A1E11: Committee on Major Activity Center Circulation Systems
Chairman: Lawrence J. Fabian, Trans21

Automated People-Movers

ROXANNE WARREN, *Roxanne Warren & Associates, Architects*

The interweaving of public transit and public spaces will be a vital ingredient in the evolution of more civilized and prosperous community centers in the 21st century. With increased population and congestion, we have a corresponding increase in the need for fine-grained, high-quality systems of circulation within major activity centers (MACs) and for connections between these centers and longer-distance modes. Automated people-movers (APMs) are well suited for this purpose; their exclusive rights-of-way and driverless operation allow unimpeded, frequent service on an around-the-clock basis, attributes that vastly enhance their attractiveness to riders.

APM technology has, over the past 30 years, already proven its merit at many airports and amusement centers, as well as on full-scale driverless metros abroad. The potential of APMs in enabling more fluid circulation in the public urban environment is obvious. For this potential to be realized, comfortable communication between community planners and APM system designers must be established at the conceptual stage. APMs must be tailored to urban and suburban criteria, and costs must be brought sufficiently low to induce developers to incorporate APMs into their plans.

STATE OF THE ART OF APMs IN ACTIVITY CENTERS

There are nearly 100 passenger transportation systems in service around the world with enough electronic intelligence to be capable of fully automated services. Half of them are in airports and leisure settings. About one-quarter are operated as mass transit, and the remaining two dozen are operated by a variety of nontransit institutions such as hospitals, retail malls, special districts, development districts, and so forth.

These APMs range in size from very small “hectos” a few hundred meters long and with light capacities of a few thousand passengers per hour per direction to full-scale driverless metros with line capacities of up to 40,000. However, they all entail full integration of electronic communications and controls, which eliminates the need for vehicle and station attendants. Several dozen companies, most very international in character, now form the core of an APM supply industry that has a project pipeline worth about $6 billion. These projects include an increasingly sophisticated mix of system supply, fleet additions, test tracks, and vehicle and system rehabilitation and upgrading. In addition, many suppliers maintain and even operate APMs for clients.

Compared with rail transit, the construction period for APMs can be remarkably fast. Small systems can be designed and installed in less than a year. This smaller scale is amenable to design-build-operate contracting. To satisfy temporary needs, APMs can be supplied for a limited time, then dismantled and removed after a season or after 5 to 10 years.

Building an APM is a major commitment of capital resources. Public and private planners therefore typically investigate less capital-intensive solutions to mobility needs and congestion problems, including transportation management, pedestrianization schemes, and shuttle buses—all capable of being enriched with advanced communications.

Capital costs of APMs are substantial and vary widely. Costs per dual-track mile have ranged from about $15 million for small, simple shuttles to $110 million for large, sophisticated systems. Excluding large automated guideway transit such as the Vancouver SkyTrain, JFK Airport Access, and *VAL* driverless metros in France, total projects have cost from $15 million to $450 million or more.

Shuttle projects tend to be smaller and have cost as little as $4 million, as in the case of the privately owned Mystic Intermodal Center north of Boston, Massachusetts. More typically, shuttles range from $15 million to $50 million. Their lower costs are due in part to reduced vehicle weights and in part to the much greater simplicity of their control systems. In lieu of heavy on-board motors, propulsion is achieved by means of either a stationary motor or a series of motors along the track. This reduces the structural requirements for the guideway and, hence, its cost. Since vehicle speed and position are derived from the propulsion member to which it is attached, system control and safety are more easily assured.

Civil work can amount to 50 to 70 percent of the capital cost of self-propelled vehicle systems, the bulk of the expense being in fixed facilities—the guideway, stations, and maintenance infrastructure. Figure 1 shows a typical cost breakdown for this type of APM. The civil costs largely depend on how the APM is designed into its environment. The buildings and streets of the existing MAC both restrict and suggest alignments—whether guideways should be elevated or underground, the parameters of the structural issues, and special architectural requirements.

