transit primarily to get others off the road and any campaign to gain passage of a new mass transit project must emphasize its impact on traffic congestion.

The Zürich study showed similar results, with the transportation leaders believing that although they preferred transit solutions, their constituents would prefer roadway solutions. The Zürich opinion leaders, however, were much more cynical about the values of their constituents than are Santa Clara County officials.

Strong public official support is necessary to implement transit improvement projects, such as transit priority. When elected officials underestimate public support for these types of programs, they are not fully implemented. The consistency between elected officials in Zürich and Santa Clara County in underestimating public support for transit improvements is troubling for the transit industry.

The results of the Santa Clara County survey prove that more research on the topic of perceptions that elected officials have of public support for transit are required. This research, as in Zürich, should survey elected officials and the public to compare the perceptions and actual support in a U.S. situation.

For Santa Clara County, the obvious question now is: What does the public actually think? Our data do not address this question. While Santa Clara County leaders have been exceptionally successful at garnering public support for transit projects, it is tempting to speculate about what could be accomplished. Similar to their Zürich counterparts, Santa Clara County residents are ready for more rather than less emphasis on mass transit. The Zürich experience proves that a citizen-led initiative designed to improve transit service succeeds beyond the expectations of elected officials.

IMPLEMENTATION LESSONS FROM ZÜRICH

INTRODUCTION

The most difficult aspect of a transit priority program is its implementation. Most transit priority techniques are simple, well known, and inexpensive, yet they are often are hard to implement because they are frequently small, require a detailed understanding of traffic movement, and are perceived as being against automobiles. However, Zürich has successfully implemented a comprehensive transit priority program. The objective of this research was to understand how Zürich was able to implement its program.

At the outset, perhaps the primary lesson to learn from Zürich is that successfully implementing a transit priority program means taking a comprehensive long-term approach. Zürich's success has required effective political leaders and motivated city employees who have steadily implemented the program over the past thirty years. This chapter summarizes lessons identified in the research that helped Zürich implement its transit priority program and starts with a short description of why these lessons are relevant to other cities.

This section summarizes Zürich's successful transit priority program. Many of the lessons are not surprising but rather common sense and well known. A good example is the first lesson: Obtain and Maintain Strong Public Support. In these cases, it is not so much the lesson that is interesting, but rather the specific techniques and strategies that Zürich used in the implementation process. The techniques and strategies are outlined for each lesson, then described in more detail.

Lesson #1: Obtain and Maintain Strong Public Support

Public support is the most critical element of implementing any government program. Public support is particularly important for a transit priority program because effective transit priority programs create winners (public transit) and losers (other roadway users). A particularly problematic aspect of transit priority programs is that they are most effective when implemented comprehensively so it takes some time before they can generate public support, but the specific improvements generate immediate criticism from other roadway users.

In Zürich, the public took an active role in forcing the city administration to implement transit priority more comprehensively and more boldly than would have been possible without strong public support.

With respect to comprehensive implementation, it was a group of citizens who put forward the concept of implementing transit priority improvements throughout Zürich's existing surface transit system as an alternative to constructing a major new rail transit line. Passage of their transit priority initiative provided funding and a degree of political support for implementation of the program. Thirty years later, it is obvious that their plan was better from the perspective of transportation and urban livability as well as being significantly less expensive than the proposed rail system.

Constant pressure from activists forced the city leaders to implement the transit priority improvements. Transit priority improvements can be implemented by degree—strong implementation is better for transit but has more impacts on private vehicles. Transit priority activists frustrated the objectives of private vehicle drivers. Activists placed pressure on the government using all the normal tactics of politically active groups, including lobbying, initiative campaigns (there were many transportation initiatives during this period in Zürich), and political endorsements.

Public support is required to implement a transit priority program. As time passes and the benefits of the system become more evident less active support is necessary, but because those effective transit priority programs always create winners and losers advocates need always to be vigilant.

Lesson #2: Enlist Elected Official Support

Elected official support is required to implement a transit priority program. Elected officials force overburdened governments to undertake long-term and challenging citywide programs.

In Zürich, elected official support was slow in coming. Almost all officials supported construction of the heavy rail transit system over comprehensive implementation of the transit priority program. They did not want to implement the more controversial parts of the transit priority program. Elected officials supported the program after seeing clear benefits and years of active pressure from citizens groups. It is still difficult to implement improvements to the optimum degree, but elected officials in the city of Zürich are generally on-board with the program.

