Dual Mode, The AVT and Maglev

Frank Randak
AVT-TRAIN.COM, Inc., 8 Fallen Oaks Drive, Thousand Oaks, CA 91360 USA
Phone/Fax: 800-923-3306 / 805-492-5634
e-mail: frank@randak.com URL: WWW.AVT-TRAIN.COM

Keywords
Continuous, Trains, Vehicles, Shuttles, Docking

Abstract
Traffic and energy problems are worldwide. Dual Mode (DM) systems transport vehicles with their passengers automatically, quickly, safely and more efficiently than highways. The Advanced Vehicle Transport (AVT) eliminates the inherent disadvantages of typical DM designs by combining the best features of DM and high-speed Maglev trains. The AVT design minimizes the cost objection to Maglev because the AVT Train transports vehicles, passengers and freight continuously, without stopping, producing a very popular, efficient, high capacity and profitable operation. Continuous operation is accomplished by loading and unloading moving AVT Trains with AVT Shuttles that travel on a parallel track. Shuttles pickup parked vehicles at stations, merge with a passing Train, then dock with the Train and then transfer the vehicle onto the train. Unloading vehicles is accomplished by running the operation in reverse.

1 The Car – A Mixed Blessing

Given the choice, people would rather travel in their own car than ride the bus, the train or even fly. And it’s easy to understand why. The car provides comfortable, secure and private door-to-door transportation at any time. That is why the car is so popular in daily life and why most of our major roads are overloaded with traffic.

The desire of almost everyone to own and drive a car has resulted in traffic problems on major roads that connect cities, home and work. Long car trips quickly absorb limited highway capacity. Adding more lanes to major roads helps but causes other serious problems such as higher accident rates due to more lane changing, more pollution, and more wasted energy and time in traffic.

Highways have a relatively low capacity for handling traffic and they are not designed to handle overload conditions. At about 60 MPH, a highway can only move about 2,000 cars per lane per hour under ideal conditions – without any problems. When the highway nears maximum capacity, which happens almost every day, adding more cars slows down everyone but there is no way to stop the cars from flowing in from the on-ramps. At the time we really need high capacity – we lose it because of overloading. Speeds diminish rapidly and gridlock results.

Any road maintenance, bad weather, police action or minor accident diminishes the capacity dramatically. Eating a burger, talking to a passenger and talking on mobile phones cause the driver to drive erratically – reducing capacity.
The amount of lost time, wasted energy and suffering associated with driving is shocking. Here are some interesting statistics on traffic a few years ago from the book, “Statistical Abstracts of the United States”. Over 10 billion dollars were wasted in fuel and human resources due to traffic delays in 1996 in Los Angeles alone, not including the waste of driving when there are no delays. The cost of owning and operating a car was 53 cents per mile in 1997 and there were 42,000 traffic deaths.

Even if there were never any traffic problems because of unlimited highway capacity, driving would still be a tragic waste of time and natural resources and a serious cause of air pollution.

2 DualMode Solutions to Overflowing Traffic

DualMode (DM) systems alleviate these problems by removing through traffic from the main arteries and transporting the cars automatically on elevated guideways. DM travelers are freed from terminal parking costs, ticket lines, baggage handling, security checks, and waiting for trains and planes at passenger terminals. Delays due to bad weather and the inconvenience of renting a car are eliminated.

DM systems can also carry freight and travelers without cars.

In May 1974, the Transportation Research Board conducted The International Conference on DualMode Transportation in Washington, D.C. Approximately 300 people from 10 nations attended. It was the first general conference on the subject. General Motors and the Rohr Corporation presented specific DM designs. However, to date, no DM systems are in use.

There are significant problems with typical DM designs that might explain why no DM systems have ever been built:

1. They rely on mechanical Y switches that must operate at dangerously close timing tolerances at highway speeds.
2. Some designs must perform the complex task of distributing empty vehicle pallets, thereby wasting guideway capacity and efficiency.
3. Specially built or modified vehicles are required in some designs.
4. Vehicle engines must be kept running to supply power for air conditioning.
5. Restrooms and first class accommodations are not available.
6. In order to increase guideway capacity and reduce drag, complex vehicle platooning methods are proposed that reduce the distance between vehicles, decreasing the privacy of the passengers.
7. Maximum speed is slow compared to that of pressurized high-speed trains and very high DM speeds are impossible.