Figure 2 shows a typical cost breakdown for an elevated APM shuttle. Here the system cost is a more significant part of the total, but civil work still plays a dominant role. The percentages can, of course, vary widely. On one recent shuttle installation, for example, the air-conditioned stations cost nearly 40 percent of the total.

However, the capital cost is only part of the story. Operating and maintenance budgets also need to be considered. For a small system running 24 hours a day, provision of even one maintenance person and a central control operator for three shifts, plus supervisory staff, can amount to $500,000 a year. The key to reducing these costs is to have the central operator share other functions, such as building operations, and to move toward off-site, on-call maintenance, as is commonly provided for elevators and escalators.

Particularly because they have achieved this goal, cable- and belt-propelled APMs offer a relatively inexpensive solution for short-range MAC circulation. They can be appropriate when hourly demands are below about 4,000 passengers per hour per direction. These “hectos” have operating speeds up to 50 km/h.

The past 25 years have witnessed significant advances in these passive-vehicle APM technologies. In 1982, only two firms were supplying urban cable APMs. Currently, eight firms and one consortium are active. In 1982, no firm offered gondola-like technologies with strings of vehicles. Today planners can choose from five alternative “detachable” systems.

A number of transportation professionals contend that small, taxi-sized vehicles operating over continuous guideway networks will not only attract greater ridership by precluding the need for station stops and transfers but will reduce costs by allowing lighter infrastructure. These higher-order APMs are called personal rapid transit, or PRT. Their market readiness is still quite tentative, despite about 30 years of PRT-like operations on a system with somewhat larger vehicles in Morgantown, West Virginia.

MAJOR APM ISSUES

There are different opinions about the viability of PRT. Optimists argue that its significantly superior service will be worth the research and development expense necessary to bring prototype designs to market readiness and to explore optimal ways to fit into existing MAC environments. Others urge that available resources be invested in simpler but clearly feasible hectos and monorail-like APMs. To them, PRT is inherently infeasible. We should instead move forward with incremental interlinkings with simpler APM technologies. PRT advocates contend, on the other hand, that the simple innovations have been proceeding with private funds and that the public sector should support longer-range efforts with more ambitious objectives.

Within local districts and institutional campuses, trips are short and largely dispersed outside traditional commuter peaks. Particularly in the United States, capacity requirements are likely to be low compared with heavy and even light rail. In such settings, the scale and economics of APMs appear to offer a better fit with demand. In many of them, the design flexibility and nonstop network access afforded by the off-line stations of PRT appear attractive. PRT is most likely to find beneficial applications in such dispersed, moderately dense settings.

The following subsections present other technical issues that will affect prospects for the use of APMs in MACs.

Governance

In American cities, much urban commercial activity has migrated out of the historic central business district (CBD); major retail and employment facilities have been relocated in highway-oriented MACs poorly served by public transport, if at all. Suburban developers have taken advantage of the metropolitan levels of accessibility at interchanges of the Interstate and other expressways. Strip development, malls, office parks—they are all around us, defining large segments of American life. From the developer’s point of view, this was easier to accomplish where suburban boundaries met, creating a void of public oversight and governance that might have shaped these developments to better achieve public goals. Sprawled, haphazard development has resulted, creating significant local congestion amid a pedestrian wilderness with few welcoming public spaces. Will these MACs evolve into more balanced, public, and transit-friendly places?

Transportation Management Organization Evolution

With traditional transit services focused on the CBD and older, denser suburbs, the role that public transport plays in highway-oriented MACs is minimal. More attention to solving MAC congestion problems has been invested in transportation management organizations (TMOs) that promote ridesharing and on-site day care facilities, ensure late-shift rides for carpoolers and vanpoolers who need to work late, and so forth. Sometimes TMOs operate van services to connect to remote parking or a nearby regional rail station or airport, or to circulate internally within the MAC.