Although the support of elected officials is required, it is not easy to gain. An interesting aspect of enlisting such support is that elected officials often do not understand the depth of support for transit among the voters.

For example, the city's elected officials did not support Zürich's transit priority People's Initiative. They only agreed to implement it after the voters approved it. Results of a survey of public officials in Zürich and a similar survey carried out for this research in Santa Clara County indicate that elected officials often underestimate public support for transit. While the elected officials surveyed say that they support transit, they believe that their constituents do not.

In Zürich in the early years, several elected officials strongly supported the transit preferential program. Environmental protection and quality of life were the basis for support. These people acted as leaders in the Stadtrat and in supporting controversial improvements and programs.

Strong elected officials are required to implement these types of programs. While environmental leadership was more common in the 1970s than today, quality-of-life concerns still are important to voters, so finding leadership in these areas is still possible. Over the years, as the benefits of the transit preferential program became more obvious, support grew for the program. The voters passed several supportive funding measures and transit policy. These direct votes of the people helped maintain elected official support for the program.

Lesson #3: Use Smart Implementation Techniques

While advocates are needed on the outside to force government to take action, those in government responsible for implementing a program need to implement it intelligently in order to maintain and sustain public support. In Zürich City, planners used several techniques to foster public support for the transit priority program including the three described below.

The lesson from Zürich is that smart implementation helped provide public support for the transit priority program and minimize criticism.

Implement High-Impact Projects Quickly and Publicize Their Benefits

In Zürich, high-impact projects were implemented quickly and their benefits publicized. After plan approval, the public desires to see immediate changes.

This created positive responses in favor of the program. Zürich used several specific techniques to accomplish this strategy, including:

- Many specific improvements had been identified before voter approval of the initiative and only needed the funding and political support provided by the initiative for implementation. Having a set of good projects on the shelf and ready for quick implementation was helpful to the success of the program.
- Extensive data was collected to document the benefits of transit priority improvements. The data was communicated to the public and elected officials to increase support for the program.

Zürich's approach has been successful. Citizens continue to support implementation of transit priority improvements and other transportation-related livability measures in elections and their use of transit.

Don't Unnecessarily Alienate People

As a corollary to Lesson #3, transit priority improvements that alienate people should not be implemented. The most obvious potential for alienating people is where road space or traffic signal time needs to be taken from private vehicles and given to public transit. There will be cases where transit priority improvements will impact private transportation, but the lesson from Zürich is to only do this where it is really necessary and try to minimize the impacts.

The best example of Zürich's approach is the traffic signal system. As outlined in "Zürich's Transit Priority Program," the first attempts to implement transit priority at traffic signals did not work well for transit or private traffic. Zürich then developed a new system that provided transit priority without significantly affecting private traffic. The system provides transit with the minimum amount of traffic signal green time necessary to achieve prioritizing at exactly the time when the transit vehicle needs it.

Zürich's approach prevents the situation seen in some traffic signal priority programs where a signal turns green for transit, red for private traffic, and well before the bus or tram arrives. In this situation, private traffic drivers become upset about the system's inefficiency and complain. The visible efficiency of Zürich's system has helped to minimize complaints from private vehicle drivers.

Implement Improvements Comprehensively

A city is more than a transportation network—it is a place where people live, play, and work. In Zürich, transit priority improvements were implemented as part of a larger and more comprehensive program designed to improve neighborhood livability. This approach enabled Zürich to achieve multiple goals and helped sell the transit priority improvements. It is also one way Zürich implemented the transit priority program with an eye towards increasing public support for the program.

A good example of achieving two goals is closing a cross street where it intersects with a transit corridor. This single action both reduces conflicts between turning traffic and transit and creates a cul-de-sac to reduce neighborhood through traffic and create a more livable side street environment. Other examples include building bus stops that are pleasant pedestrian spaces and using traffic signals to provide priority to transit rather than taking road space.

One good reason to use the comprehensive approach is that by implementing improvements together, residents can focus on the overall benefits to their neighborhood of the entire program, rather than on a specific improvement that they may dislike. For example, a neighborhood could negatively view removing parking to provide a transit lane. A residential parking program designed to reduce parking demand could be acceptable to the neighborhood. This type of comprehensive planning is more difficult to complete, but enables more improvements to be implemented.

Lesson #4: Organize Government to Effectively Deliver Program

Transit priority improvements affect many different departments, and bureaucratic concerns frequently prevent effective implementation. In Zürich, two task forces, one at the political level (Executive Council) and one at the department level (Working Party) addressed this issue. The department-level committee developed detailed implementation plans and the political-level committee focuses on overall strategy and implementation.