A comprehensive list of current and past DM efforts can be viewed on the Internet at: http://faculty.washington.edu/jbs/itrans
3 DualMode and the AVT

The **Advanced Vehicle Transport (AVT)** has a simple and unique design that eliminates all of these problems by combining the advantages of high-speed trains with the DM concept. The AVT transports cars and their passengers in private quiet train compartments that have air conditioning, restrooms and entertainment centers. The AVT is designed to be simple to use and enjoyable to ride. You simply drive into a station, park your car, select your destination, and you and your car are automatically transferred onto a train and transported to your destination. On arrival you simply start your car and drive away. The following 9 illustrations depict the operation of the AVT.

**Key Frame:** Highways have 2 guideways, one on each side - high above the shoulder. There is an Arrival Station in the foreground with cars leaving the station and a Departure Station across the highway. The corresponding Arrival and Departure Stations are at the top left – about a mile away.

There are 4 AVT stations in this configuration that are connected by a Shuttle loop. There are elevated guideways on each side of the highway on which the AVT Trains run continuously – every 8 seconds during rush hour. Cars with their passengers are loaded onto passing trains by shuttles while the trains are moving. Each guideway will transport over 10,000 cars per hour because the trains do not stop at stations.
Shuttles pick up parked cars from Departure Stations, catch up with a passing train, dock with the train and move the car with their passengers onto the train. Shuttles also unload cars from moving trains and park them in Arrival Stations. Shuttles travel on a separate guideway loop that services Departure and Arrival Stations on both sides of the highway.

AVT Trains travel at 80 MPH when cars are being transferred, up to 150 MPH between stations and over 200 MPH between cities.

Stations may also be built over the highway, like overpasses, in locations where there is insufficient room next to the shoulder. Special on and off ramps can be used to access the stations, virtually eliminating the impact on the existing highway infrastructure.

The AVT is a less expensive way to add capacity to existing highways that provides many benefits such as less noise and pollution, fewer traffic accidents, faster travel and less energy consumption.
Frame 1: Departure Stations are like elevated parking structures with 4 to 20 diagonal parking spaces. Shuttles arrive on a guideway from across the highway where there is an Arrival Station for the opposing traffic. Cars enter the station and park diagonally.

For clarity in this presentation, the illustrations show translucent station covers. Actual stations and trains will be covered with photovoltaic solar panels.

Frame 2: A driver enters a departure station and parks in the first available space where there is a retractable ATM machine. A gate at the entry prevents driving into the station if it is full. Trains are passing above and next to the station. Cars on Shuttles are leaving the station on the right.
Frame 3: After parking, the driver uses the ATM machine to enter a credit/debit card and select a destination. Shortly thereafter, the car is rotated 45 degrees and conveyor belts transfer the parked car onto a waiting Shuttle. An approaching Train and Shuttle are on the left. Simple conveyor belts move a vehicle from the station onto a waiting Shuttle.

Frame 4: Once the car is secure, the Shuttle, with the car and passengers, accelerates to meet with an approaching train. A shuttle is about to dock with a train. The Shuttle in the foreground will dock with the same train, a few cars behind the one in front.

Frame 5: When the Shuttle is next to an empty train compartment, it docks with the train, the door on the train opens and conveyor belts transfer the car into the train compartment. The door then closes and the Shuttle undocks from the train. The driver can read status messages on the Shuttle and the screen inside the train compartment during the process, which takes about 15 seconds.
Frame 6: A status message on the TV screen in the front of the compartment notifies the passengers when the docking is complete and it is safe to get out of the car. There is a good view from the train compartment because it is high above the traffic and the ride is very smooth and quiet.

Frame 7: The rear of the compartment has a restroom, vending machines and a jump seat for lounging outside the car. When traveling first class, there is a door to the rear compartment in the lounge area. The rear compartment is an office and living room suite.

