Beyond the Airport Terminal: People-Mover Technologies at Seattle-Tacoma International Airport

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Seattle-Tacoma International Airport has been on the forefront of people-mover technology since the early 1970s and the installation of the Westinghouse Satellite Transit System (STS), an automated guided vehicle. The STS is integral in supporting the airport's efficient centralized terminal complex. The question today is How can such a system support further integration of the airport with the city beyond its automobile oriented landside access area? Historically, the interactions between the airport and private property have been minimal. The recent design development of automated people-mover systems (personal rapid transit or PRT) with small vehicles (three per vehicle) has presented urban planners and developers with a new option for meeting transportation needs. Whether and how such systems will be successfully integrated into a community remains to be seen. PRT is distinguished from the fixed guideway people mover already in use at the airport. How studies of the PRT concept were incorporated into studies of the airport transportation system and the complications involved in introducing PRT technology into a real urban environment are discussed.

Seattle-Tacoma International Airport (STIA) is midway between Seattle and Tacoma in Washington State. In the early 1970s major terminal expansion, a new parking garage, an airport access freeway, and an underground fixed-guideway transit system to carry people to outlying gates were built. The transit system uses group rapid transit (GRT) technology and can carry 40 passengers per car.

As the urban areas around Seattle and Tacoma grew into one metropolis, urban commuter traffic began to congest nearby roads. As a result, local transportation planners began looking for ways to improve transportation for the airport, businesses, and nearby neighborhoods. Potential new freeway access to the airport from the south and regional planning of a rail system (with an airport station) added to the local interest in additional development in the airport area. The recent design development of personal rapid transit (PRT) systems (small vehicles for one to three passengers, using light and less expensive elevated steel guideways) attracted airport area planners as a way to address local transportation needs and development potential.

STIA PEOPLE-MOVER SYSTEM

The STIA satellite transit system (STS) has provided a critical link between the main terminal and outlying aircraft gates for passengers, crews, well-wishers, and airport employees since 1973. The STS operates on three routes: two loops, each of which connects the main terminal to a long concourse and a satellite terminal, and a linear shuttle within the main terminal that links the two loops. STS is underground with all stations beyond the airport security checkpoints (see Figure 1).

Current Airport Operations

In 20 years, ridership has grown to almost 20 million passengers a year. The Westinghouse STS grew from two one-car trains in the 1970s to three two-car trains in each of the loops. A loop ride takes approximately 5 min to travel about 1.2 km (¾-mi). The shuttle has one car on a 3-min round trip along its 300 m (¼-mi) track. Headways (time between trains) on the loop routes are just over 1 min. An off-line maintenance area is also underground. Passenger safety is enhanced by a pre-recorded, multilingual greeting, closed-circuit television surveillance, and two-way voice communication by means of handsets in each car, linked to a central control facility.

The operating costs have risen (see Table 1), because of increased labor (supporting increased ridership) and triple power costs (although power represents only 2 to 4 percent of the total budget). In 1991 there were some operating changes. First, the system increased capacity by adding a third pair of trains to each of the loops. Second, for 4 months security restrictions because of the Gulf War resulted in fewer riders, because only passengers and crews were allowed beyond security checkpoints, where they boarded the STS to outlying gates. Even with those considerations, costs remain at a reasonable level, under 10 cents per passenger, despite an aging system, increased annual vehicle miles, and addition of a third train. The annual kilometers traveled have increased because of longer hours of operation and additional train capacity. System reliability has always been excellent.

To maintain modest operating and maintenance costs, the airport's system benefits from several diagnostic tools and cost saving procedures.

- A failure discrepancy report data base is maintained with historical data to track patterns of problems and help develop solutions.
- A vehicle data acquisition system (VDAS) provides an interface with each car's computer control system to help identify and assess problems. VDAS functions similarly to the black box in aircraft avionics to monitor operations.