While departments work together on developing projects, a single department (the Traffic Police) has the sole responsibility for making changes to the roadway system (including signs, traffic signals, painted markings, and road construction). According to the traffic police chief, it is critical that the department that will eventually operate the roadway be closely involved in its

design. Furthermore, the responsible department can make instant minor changes to solve problems. According to the traffic police chief, the normal planning cycle is too slow to address the dynamic nature of changing traffic patterns.[157]

Executive Council

One successful technique used in Zürich was creating the Executive Council to focus the involvement of elected officials in implementing the transit priority program. The Executive Council consisted of three Stadtrat (city executive group) members and four city department heads. This group forced overlapping city departments to work together, approved implementation plans, and acted as champions for the program.

Working Party

Many transit priority improvements are small and their implementation requires several different departments in traditional city organizations. In combination, the planning and comprehensive implementation process for these improvements is complicated. Therefore, it is critical that city departments work closely together on the transit priority program.

One technique used in Zürich to foster better coordination was to create an interdepartmental working group, called the Working Party, to plan specific transit priority improvements and oversee their implementation. Since success in transit priority depends on doing many small things right, developing a working relationship between members of all departments involved in the transportation system helps ensure that the small things would fall through the cracks.

An interesting aspect of the Working Party's structure is that as a group with changing representation, many members of city departments have participated on it at one time or another. This serves to broaden the view of normally single-focus department staff. Specifically, the understanding of transit priority techniques obtained through participation in the Working Party has enabled them to improve projects they are working on that are not part of the official transit priority program.

Although the Working Party successfully bridged the gaps between competing departments, it took many years before departments were working together

well on implementing transit priority projects. As one participant reported, "it took some retirements before the changeover was completed."

Lesson #5: Careful Traffic Engineering and Technology Is Critical

One argument against complex programs like transit priority is technology. People often say that something cannot be done. This was also true of Zürich. Government officials said that certain programs could work in smaller, less complex situations but would fail in Zürich and other large private traffic systems. The city was forced to implement the program after Zürich voters approved the transit priority initiative. Difficult technical solutions were developed and implemented

The Zürich lessons are technical issues surrounding implementation of a transit priority program. The answers derive from creating new technologies and thinking carefully about application of transit priority techniques.

Application of Technology: Careful Traffic Engineering

Providing transit priority requires taking street space used for mixed traffic and dedicating it to transit. Now, new routes are required for private vehicles. In Zürich, sophisticated traffic engineering techniques such as channeling and traffic signal placement have enabled private vehicles to circulate while providing transit with priority. The lesson from Zürich is that sophisticated traffic engineering can help reduce opposition to transit priority techniques.

Developing New Technology - Traffic Signal System

When existing technologies could not achieve the degree of improvement desired, Zürich developed its own technology by taking a fresh look at the problem. The best example is the citywide integrated traffic signal system. As described in "Zürich's Transit Priority Program," this system is unique and provides transit priority throughout the city as well as improving vehicle traffic flow.

In developing the new system, Zürich evaluated several different approaches to the problem of providing transit priority at traffic signals. The first were similar to other cities but did not provide enough transit priority and had negative impacts on traffic flow. Therefore, the city took a fresh approach.

Responsible staff members were operational research specialists, not traffic engineers. Zürich's staff diversity created fresh perspectives. The staff applied a systems approach to transit priority and vehicle flow, rather than a traffic engineering approach. They worked closely with other departments to understand the problems. They learned to drive buses and trams to learn what drivers could and could not do practically. The staff also considered various ways to achieve the objective of transit priority.

A theoretical approach is identified before implementing a citywide plan. The theory is proved before citywide implementation. Throughout the process, detailed "travel time savings" data was collected to assess the system's benefits. Today, the system is constantly improved and modified to accomplish additional goals. A winning modification is a traffic signal phase that allows pedestrians to reach transit-boarding islands, before arrival of a transit vehicle that prevents pedestrians from crossing against traffic to catch a bus.

Lesson #6: Implement Complementary Programs to Improve the Transit System

Transit priority will not, by itself, create an excellent transit system—the transit system itself has to provide good service in terms of frequency and customer attractiveness (for example, safety). In addition to this basic transit service, there are several complementary programs that cities can implement to further support and improve the transit system.

Zürich implemented three complementary programs that helped support the city's transit system. The system's strong ridership and high public approval can be used as an argument to strengthen the transit priority program. Zürich implemented the following complementary programs.