Frame 8: After unloading a car from a train, the Shuttle docks at the Arrival Station and conveyor belts automatically transfer the car from the Shuttle into the station. The car is rotated 45 degrees; the driver starts his car and drives away. The empty Shuttle then crosses the highway to a Departure Station where it picks up another car.
3 Other Possibilities

Using the AVT is very easy, enjoyable and convenient. In addition to transporting cars, there are even more possible uses for the AVT such as:

1. AVT stations can be integrated into parking structures in central business districts, providing door-to-door transportation and reducing street traffic.
2. Shuttles and small buses can provide public transportation between stations without the use of cars and bus drivers.
3. The AVT can transport containers of freight as well as cars.

4 AVT and Maglev

Maglev makes the AVT more energy efficient, reduces noise and virtually eliminates rail and truck maintenance. There are many Maglev solutions under development that could be used for the AVT Trains. Solutions that use permanent magnets are particularly attractive.

Modern Transport Systems Corp (MTSC) in Westlake Village, California has developed and patented a promising approach that uses permanent magnets in the train trucks for levitation, keeping the cost of the guideways very low compared to other Maglev technology. Please consult www.magsupport.com and section 8 Photos for more information

5 AVT Capacity and Efficiency

A single AVT Guideway running above the highway shoulder can carry 10,000 cars per hour; the equivalent of a five-lane highway, and it is immune to the problems that cause traffic delays because it is a completely controlled system. There are main computers in each Station, Shuttle and Train that communicate over a wireless network. Many smaller specialized computers control individual tasks like opening the door on the Train and moving the conveyor belts.

And it costs less to build an AVT Guideway than to add one lane to the highway. Think about it. Did you ever watch a highway lane being built? First a survey is done followed by grading, building walls, moving signs, filling with sand and gravel, adding drainage pipes, pouring concrete, landscaping, new signs and painting – all requiring many months of work by many workers as well as long delays and inconveniences to car drivers.

In comparison, an AVT guideway is simply constructed by drilling holes along the side of the highway. The holes are filled with concrete, forming pads near ground level that will support the guideway. Prefabricated guideways are then lowered onto the pads with minor disturbance to traffic.

Since the AVT runs above the highway shoulder, it must be able to climb grades that are too steep for normal trains. Normal trains can only climb a 4% grade but some highway passes are 7%. There are 2 simple solutions that will assist the train on steep grades: electric motors on each wheel and/or Linear Induction Motors in the guideway to give the train a boost like a roller coaster.
Although the AVT will be very popular, it will not slow down when the demand exceeds the capacity – unlike highways, which slow down rapidly with any small disturbance. If the AVT is full then cars cannot be added but this is not a problem because if the AVT is full it probably means the highway is relatively empty and cars have an alternate path.

Transporting cars on the AVT is about ten times more efficient than driving them individually because AVT Trains have much less rolling friction and aerodynamic drag.

In addition, AVT air-conditioning costs are much less because cars travel in shaded insulated compartments. The windshield and rear window are not exposed to direct sunlight.

Then there is traffic. The AVT travels at a constant speed whereas cars on the highway must slow down and speed up due to erratic driving and traffic problems that increase the cost of driving dramatically.

Less rolling friction, aerodynamic drag, air-conditioning costs and a constant speed combine to make the AVT about 10 times more efficient.

But the cost in dollars to run the AVT is much less than 10% of the driving cost because the AVT is powered by natural gas and photovoltaic arrays instead of heavily taxed retail gasoline. Clean burning gas turbine generators in the stations generate most of the energy and photovoltaic arrays on top of the trains and stations generate the rest.