All too seldom, however, does a local public jurisdiction with taxing powers to raise funds for capital improvements and management services have a mandate to focus on managing and developing the MAC. TMO efforts have advanced during the last decade, but there are few examples where they have taken more than a casual look at APMs to solve their problems. As the value of uncongested circulation increases, interest in APMs will intensify.

Capital Cost Reduction

An important key to increased interest in APM solutions is to reduce their costs. Two ways are to simplify technology and the procurement process. It is hoped that the APM standards presently being developed by the American Society of Civil Engineers will significantly reduce APM costs and make APMs practical for smaller MAC projects. If an adequate market is present—especially for the simpler, lower-cost APM shuttles—then MAC planners and managers will benefit from the availability of a spectrum of more affordable APM choices. For shuttles, these range from low- to high-speed vehicles, small to large vehicles, detachable versus shuttle modes, various propulsion techniques, and bottom-supported versus suspended vehicles. One of the factors limiting cable APMs is rope speed. An alternative solution, which has operated in a ski resort since 1996 and at a gaming complex since 1998, is belt propulsion. In this case the vehicles are attached to a rubber belt, which is driven by motors distributed the length of the guideway. This eliminates the concentration of structural forces and the need for a machine room, while appreciably reducing vibration and allowing greater range and flexibility.

In many MACs, APMs can serve less critical functions than they do at airports. Especially when they serve in part as an attraction, to entertain and allow views, more relaxed performance requirements can lead to somewhat lower costs.

However, APM cost reductions will have little effect on the cost of civil infrastructure. A 25 percent reduction in the system cost would typically reduce total project cost by less than 8 percent. More significant cost savings may accrue from breakthroughs in material production and construction techniques.

MAC Transit

Internal MAC circulation is not the traditional market of mass transit. Moreover, it is difficult for those who deal with extensive metropolitan transit services to shift down several orders of magnitude to the scale of MAC circulation. Likewise, it is difficult for private developers to fully grasp the benefits of local public mobility services or to cooperate with other public and private agencies to jointly underwrite them. The Transportation and Community and System Preservation Pilot Program of the Transportation Equity Act for the 21st Century provides support for innovative approaches to investigate ways to satisfy local circulation needs.

CBD Boosters

Other functions for APMs are to provide access between the CBD and peripheral parking facilities, to feed into rail rapid stations, and to serve as alternatives to new highway bridges, such as along major rivers. Downtown people mover operations in Detroit, Michigan, and in Jacksonville and Miami, Florida, are perhaps too new and limited for conclusions to be drawn from their experience.

Civic Design

APM stations and transfer nodes should be designed and managed as “urban rooms.” They are perfect locations for convenient and income-generating facilities such as retail shops, restaurants, cafes, libraries, day care centers, and social centers. To attract a maximum amount of pedestrian traffic, the stations should be contained within the major buildings that they serve—that is, they should be jointly developed. The smaller scale and lower noise and vibrations of APMs relative to rail transit make this possible.

Private Initiatives

Such joint development will, of course, present a greater challenge in coordinating the simultaneous design, construction, operation, and maintenance of both elements. This is a compelling reason why the development of local-scale APMs should be accomplished privately. However, decisions to share the risks, the framing of tax incentives to attract investment, and the retailoring of zoning to permit it will, by definition, need to occur in the offices of government at its various levels. Incentives need to be defined in the governmental sector to motivate the deliberate and cost-conscious action that appears more readily achievable through private initiative.

Guideway Elevation

APMs can be and often are built underground, either in whole or in part. Some segments can run on the surface if well segregated from adjacent uses. But typically, because of the high costs of tunneling, they are conceived, designed, and built with elevated guideways. This introduces a highly visible and permanent element into the street or landscaped environments over which they pass. While the dimensions of APM structures are smaller than those of rapid transit (see Figure 3), their construction still constitutes a potentially controversial insertion into any particular MAC. Significantly quieter than rail systems, APMs can be more environmentally compatible. Designers can also strive to complement and match surrounding buildings.