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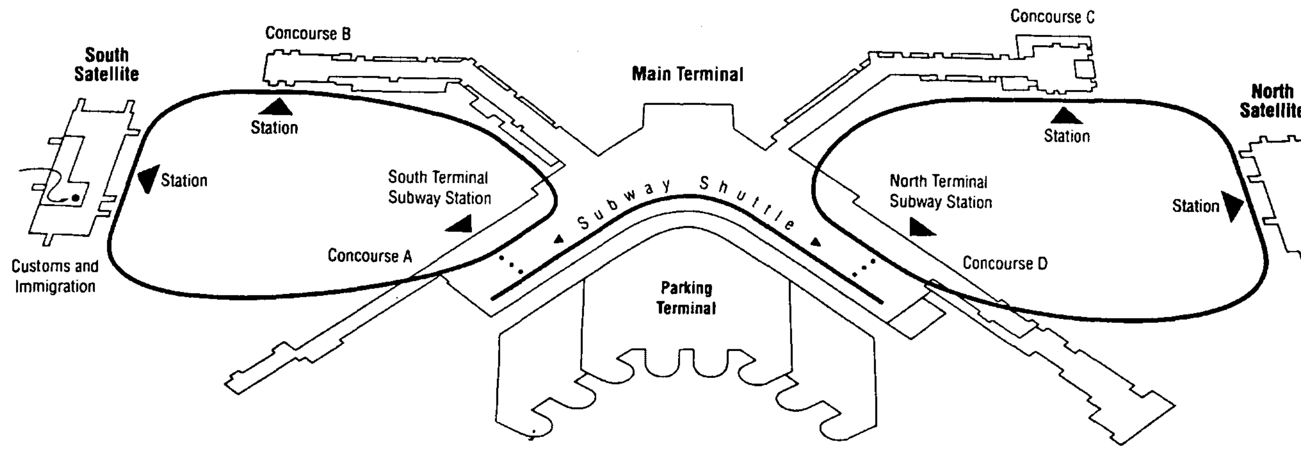

FIGURE 1 STS route.

- Thirteen electronics technicians are dedicated to the system. Operating engineers, mechanics, and electricians, who perform maintenance and repairs, are shared through the airport's maintenance department. Thus, only that portion of their salaries actually attributable to working on the transit system is billed to STS. This represents about 10 full-time equivalent positions.
- Because the system has spare vehicles, most work can be performed on all shifts. Routine maintenance can be scheduled by rotating vehicles, and unexpected breakdowns can be replaced with working vehicles.

Future Uses

Planners are studying now how best to meet airport capacity needs in the 21st century. Airport passenger forecasts for STIA (from 16 million annual passengers in 1990) call for 34 million annual passengers by 2010. Compared with investments recommended for other parts of the airport, the STS design will require only minimal upgrades: the addition of a third car per train and some controller and electronics improvements. STS can reach its design capacity of more than 9,000 passengers per hour per loop. The capacity is well beyond that expected for the system peak hours in 2010. Costs of the electronic upgrades will be approximately $6 million to $7 million.

PEOPLE-MOVING SYSTEMS

Urban Development Near STIA

STIA's eastern boundary is US-99, an older urban highway with typical strip commercial development. Four factors shaped urban development around the airport: (a) airport-related land uses, (b) transportation congestion, (c) suburban land uses, and (d) lack of strong local government.

Airport-Related Land Uses

Land uses around STIA are similar to many airports: hotels, parking lots, rental car agencies, fast food restaurants, warehouses, and air cargo facilities. These uses rely on low-density land development characteristic of the area (*1*). Whereas many of these uses face US-99 across from the airport, others are on cross streets, so that existing development is not strictly linear or coherently planned. About 30 nearby hotels (with more than 4,500 rooms) operate courtesy shuttle services to the airport.

About 25 parking lots provide more than 15,000 parking stalls: about one-quarter remote airport employee lots, one-quarter airport terminal area parking, and one-half commercial park-and-fly lots. Parking capacity is forecasted to be 21,000 spaces by 2010. Twelve parking lots operate shuttles

TABLE 1 SeaTac STS Operating Costs

	1980	1985	1990	1991 [1]
Annual Operating Cost	$800,000	$1,120,000	$1,265,000	$1,460,000
STS Passengers/year	11.0 mil	13.6 mil	19.3 mil	15.9 mil
Cost/passenger trip	$0.07	$0.08	$0.07	$0.09
Vehicle Kilometers	887,000	1,061,000	1,092,000	1,132,000
Cost/Kilometer	$0.90	$1.06	$1.16	$1.29
System Reliability	99.8%	99.9%	99.9%	99.9%

[1] 1991 includes two months' operations with an increase to three two-car trains, as well as 4 months' operation with only ticketed passengers and flight crew allowed beyond security check points.

into the city of SeaTac, a doughnut-shaped city around the airport.

Transportation Congestion

Traffic congestion in the local area is attributed to several sources: low-density land uses, regional traffic through trips, and airport passengers and related businesses. Interstate 5, 1 mi east of STIA, is the primary regional highway. Peak-hour slowdowns on I-5 encourage alternative commute routes, such as US-99, which passes the main entrance to the airport. The Municipality of Metropolitan Seattle (METRO), the area transit agency, provides some bus service. Transit and pedestrian facilities are not well used, and there is continuing reliance on automobiles and vans. A north access freeway connects about 60 percent of the travelers directly to I-5. The remaining 40 percent use local arterials to reach local facilities, or to travel east or south on I-5.

Suburban Land Uses

Land near the airport, not used for the purposes just described, is mostly low-density residences. Thus, the area's transportation problems include those of the residential community.

