4.0 SUMMARY OF ALTERNATIVE TRANSIT TECHNOLOGIES

This section both describes and compares various types of driverless fixed guideway technologies. It also summarizes the Monorail/AGT technologies under consideration. There is a wide range of performance capabilities and not all are applicable to the Wilmington study area. After describing and comparing some of the more applicable technologies, a discussion of technological maturity is provided.

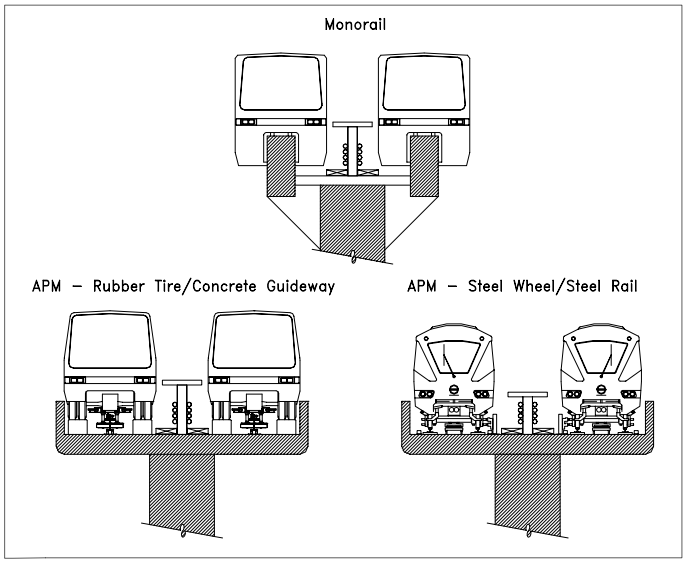
A review of the literature on driverless fixed guideway technologies would reveal that the terms Automated Guideway Transit (AGT) and Automated People Mover (APM) are used interchangeably. The American Public Transportation Association (APTA) defines AGT as, "guided transit passenger vehicles operating singly or in multi-car trains with a fully automated system (no crew on transit units). Service may be on a fixed schedule or in response to a passenger-activated call button".

4.1 AUTOMATED GUIDEWAY TRANSIT

AGT describes a fully automated and driverless transit system that operates on an exclusive right-of-way guideway. Monorail is considered a subset of AGT technology. The various AGT technologies are typically proprietary system designs with components that are not interchangeable. These systems have varying operating characteristics and facility design requirements.

Rubber tire systems, including monorails, are the most common type of existing AGT application due to their carrying capacity and operational characteristics. Steel wheel technologies offer similar carrying capacities, potentially higher speeds, and do not require guideway heating in climates with ice and snow. The latter is a significant operational and maintenance expense of rubber tire systems. Steel wheel systems offer less flexibility in alignment layout due to substantially increased crossover length requirements. A limited number of crossovers reduce operational flexibility, particularly for failure management.

Monorail systems are a form of AGT distinguished by a unique transit vehicle that rides on top of, or is suspended from, a single concrete or steel beam. Urban monorail systems exhibit virtually all of the same operational characteristics as other driverless AGT systems. Monorails can operate on short headways like other urban systems. They can achieve the same high speed operation as well. Monorail systems typically use electrically activated moveable steel beam segments for branching and electrically activated merging and the systems employ proven wayside and vehicle subsystems to ensure high system reliability and availability.



Since monorails use a concrete or steel guidebeam for both the vehicle's running surface and structural support, less guideway maintenance is required than for more conventional steel-wheel on steel-rail or rubber-tired technologies. The monorail guidebeam does not require periodic adjustment, replacement, grinding, tightening, or other similar maintenance. Monorail systems generally have a smaller footprint on the environment and the narrow guidegeams are less obtrusive than conventional through-type guideways that almost look like aerial road structures.

In general, comparable monorail systems can operate within the same alignment corridor as rubber tire and steel wheel technologies as long as the alignment is not laid out to the absolute minimums for the latter technologies.

4.1.1 Service Proven Systems

Service proven AGT systems include both cable-propelled and self-propelled systems. The term "service proven" means the technology has been successfully implemented as an integrated system in current or seasonal passenger service operation for a period of time sufficient to demonstrate satisfactory operation, which is approximately two years. The approximate two-year time period is significant in that it provides time to detect any technological or design deficiencies that occur in service conditions and make adequate corrections for any deficiencies and then attain steady state performance. There are five main categories of risks inherent in selecting and implementing an emerging technology for the Wilmington region. These categories, which apply in varying degrees to each of the technologies discussed, are as follows:

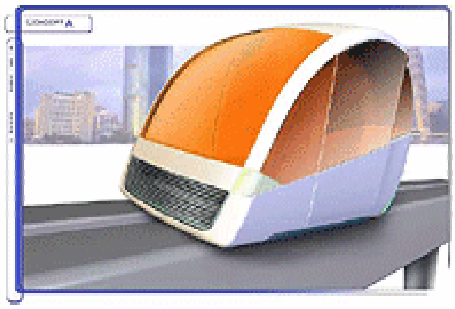
1. Adopting a Technology Before it is Fully Developed
2. Market Obsolescence
3. Incomplete Understanding of Costs
4. Unanticipated Safety Hazards
5. Level of Competition

Cable-propelled technology consists of small-to-large capacity vehicles using cable propulsion with various suspension systems. Cable-propelled vehicles do not have engines, motors, or braking systems. System line speeds of 30 to 40 miles per hour can be achieved. Cable technology controls are stationary and typically located in the passenger terminal building. Because each vehicle is attached to a cable and unable to cross over to a parallel

guideway, switching is not possible. Cable propulsion is best suited for two- or three-station shuttle applications with relatively straight guideway alignments of one mile or less and therefore not applicable to the WILMAPCO region.