Full Integration

In new development on greenfield sites, it will be possible to integrate guideways into buildings, economizing on structural elements. In this configuration, guideways might cross a street midblock instead of running along its length. The midblock overpass may well be perceived as an interesting, animating feature of the overhead streetscape, reflected in architectural treatment of the buildings that form the street walls.

PROSPECTS FOR THE 21st CENTURY

We enter the next century with a menu of interesting and increasingly cost-effective options for local decision makers to provide mobility services within and around MACs. Much will depend on how planners and policy makers respond at the local level—in the planning and public works departments of municipalities, in zoning commissions, in development authorities, at the MPO level, and in state capitals. This emphasis on the local approach is in line with long-term trends to downsize government.

There is much current interest in transit-oriented (or transit-supportive) development, “main street” initiatives, sustainable neighborhoods, livable communities, and so forth. APMs may play a role in many of the problems that these efforts identify. MACs around suburban highway interchanges have already been discussed. Just outside the traditional CBD, many cities and towns have waterfronts and obsolete industrial districts ready for redevelopment. Major public and quasi-public facilities—convention centers, stadiums, arenas, museums, and so forth—have been built or are planned, creating the need for short-range linkages to the existing core, parking resources, and regional transit facilities. Here too is a role for APMs that can be intimately integrated with public spaces.

Transportation issues cannot be disassociated from land use. It is insufficient to address problems of circulation without considering what might induce people to want to remain within an urban area in the first place. In countries where car ownership is high and land use is relatively unrestricted, urban sprawl continues unabated, causing populations to continue to move away from areas that are of sufficiently high density to support quality transit.

Whereas other decentralizing factors should not be underestimated, the attractions of a green environment are widely acknowledged as a key determinant in this out-migration, particularly for families with children. At the same time, the social isolation of exurbia is not universally coveted; rather, the dramatic economic success of the new “edge cities” attest to the persistence of the gregarious element of the human psyche. Despite the Internet, we still need face-to-face contact.

Conventional transit-oriented development typically meets with resistance from surrounding communities, at least in part because of the anticipated concentration of motor traffic. Given ubiquitous parking provisions for cars, even moderately high transit-supportive densities of around 40 dwelling units per acre (98 per hectare) result in largely paved environments.

In contrast, urban oases of the future—either as traffic-calmed or pedestrian zones—would have car parking located at the periphery, in garages or along ring roads. This will allow the combination of the desirable elements of landscaping with urban densities appropriate for medium-capacity APMs. Each cluster of development would be within an easily walkable ¼ mile of its APM station, by which it would be efficiently linked to peripheral parking and regional transit networks.

These urban oases can be commercial (office, retail), civic, or residential. Each would have it own characteristics, but all would orient their citizens to walk or take short APM rides to nearby destinations and to peripheral parking facilities or regional transit stations. A decreasing portion of travel would be by automobile. The MAC environment would be cleaner, quieter, and greener.

ACKNOWLEDGMENT

The following committee members also contributed to this paper: Wayne Cotrell, University of Utah; Chuck Elms, Lea & Elliott, Inc.; Tom McGean, Annandale, Virginia; Edward Neumann, University of Nevada; and Tom Richert, Linbeck Construction.