6 AVT Benefits

The AVT not only solves the highway traffic problem but also improves our way of life and standard of living. It’s the only practical and popular solution to relieving traffic congestion that provides lots of extra benefits. The obvious benefits from the AVT are:

- Convenient, fast and comfortable travel at a reasonable cost
- Energy savings and less pollution
- Fewer traffic deaths and injuries
- Lower insurance rates and car maintenance costs
- More convenient travel for the handicapped and senior citizens
- Secure private travel for everyone including government leaders and celebrities

Other benefits include:

- A higher standard of living due to a more productive work force
- An increase in local business due to a wider customer base
- Lower taxes due to lower highway construction and maintenance costs
- Less airport congestion
- Extended range for electric vehicles
- Recharging electric vehicles while traveling
7  Typical Questions and Concerns

The following topics address questions and concerns that have been expressed by the public and government agencies that are evaluating the AVT.

7.1  Vehicle Transfer Problems

Getting on and off the AVT Train is safer than changing lanes on the highway. However, if the onboard computers detect an incomplete vehicle transfer then an emergency backup mechanism will attempt to complete the operation, e.g. a separate device will grasp the bottom of the vehicle and move it into the train compartment. If all else fails, emergency tread breaks will be deployed – stopping the system.

7.2  Medical Emergencies

Each AVT Train has a computer that is connected to an AVT computer network and the Internet. Each compartment has an interactive device that is used to change destinations, select entertainment options and alert the system to emergency situations. The AVT is well equipped to respond rapidly to emergencies like displaying CPR instructions to passengers and providing communication with paramedics.

7.3  Passenger Safety

Passengers who are traveling in their own vehicles are much more secure than those who are driving because they are protected in a private compartment and are less likely to be involved in a traffic accident.

Passengers who are sharing mini-buses are protected by video surveillance and instant communication with the AVT control system via panic buttons. Alternatively, pedestrians could reserve mini-buses for exclusive use if security was a major concern.

7.4  Vehicle Does Not Start on Arrival

After a shuttle transfers vehicles to a destination exit space its unloading mission is complete and it is ready to provide service to another vehicle. If the vehicle can’t start it simply occupies one of the exit spaces until it is repaired or removed by a tow truck. A typical exit station will have about 10 exit spaces so the momentary loss of one space should not impact the performance appreciably.

7.5  Engine Overheating While Waiting for Shuttle

Automobiles will be waiting in the shade at AVT departure stations and the wait should be less than the time at a traffic signal.
7.6 Vehicle Sizes

The interior dimensions of a standard AVT vehicle compartment are about the same size as a standard one-car garage, i.e. 22 feet long and 12 feet wide. That size will accommodate pickup trucks and most SUVs. The AVT is designed to transport most of the through traffic but not all. However, larger compartments could be provided based on the demand.

7.7 Passengers Outside Vehicle at Destination

The Train Compartment will be monitored with infrared sensors that will detect when people are outside the vehicle and the door on the compartment will not open. In this case, the vehicle will be unloaded at the next arrival station and the driver can drive back or board a returning train.

7.8 Fumes in AVT Train Compartment

The AVT Train has central heating and cooling which provides much better airflow than a standard home garage and it will prevent the accumulation of fumes while traveling on the AVT. Emergency backup systems will open vents in case of a ventilation problem.

7.9 Maintenance of Restrooms

Normal maintenance is performed each day in early hours when the AVT Trains are not running. Restrooms, conveyor belts and vending machines will be serviced each day by robotic devices with special service during the day as required.

7.10 Size and Number of Trains

If cars are traveling in a single lane at a constant speed of 80 MPH spaced at 30-foot intervals then 13,440 cars will pass by in one hour.

Each AVT Train has 10 train cars 60 feet in length and each train car has 2 compartments so each AVT Train will carry 20 vehicles.

If the AVT Trains occupy 75% of the track, leaving 200 feet headway between trains, then one AVT guideway will transport a maximum of 10,000 cars per hour. In high density areas, doublewide AVT Trains could be used that would transport up to 20,000 cars per hour on a single guideway or the equivalent of 10 lanes of freeway in each direction.

7.11 Construction and Operating Costs

Since one AVT guideway has the transport capacity of 5 freeway lanes, it is far less expensive to add capacity to freeways by building AVT guideways. The AVT Trains and Shuttles are added to the system based on demand and ticket sales will more than cover the cost of the trains and shuttles.
For example, one AVT Train car that operates 18 hours a day and travels at an average speed of 100 MPH will generate $360 per day in revenue at 10 cents per mile or $131,400 revenue per year at full capacity.