Self-propelled technologies (such as the INNOVIA pictured) perform well over a wide range of distances and are relatively easy to expand in terms of capacity and coverage. Power distribution is provided by power rails mounted along the guideway lane. Self-propelled AGTs typically run on dual lanes enabling operational switching. The unique designs of guideway cross-section and vehicle suspension have a great impact upon the complexity, performance and feasibility of operational switching. These unique designs can be expensive because they require sophisticated controls to avoid collisions, operate switches, and maintain headways.

4.1.2 Emerging Systems



There is a wide range of emerging automated technologies, which have yet to reach a "mature status". These technologies range in terms of size, support mechanism, speed and development status. None of the following systems are being considered for the Wilmington metropolitan area:

Personal Rapid Transit (PRT). PRT systems have been developed to the full-scale test track level in the case of one supplier or are still at the concept level for other suppliers. Small or "personal" size vehicles carrying groups of one to three passengers operate automatically over a grid-like network with numerous off-line stations. System line capacity is very configuration dependant but has been estimated in conceptual studies to range between 300 and 1,000 passengers per hour per direction. It is not considered appropriate for the high volume line-haul application anticipated for the WILMAPCO region.

Maglev Systems – Vehicles are magnetically levitated and propelled by linear motors (either linear induction motors or linear synchronous motors). Electromagnetic maglev systems use permanent magnets and develop their levitation using a moving magnetic field. There are high-speed (90 mph) and low-speed (30 mph) maglev systems. High-speed maglev technology in the development stage on test tracks in Germany and Japan are inappropriate for the system length under consideration in this study. There are several low speed systems in test track and passenger service operation, and others are under development.

Monobeam – The monobeam technology is still at the concept level with an elevated single or mono-beam that supports two-way travel on a single triangular guideway. Vehicles ride along both sides of the monobeam in opposite directions by means of cantilevered suspension. Trains "turnback" at the end of an alignment via a loop. Failure management capabilities are very limited compared to other fixed guideway technologies.

Given the potential breath and scope of a Wilmington AGT system, it would be most prudent to procure a service proven technology rather than an emerging technology that has not been adequately "tested" in actual field service.

4.2 MONORAIL/AGT IMPLEMENTATION AND LOCAL IMPLICATIONS

In recent years, a growing number of Monorail/AGT technologies have been built in urban areas primarily serving as circulators/distributors. As shown in Table 4.2-1, there are a number of comparable urban AGT systems in operation that can be useful to the Monorail/AGT development and decision making process in the Wilmington metropolitan area. These urban systems are located in Las Vegas, Seattle, Jacksonville, and Vancouver. These systems have been implemented within subsystems of the urbanized area. The key concern has been insuring that a relatively strong transportation demand exists between the urban subsystems.
The number of driverless rapid transit systems have steadily increased in Europe and Asia; however, in North American this growth has not yet occurred, except in Vancouver, the only non-monorail system discussed in this Section. The existing monorail systems in Las Vegas and Seattle have drivers while it is anticipated that each expanded system will be driverless. The Jacksonville Skyway monorail system is driverless.

4.2.1 Las Vegas Monorail System

The Las Vegas Monorail began as an upgradeable 0.7-mile dual beam system with two stations at the MGM Grand Hotel and Bally's Hotel and Casino. An expanded system will be implemented in two phases during the period between 2003 and 2006. The first phase will be 3.6 miles of dual lane guideway from the MGM to the Sahara Hotel. This segment will have seven stations. The second phase adds 3.2 miles of dual-lane guideway and six stations between the Sahara and Downtown.

The Las Vegas Monorail is considered by project stakeholders to be an effective means of positively influencing land values and redevelopment efforts. With the monorail, it is expected that there will be commercial and retail growth, a conversion of residential to commercial and a higher density of development for tourist commercial use. The system is expected to be a tourist-oriented system and its station locations should attract ridership. The monorail is also expected to increase employment during the construction of the system. The expanded Las Vegas system is similar to what is being considered in Wilmington with regard to being a line-haul service connecting several employment and recreational generators with limited direct