Local Government

Land around the airport was historically unincorporated under the land use control of the county. The recent incorporation of the city of SeaTac will lead to more detailed planning, but the current urban form is largely a result of past weak local government policies.

SeaTac's Agents of Change

Many changes have come to the area: increasing intergovernmental cooperation, new city government, and legislatively mandated proactive urban planning.

Recent developments may affect the potential for an airport people mover and have already led to a PRT feasibility study for the area. In 1989 government agencies and local developers jointly funded a feasibility study of a south access road to provide high-speed access for southerly airport traffic and local access to 200 acres of underdeveloped property planned as a business park. This potential mixed-use development could include offices, hotels, a civic center, airport support facilities, retail, and light industry.

In addition, incorporation of the city of SeaTac in 1989 brought local representation to more than 22,000 residents. To encourage economic development a flag pavilion and street banners were provided and the business park area was rezoned to urban densities.

Other agents of change are planning for a regional transit project, a state Growth Management Act and Commute Trip Reduction Law, the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), and the Clean Air Act. A people mover could improve accessibility for nonautomotive travel, which this recent legislation supports.

Feasibility Study

Many planners and developers were interested in increasing local mobility by reducing some local area trips on the roadway. In 1991 METRO organized a study (*3*) of an airport city people mover to answer three questions: What is the appropriate technology? What governance structure should implement a system? How should capital and operating and maintenance costs be paid? Joining METRO in the study were the city of SeaTac, Port of Seattle (airport operator), King County, and private businesses, such as developers, an airline, and some hoteliers from the study area. The committee's project management consultant was TDA of Seattle and the consultant team was led by BRW of Minneapolis.

Three transportation goals were defined: (a) public transit, (b) airport ground travel, and (c) city circulation. Public transit goals were to provide a collector-distributor system for regional transit system linkage and compatibility and matching appropriate technology with transportation function. The airport's goals were to serve remote employee-parking lots, remote airport employment, commercial park and fly lots, hotels, and rental car lots, and reduce congestion of the terminal access roads. Goals of serving employment centers (like the future Aviation Business Center), intercepting regional trips to the city, and reducing traffic congestion were important to the city. Secondary benefits would be reductions in vehicle miles traveled (VMT) and improved air quality. The land uses that a system would serve are shown in Figure 2.

The study's primary conclusion was that whereas shuttle buses can continue filling a people-mover function in the near term, a PRT technology application, if available, could provide even better mobility for many trips into the city. The necessary components of a PRT are as follows (*2*):

- Fully automated vehicles,
- Vehicles on a small guideway reserved for these vehicles,
- Small vehicles for only individual or small groups,
- Direct origin-to-destination service, and
- Service on demand not fixed.

To date, PRT technology is under development and has not been used anywhere; therefore, its feasibility cannot be assessed and capital and operating costs cannot be ensured.

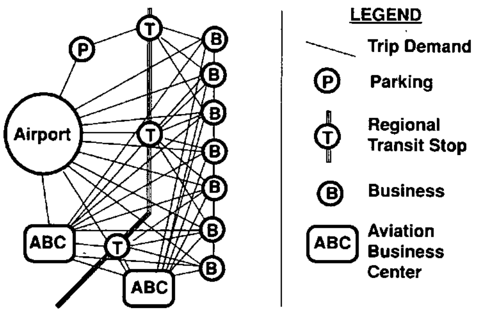

FIGURE 2 City of SeaTac travel patterns.

Study Findings

The three questions asked at the beginning of the study are explored. The question of technology relates to the city's urban form, types of development, special needs of the airport trip, environmental impacts, and technology development. The question of financing relates to patronage, costs, and potential financing. The question of governance relates to when the joint sponsorship retreats, who the operator should be and how the private sector would participate.

Technology

Three technologies were considered: jointly operated bus and van service, GRT, and PRT. An obvious choice is to extend the airport STS. Against expanding the 20-year-old system is that interim technology has improved. Furthermore, because the STS is underground, surrounded by a highly developed infrastructure, and beyond airport security, development costs would be high. This solution was thus deferred to a study of the range of options.

The city's form, like many airport cities, leads to trips with widespread origins and destinations (hotels and restaurants, remote employee-parking lots, off-airport rental car agencies, park-and-fly lots, and future development). Future uses would include one or more regional rail stations, the newly rezoned Aviation Business Center, and a regional park with a community activity center. Because most of these developments generate a few riders at a time (except the regional rail stations with several train loads disembarking at once), PRT's individual service and small footprint meet these considerations well.