Cost is important but we must give even more consideration to the benefits. There have been times in our history when universal benefits have far outweighed the costs, e.g.

- Building the transcontinental railroad
- Building the Panama Canal
- Going to the Moon
- Destroying the terrorist menace

We are experiencing for the first time in the history of our civilization a unique phenomenon – overflowing vehicle traffic that is degrading the quality of lives and our productivity. Our most valuable natural resource, our labor force, is sitting idle in traffic. Even if there were never any traffic problems because of unlimited highway capacity, driving would still be a tragic waste of time and natural resources and a serious cause of air pollution.

We must solve the highway traffic problem as soon as possible.

### 7.12 Power Failures

The AVT is immune to power failures because it is powered by electric power generation systems in each station forming its own grid that is powered by natural gas, e.g. Coastintelligen Power Generation Systems, web site [www.coastintelligen.com](http://www.coastintelligen.com).

Even if multiple generation systems failed simultaneously, the AVT would continue to operate at a diminished speed.

### 7.13 Vehicle Oil Leaks

Vehicles are always parked on conveyor belts that are made of stainless steel chain link construction which have small gaps so that oil and dirt will fall through. There is a drip pan below each conveyor belt that is covered by an absorbent fire retardant material. The drip pans will be cleaned periodically, weekly or monthly. The conveyor belts are automatically steam cleaned each day.

### 7.14 Electric Motors for Trains and Shuttles

We are planning to use small Linear Induction Motors, LIMs, on board the AVT Trains and Shuttles to maintain speed with additional LIM motors in the guideway to provide extra acceleration where required. LIMs have no moving parts so maintenance costs are reduced to a minimum.

Each AVT Train car will contain a small LIM and each Shuttle will have two small LIMs. This design keeps the cost and weight down and provides redundant power in the case of a motor failure.
7.15 Interchanges

There are two ways to transfer vehicles between AVT Trains that cross paths: manual and automatic.

The manual method involves exiting the AVT, driving through the freeway interchange and boarding another AVT in a few miles. Remember, the freeway interchange will not be congested because almost all the through traffic will be on the AVT. This is an inexpensive solution that takes advantage of the existing freeway interchanges.

The automatic method involves building a Shuttle guideway interchange to unload vehicles and transfer them onto another train. This is a much more expensive solution.

7.16 Transition Between Heavy and Light Traffic

Many more AVT Trains are required for transporting vehicles between Santa Monica and San Bernardino than are required between San Bernardino and Blythe. If all of the AVT Trains travel from Santa Monica to Blythe there will be a large percentage of unused compartments traveling through the desert.

The wasted energy is less of a problem than the wasted compartment space. The solution is two train loops. Travelers from Santa Monica would exit the AVT in San Bernardino, drive a few miles west on the I-10 and board another AVT through the desert which runs AVT trains every minute instead of 4 Trains per minute.

7.17 Americans with Disabilities Act Compliance

The central tenet of the ADA requirements is that whatever is provided for “normal” riders must also be provided for the disabled. Any person capable of driving a vehicle can be accommodated by the AVT.

The AVT will carry a van or car that is equipped for the handicapped and in that sense it is well suited to disabled drivers. Restrooms on the AVT probably may be exempt from wheel chair access requirements because it would not be practical or advisable to remove a wheel chair from a vehicle while aboard the train.

We assume that the mini-buses and sections of the AVT stations that provide access to pedestrians will be subject to standard government regulations regarding the handicapped. The mini-buses could be designed for wheel chair access and the restrooms in AVT Train compartments that transport mini-buses could also be designed for wheel chair access.
8 Photographs

Frank and Nancy Randak with the AVT Prototype at Griffith Park in Los Angeles, California.

This is one of the Maglev prototypes that were created by Modern Transport Systems Corp. that is referred to in section 4 AVT and Maglev. Visit www.magsupport.com for more information.