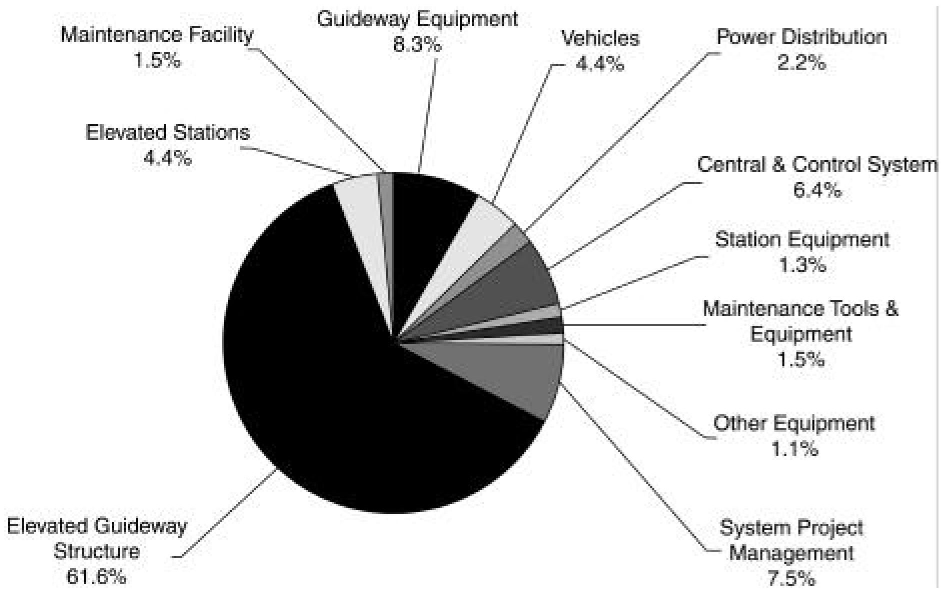

FIGURE 1 Typical cost breakdown of pinched-loop and loop-type APM systems.

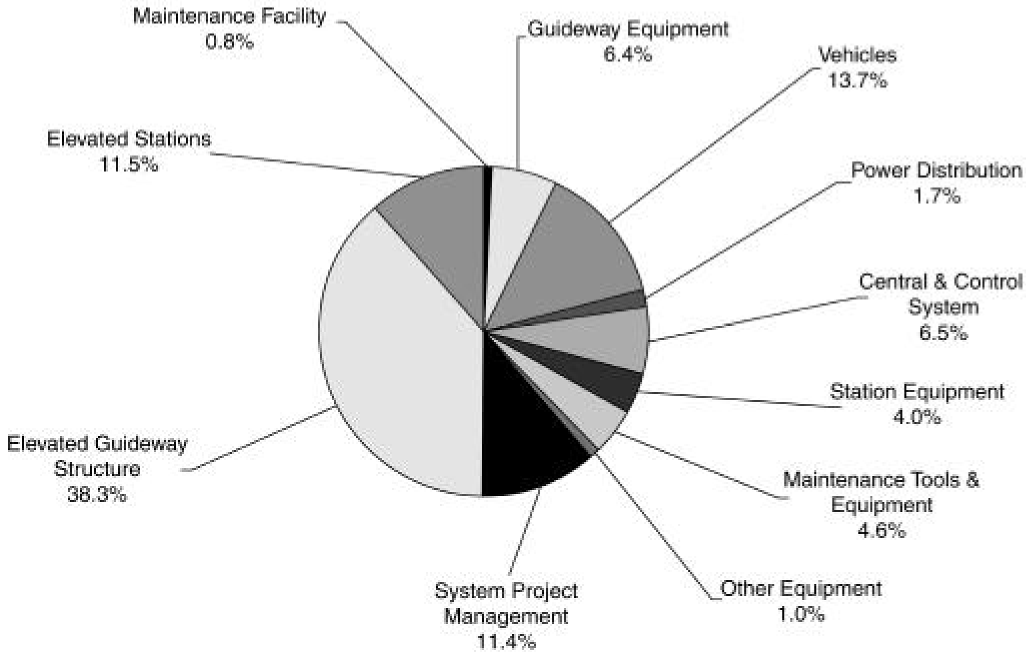

FIGURE 2 Typical cost breakdown of shuttle-type APM systems.

FIGURE 3 APM shuttles have much smaller dimensions than conventional rail transit and can fit comfortably into existing activity centers. (Photo courtesy of Trans21.)