Because a trip to the airport often involves time pressure and carrying luggage, the PRT's direct, individual service helps. In fact, PRT designs often show penetration of the building shell, allowing PRT boarding in a hotel lobby or the airport terminal. Environmentally, PRT proponents point out that guideways can be built offsite and elevated quickly with little construction disruption. Operationally, effects of noise and air pollution appear to be less than with the automobile. Because of the light, slim structural requirements for the guideway, other benefits of this technology are expandability, route flexibility, and minimal geometric restrictions. A proposed layout included 17 mi of one-way guideway, 31 stations, and 260 vehicles. Although a theoretical case can be built for PRT, there is no demonstrated system in operation. Clearly, the level of risk financing partners would be willing to assume will affect how much further development and testing will be necessary before investment.

Financing

Financial considerations are capital cost operation and maintenance costs, patronage, institutional and special benefits, and financing sources. The consultant team estimates $195 million to $316 million, on the basis of the technology developers' estimates, experience with other public transit projects, and contingencies. The range of costs is broad, because no system like this has been built. The technology developers estimate costs of vehicles ($450,000 each), guideway ($1.9 million/mi), stations (approximately $2.7 million), and maintenance and control (approximately $2 million). Add-on contingencies of 60 percent for development costs and 31 percent for engineering and administration have been estimated. A very low estimate is $113.7 million. However, because of experience with other systems, the consultant team recommended $195 million to $316 million, which nearly doubled the baseline costs.

The developers' operation and maintenance costs were estimated at $2.8 million in 1991 dollars. Although this is also very low compared with other technology systems in operation, it is inherent in the definition of PRT that lower operation and maintenance costs are incurred. Station security and landscaping are not included in the estimate. By comparison, the existing aggregate cost of the various shuttle buses and vans is $6 million to $12 million/year.

The team developed forecasts for patronage by means of a multistep process, from existing and planned land uses. The potential trip generators are employee and public park and fly lots, rental car lots, hotel, office buildings, the airport, and the regional transit station. From there, three more steps refined the forecasts. First land use "intensity" (number of trips generated per site), based on the ITE Trip Generation Manual, was estimated. Second, an "affinity" factor (likelihood of trips to start and end within the SeaTac people mover) was assigned. Finally, a "propensity" factor (likelihood of use of the people-mover modes under analysis) was developed. After ordering each site by rank by number of trips forecast, the consultants sited stations and linked them to minimize travel distance. Both PRT direct service and the very low wait and travel time increase the estimated patronage far above that of other technologies: 30,000 for PRT, 23,500 for GRT, and 18,600 for traditional bus. The PRT forecasted estimated trips between the airport and hotels are 34 percent, regional rail transfers 23 percent, and employee parking lots and future employment centers (at the ABC) 16 percent each. The remainder was passenger parking lots, recreational riders, rental car lots, and others. The cost per passenger is $2 to $4 per ride.

Suggested sources of public financing are city bonding capacity, county or METRO sales tax or motor vehicle excise tax, or airport passenger facilities charges. Some suggest pursuing a federal sponsorship as a demonstration project, in line with the philosophy of ISTEA. Private financing could come from property developers agreements or a local improvement district. Operators of existing shuttles could also discontinue the shuttles and apply cost to PRT funding.

The consultants reached the conclusion that, with an unproven technology, the cost ranges are wide and risk is high. If the risk capital is minimized, this location could demonstrate the viability of PRT technology.

Governance

The study recommended continuation of the joint sponsorship, under the METRO's lead, with the port and city as the other sponsoring agencies. Interlocal agreements could guide three follow-on phases:

1. Policy review and plan adoption;
2. Engineering, environmental, and financial plan; and
3. Construction, testing, and acceptance.

Only in the final operation stage would one agency have sole responsibility for the people mover. Joint sponsorship allows a centralized authority to draw on the staff and debt capacity of all three governmental agencies.

Private-sector participation is an extension of the governance issue. The developers and shuttle operators who participated in funding the study recognize the benefits of a PRT having access to their property. However, a group of smaller shuttle operators interviewed supported the status quo, especially if service to their businesses could not be guaranteed. A part of this hesitancy comes from two indirect marketing benefits of shuttle vans. A mobile billboard on vans that drive past travelers awaiting pickup exposes the travelers to the company names and logos. Second, for off-airport rental cars or hotel shuttle vans, passengers without reservations may take the first van they see. Only a Port of Seattle policy to ban shuttle on the terminal drives would ensure full participation, but that would be of questionable merit.

CONCLUSIONS

It has been seen that the STS people mover inside the airport, managed by a single operator for a single purpose, and behind a secure checkpoint has served the airport well. In transferring service outside the airport, there are theoretical indications that a PRT could meet the many goals and serve the most needs. However, there will be roadblocks. The undemonstrated reliability of PRT technology, the risk associated with financing, and the lack of solid support from competing community interests loom as significant issues to overcome. The authors look to further research in the industry to help answer some of these questions.

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