Georgia Public Policy Foundation

Foreword

The Georgia Public Policy Foundation has focused much effort in recent years on sorting out the facts and identifying realistic solutions to Metro Atlanta's transportation and air quality challenges. We have been quite skeptical of solutions based on light and heavy rail because very reliable data indicates that these modes of transportation will have little impact on traffic congestion and air quality because they do not attract a significant number of people out of their cars. For mass transit to entice drivers out of their cars, it must satisfy consumer demands. In other words, mass transit needs a better product.

Despite these facts, the Metro Atlanta area seems intent upon building more rail-based transit. If so, we would encourage Atlanta's leaders to consider more effective options. This study presents a fundamentally different process that appears to have the ability to be much more successful than current rail choices in competing with private vehicles. We would be remiss in not studying this idea before investing billions of dollars on ineffective solutions. We believe that complex problems can best be solved with creative ideas, critical analysis and rational, fact-based discussion. By bringing these ideas into the public debate, we hope to improve our chances of finding a realistic solution.

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Kelly McCutchen
Executive Vice President

The **Georgia Public Policy Foundation** is a private, nonprofit, nonpartisan research and education foundation. The Foundation is a champion of personal and economic freedom and is committed to providing a free market perspective based on the principles of limited government, respect for the lives and property of others, and responsibility and accountability for one's actions.

SyncTrans: A Vision for the Future of Mass Transit

William V. McRae

Executive Summary

Major metropolitan areas in the United States have expanded dramatically for the past half-century, resulting in traffic congestion and air pollution concerns that are now presenting barriers to further economic growth. In an effort to alleviate these problems, the focus has shifted to mass transit as an alternative method of transportation. However, transit has not been successful in enticing a significant number of individuals from the mobility and convenience provided by their own automobiles.

Mass transit has not lived up to expectations because it fails to provide the benefits that consumers demand. First, since we live in such a “hurry up” society, average trip times must be competitive with the average trip time provided by automobiles. Second, convenience, accessibility and safety must be improved. In order to attract a significant number of people out of their cars, it will be necessary to mold the product (mass transit) to fit consumer demands rather than our failed effort to mold consumer demands to fit the existing product.

Fortunately, a new process, called SyncTrans, has the potential to revolutionize the urban mass transit market by overcoming the above drawbacks. Its projected performance is superior to current mass transit alternatives. In fact, using just a quarter of its capacity, the system can transport an equivalent number of passengers per hour as 16 freeway lanes – and this is just counting passengers that are comfortably seated rather than standing. Even better, average trip times are less than half that of traditional urban trains because SyncTrans can transport passengers non-stop from their origins directly to their destinations at an average trip speed approaching 60 miles per hour.

The SyncTrans system is comprised of small family-sized cars that travel non-stop on an elevated guideway between stations. The quiet, electric-powered system and its cars require no drivers and can operate 24 hours a day, seven days a week. The elevated guideways are cost effective and can be erected quickly. Since the system is fully automated, labor costs are minimal.

Customer service and passenger appeal are exceptional. Non-stop travel eliminates the frustration and delays caused by transfers, trip times never vary, a continuous boarding process eliminates crowded platforms, and the average wait between cars for any desired destination is less than two minutes. Because of the way the system works, stations can be conveniently located anywhere throughout the city.

Personal safety is also greatly enhanced. If an emergency occurs while traveling, a panic button in the car gives passengers access to a voice-activated connection to the central station. If such an indication of an emergency is received, the vehicle will be switched off at the first station with medical, fire and/or police facilities. Criminals, therefore, would have a very high probability of being caught – an effective deterrent. Additionally, since the boarding area of a SyncTrans station is comparatively small and vehicle operations are non-stop from origin to destination, station surveillance cameras would be able to record all activity for future reference.

The SyncTrans system has the capability of dramatically improving the benefits offered by mass transit, therefore attracting more riders, reducing traffic congestion and improving air quality. It also provides the opportunity for the United States to become the leader in the international market for urban mass transportation systems. Given these opportunities, a rigorous feasibility study and cost-benefit analysis is warranted to assess the capabilities of this new process.

Trains, Train-Type Systems and the Train-Type Process

Train systems have been in use for more than 150 years. All train-type systems operate on a line dedicated to specific vehicles, commonly referred to as an exclusive guideway. The guideway can be placed underground (subway), at-grade (ground level), grade-separated (elevated), or in a combination of the three. Guideways can contain rails, metal or concrete strips, and can be configured as monorails. The train-type systems that employ exclusive guideways are often described as follows:

Heavy Rail: These are essentially the urban trains with which we are all familiar — the New York subway, San Francisco's BART, Washington D.C.'s Metro, Atlanta's MARTA, etc. The train cars are designed to maximize seating and standing room in order to expedite the rapidly exiting and boarding passengers.

Light Rail: At-grade systems, usually intermingled on the streets with personal vehicles, and commonly referred to as trolleys.

Circulator Systems: Grade-separated, smaller, lighter weight vehicles quite often used as people movers in amusement parks.

Although the performance of each of these train-type systems varies considerably, all of the above systems operate using the same *process*. The vehicles travel from station to station, stopping to allow passengers to exit and board at each station. This system will be referred to as the *train-type process*.

Why Trains Are Still the System of Choice for Urban Areas

The good news is that our nation's economy has enjoyed healthy growth for more than a half century. While nearly everyone has been able to purchase more goods, better homes and better automobiles, the bad news is that the traffic conditions in many of our major metropolitan areas have become almost unbearable.