URBAN AGT SYSTEMS								
		Existing				Planned		
System Characteristics	Units	Las Vegas	Jacksonville	Seattle	Vancouver	Las Vegas	Seattle	Vancouver
- Length	dual-lane/miles	0.7	2.5	0.9	18.0	6.8	14.0	13.0
- Number of stations	Each	2	8	2	15	13	16-18	14
- Fleet size	vehicles	12	18	8	150	19	Large Capacity	60
Ridership	Million/year	5.0	0.72	2.5	43.4	20.1	19.7-24.5	24.1
Cost/mile – direct Cost/mile – adjusted***	Million $/mile	$36 NA	$74 $111	$4 NA	$48 -	$91 $83	$64 $62	$48 $52
Capital Cost	Dollars	$25 million	$184 million	$3.5 million	Ph 1 $615 million* Ext1 $145 million Ext2 $97 million	$618 million	$900 million	$800 million
Operating Cost	Million/year	-	$3.5	-	$43 ($Can)	$19.8 - $23.2 (initial)	$18-$25 (Green Line)	$43** ($Can)
Population 2000 - City - County	Persons	478,434 -	735,600 -	563,374 -	514,008 (1996) -	- 1.6 million (2006)	732,400 (2030) -	514,008 (1996) -
Land Use Impacts	N.A.	Tourist commercial use.	No significant impact on land use.	Provides a link between downtown Seattle and the Seattle Center.	Provides no harmful emissions.	Commercial & retail growth, Conversion of residential to commercial, Higher density tourist commercial use.	Land use will not vary much once the monorail is built.	Encourages urban development of commercial and residential areas.
Economic Impacts	N.A.	Joint venture between MGM and Bally's Hotel/ Casino. Proposed extension to include the RTC.	Growth and development did not happen as anticipated.	Only fully self-sufficient public transportation system. Proposed extension of the system.	High ridership and route length have encouraged development.	Increase in employment during construction. Links strip with downtown.	Improve mobility and transit access along the corridor.	Increase in development. Increase in jobs with the vehicle being built in Vancouver.

* Cost in year built. Phase 1 and extensions 1 and 2 in US dollars.
** Current operating costs of existing system in 2001.
*** Adjusted to account for differences in location, level of supplier competition and inflation in comparison to a system in the Wilmington/Newark region.

TABLE 4.2-1: EXISTING AND PLANNED URBAN AGT SYSTEMS

access to residential areas. The markets each system is expected to serve, however, are quite different. The Las Vegas system is tourist oriented with the vast majority of its riders accessing the system by walking. The Wilmington system will serve the work trip with most riders accessing the system via car, bus, or rail.

4.2.2 Seattle Monorail System

The current Seattle Center Monorail (pictured) is 0.9-miles of dual lane guideway. The proposed Green Line will serve several communities between Ballard and West Seattle. According to the Draft Seattle Popular Transit Plan, the Green Line was chosen for the first regional monorail line because the 14-mile alignment would connect neighborhoods with each other and with the downtown and meet the City of Seattle's goals for intermediate capacity transit. The Green Line is expected to have 16 to 18 stations.

In addition, it was selected in coordination with other transportation agencies and after considering suggestions from hundreds of people at community meetings. This process is similar to what is now being undertaken in the Wilmington metropolitan area. The Seattle monorail plan calls for good linkages between bus, train, and ferry services, which is identical to the objectives described in Innovative Transportation Opportunities for Delaware in the 21st Century.

4.2.3 Jacksonville Monorail System

The Jacksonville Automated Skyway Express has evolved over many years. The initial system was 0.7 miles and served three stations. The first 0.6-mile extension included two new stations. There were two more extensions involving a river crossing that added three more stations.

The Jacksonville Monorail system (Skyway) currently has two intermodal stations that serve as transfer facilities for bus and park-n-ride patrons. With free transfers from bus to Skyway, this can potentially shift vehicular trips to transit. Ridership on this downtown circulator/distributor system has not met the projected levels. The transit authority attributes the lack of riders to economic recessions in downtown Jacksonville in the early 1990s that led to a decrease in development in the area.

The river crossing over the St. Johns River involved the construction of a new bridge to accommodate the Skyway. Having a bridge, which combined automobile traffic and the Skyway on a single structure, was a significant cost savings to the taxpayers. The lessons learned can be used if considering the option for Wilmington's Tyler McConnell Bridge project becomes necessary.

4.2.4 Vancouver Rapid Transit System

The Vancouver SkyTrain is a steel-wheeled AGT system. The system consists of two major lines, the Expo Line and the Millennium Line. The Expo Line is approximately 19 miles and the Millennium Line is approximately 13 miles. There are 33 stations and the fleet consists of over 200 vehicles.

The Vancouver SkyTrain also includes a river crossing over the Fraser River. The high ridership and route length of SkyTrain have several economic benefits, such as an increase in development. The Bombardier MKII vehicles for the recently opened Millennium Line are being built in Vancouver, creating jobs and an investment of $175 million in local goods and services.

4.2.5 Summary of Planning and Implementation Issues

In urban areas, Monorail/AGTs will only be operationally successful in comparison to traditional transit modes when used within a well-defined system application. The significant issues that impact the planning and implementation of Monorail/AGT systems are related to aesthetics, construction, cost, efficiency, and safety.