Plan Land Uses to Support Transit

It is widely recognized that land use planning supports public transit, but it is hard to accomplish. Zürich has worked aggressively to encourage land uses that support transit. It accomplished this through conventional land use planning techniques such as zoning and development agreements, as well as by making the areas best served by transit attractive places to live, work, and visit.

Initially, Zürich concentrated on land use in its center city. Zürich focused on improving its urbanity by reducing parking and traffic and using the freed-up space to speed up transit, create pedestrian zones, provide space for public

events, and create a lively and entertaining downtown. Zürich's economy has not suffered from reducing auto access. The cost of retail space on the city's main downtown street (Bahnhofstrasse) is one of the highest in the world,[158] and it is one of Europe's most fashionable shopping areas. Many merchants favor expanding the existing pedestrian zones to their stores.

Currently, the city is considering redevelopment proposals, including former industrial areas as well as "green field" sites not located so advantageously for transit service as the center city. In these situations, Zürich supported transit use by encouraging higher densities, reducing parking requirements, and imposing vehicle traffic ceilings. This is coupled with requirements to improve the transit, pedestrian, and bicycle networks in the areas.

Reduce Traffic Volumes

Traditionally, Zürich developed measures designed to actively restrain and reduce private motor traffic in the city. Zürich used three main approaches to control the vehicle traffic in the city: traffic calming, reduction of roadway capacity, and parking controls. As with other programs, Zürich has taken a comprehensive and thoughtful approach to controlling vehicle traffic. While activists argue that there is still too much traffic in the city, the government would say that there is less than there would have been without these programs.

Regional Transit Coordination and System

The Canton of Zürich organized the Züricher Verkehrsverbund (ZVV) to coordinate fares and schedules for the region's 42 different transit operators. Today it is possible to use a single ticket on all these systems, and careful scheduling links them. The canton also built a regional fast suburban rail system (S-Bahn) that provides regional mobility and serves as the basis for schedule coordination. Good regional transit has increased ridership on Zürich's city transit system and provides an argument for reducing traffic volumes on major routes into the city.

Improving regional transportation by investing in the commuter rail system and carefully coordinating transit service was critical to the success of the city's transit priority program. Without an excellent regional system, commuters would have needed to drive into the city, thereby reducing the amount of space available for Zürich's transit priority and livability improvements. The new system empowers the city to promote public transit as

a better alternative than driving and reject demands for increasing space for private vehicles.

Lesson #7: Use Capital Investments to Leverage Institutional Change

One of the most enlightened ideas identified in this research is the way the Zürich region used the need for a large capital investment to bring about institutional change. It is a seldom-adopted common sense idea. Simply, as part of the project to construct the new regional commuter rail system (S-Bahn), the Canton of Zürich required that transit fares and schedules for all 42 different transit operators be coordinated. The canton only agreed to fund the major investment after the creation of a system created to bring about regional coordination. The canton's funding provided the advantage necessary to get the different public and private transit operators to the table to develop a coordination system.

The canton recognized that making a major investment in the public transit system was its opportunity for getting the concessions from transit companies necessary to have a coordinated and efficient transit service throughout the region. Contrast this with the San Francisco Bay Area, which made an investment in the Bay Area Rapid Transit (BART) system in the 1960s and is still struggling to coordinate fares and schedules for its multiple transit operators.

Lesson #8: Think Carefully at the Systems Level

A unique aspect of Zürich's overall approach is the region's adoption of a hybrid type of transit system. In many cities there is a three-level system where surface streetcars and buses provide local transit; intermediate transit is provided by grade-separated systems characterized by frequent, high-capacity service (that is, subways); and regional transit is provided by a high-speed, limited-stop commuter railroad.

Zürich voters rejected the standard three-level approach in favor of a hybrid two-level system. The existing surface streetcar and bus network (local transit) was improved to serve longer trips. The improvements sped up the trips using transit preferential techniques, and the S-Bahn (regional transit) was expanded to serve more intracity trips by constructing more stations within the city than other similar systems. The intermediate-level mode (heavy rail subway) was not necessary in Zürich.

This hybrid system provides a better match for Zürich's transportation needs than the standard three-level system, because the three-level system would have required many transfers between modes with little time savings. Furthermore, it would have cost significantly more to construct.

Similar two-level systems would not work for many larger cities. Clearly, there are significant cost savings and transit service benefits by carefully considering systems-level choices and adopting the most appropriate choice. However, Zürich's two-level system could be a model for many modern cities seeking to build up their transit systems.

The two-level system would provide fast, frequent local transit in the center cities and high-speed limited stop regional transit service to suburban centers with coordinated local feeder service. An especially attractive aspect of this approach for cities that need to improve their systems is that it is quicker and less expensive to build than a three-level system.

In Zürich, it was rejection by the voters of a more typical three-level system that brought about development of the two-level system—the two-level system was not the planner's approach. However, following the vote, planners implemented Zürich's transit priority program and designed the S-Bahn system to fill the gap left by not building the intermediate-level system. Today, they wholeheartedly embrace the approach.

TRANSFERABILITY

Transit priority implementation lessons from Zürich are transferable to other cities for several reasons. First, Zürich shares many of the same problems facing other modern cities. Jobs and housing are decentralizing from the center, automobile ownership and traffic congestion are increasing, and employment is shifting out of traditional industries to service and professional sectors. Zürich's elected leaders face the same pressures as politicians in other cities, including reducing taxes and improving livability.

In addition to sharing many characteristics of other cities, two conditions are relevant to development of Zürich's transit preferential program: The reliance on local taxes for capital improvements and the importance of the initiative process in capital improvement decision-making are becoming more common in the rest of the world. For example, almost all transit capital improvements in the U.S. require citizen approved local taxes.

Zürich's approach developed over many years of planning, analysis, and public process. Other cities can take heart that the transit priority initiative was the third plan brought before the voters, the previous two having been defeated. Zürich's planners learned from their election defeats and developed improved plans for operating the existing network (transit priority) and creating a new S-Bahn system.

One potential difference is that Zürich started with a big advantage—a well-used and well-respected transit system that simply needed transit priority improvements. Zürich's system was safe, clean, easy to use, inexpensive, and provided excellent coverage and operating hours. Many people interviewed for this research agreed that Zürich has always had good public transit service; improvements to the system were needed to accommodate the city's employment growth and changing spatial patterns.

Cities with less-developed transit systems might not achieve the same results as quickly as Zürich, but Zürich's approach remains an excellent model to follow. This approach is especially relevant because building completely new transit networks (for example, subways) is often impossible given their capital cost. While there are many particular differences between Zürich and other cities (including the government system, transit financing, and social factors), they have much in common. Zürich's transit priority programs are transferable to other cities. Hopefully, many transit professionals will implement these lessons.

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ACRONYMS AND ABBREVIATIONS

SBB	Swiss National Railway
S-Bahn	suburban fast-rail system
SFr	Swiss Francs
SSFC	Self-Service Fare Collection (proof of payment)
SZU	Sihltal-Zürich-Uetliberg
TDM	transportation demand management
U-Bahn	underground heavy-rail system
VBZ	Verkehrsbetriebe der Stadt Zürich (public transportation company in Zürich)
VCS	Verkehrs Club Schweitz
ZVV	Züricher Verkehrsverbund (regional transit agency in Zürich)

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ABOUT THE AUTHORS

ANDREW BUTLER NASH—PRINCIPAL INVESTIGATOR

Andrew Butler Nash, P.E., is an independent transportation planning and engineering consultant. He is the former Executive Director of Transportation Planning for the San Francisco County Transportation Authority. Nash formerly served as a Project Manager for Caltrain and as a Manager at the Santa Clara County Congestion Management Agency. He is a registered professional civil engineer and obtained his Master of Engineering and Master of City Planning degrees at the University of California, Berkeley, where he focused on transportation policy. He also has a Master of Science in Civil Engineering from Northeastern University, where he specialized in transit operations.

Nash has been active in several San Francisco area nonprofit organizations, including serving as President of the Bay Area's Greenbelt Alliance and as a Director of the San Francisco Planning and Urban Research (SPUR). Nash ran for election to the Bay Area Rapid Transit (BART) District Board of Directors in 1992.

RONALD D. SYLVIA, Ph.D.

Ron Sylvia, Ph.D., is a professor of Political Science at San Jose State University. He earned his B.A. in Political Science from CSU San Bernardino, and his MPA and Ph.D. from Kent State University. He is the author of several books, including *Public Personnel Management*, Second Edition, and *Program Planning and Evaluation for Public Managers*. He also has authored numerous articles in professional journals, including *Social Science Journal* and *Presidential Studies Quarterly*, and has presented papers at conferences in Canada, Korea, Germany, and the United States. Dr. Sylvia's research interests include public personnel administration, bureaucracy and the political process, and program planning and evaluation.