The problem concerns more than traffic congestion and its related hazards such as accidents and injuries. There are the hidden opportunity costs of lost time, personal stress and pollution, as well as the expenses of additional street and freeway construction. Despite the fact that these problems are worsening, our largest metropolitan areas continue to build urban train systems. Why?

Fundamentally, the primary objective of mass transit is to alleviate traffic congestion. There are basically two ways to accomplish this: either increase the efficient flow of people and/or vehicles on the roads and/or get a significant number of vehicles off the roads. Below are some of the approaches in our cities:

Flow efficiency increase: Dedicated bus lanes, HOV lanes, and adding or widening streets and freeways.

Fewer vehicles on roads: Ride sharing, dial-a-ride, company buses and mass transit (buses and train-type systems).

All of these approaches have been implemented in one form or another, and each scheme supports the objective to some degree. Unfortunately, every one of the above has shortcomings either in service factors or cost-benefit trade-offs. Overall, only the train-type system (specifically "heavy rail") holds the potential of significantly reducing the number of private vehicles on the streets and freeways due to its superior performance.

Measuring Mass Transportation Performance

In order to alleviate traffic congestion, the basic performance criteria for any mass transit system must be to transport people more effectively than freeways while providing an average trip time compatible with personal vehicles.

People Flow

Although trip times will vary according to weather, traffic congestion, distance of travel and other factors, there is a yardstick for the measurement of mass flow or more simply “people flow” — the rate at which people pass by a given point in a given unit of time.

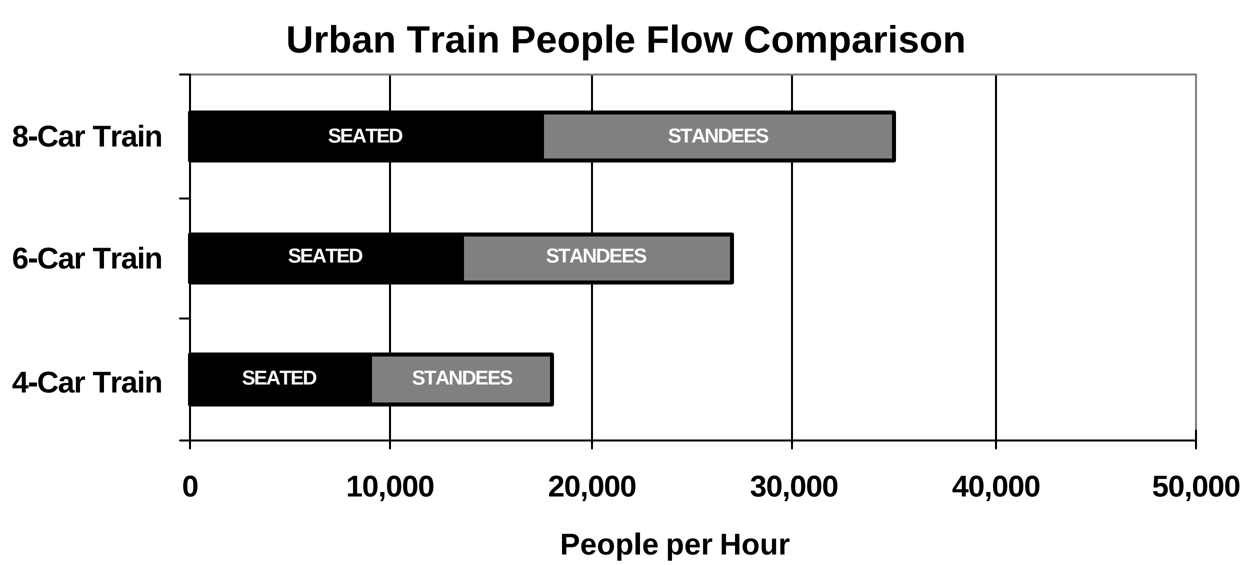
A typical freeway lane carries an average of about 2,000 vehicles per hour, with an average of about 1.25 occupants per vehicle. (Ride sharing programs are promoted specifically to increase the occupancy rate per vehicle.) Thus the average people flow rate for a single freeway lane is approximately 2,500 people per hour (2,000 vehicles per hour multiplied by 1.25 occupants per vehicle).

A typical mass transit car of an urban train contains approximately 75 seats. The train is normally comprised of 4, 6 or 8 cars, depending on the time of day and degree of demand. The New York City subways operate with a full complement of cars on a two-minute “headway” during rush hours. (Headway is the time separation between trains that ensures a safe stopping distance should the preceding train suddenly stop.) A two-minute headway means that, on average, 30 trains per hour will arrive at every transit station along the line. If all the seats of the trains are filled, then the chart below (***Figure 1***) shows the people flow capability for trains of various sizes operating on a two-minute headway.[1]

The vertical lines at every 10,000 people per hour mark represent the equivalent of about four freeway lanes. It can be argued that a single corridor train-type system chosen to alleviate rush-hour traffic congestion should have a people flow equal to or greater than four freeway lanes. Based on this requirement, the other train-type process systems such as trolleys, light rail and the so-called people movers can no longer be considered as candidates for the alleviation of traffic due to their much lower people flow capacity.

Trip Time

People flow is only half of the performance objective. The system must provide an average trip time acceptable to the prospective patron. Urban trains stop at each station on the line to allow passenger exit and boarding. This activity takes time, especially during busy times when there are many passengers exiting and entering the cars. In order to provide a reasonable *average* speed (approximately 30+ miles per hour) during rush hours, the train must accelerate to much higher speeds between stops, sometimes as high as 70 to 80 miles per hour.[2]



Each 10,000 people per hour is equivalent to four lanes of freeway traffic. Calculations based on 75 seats per car operating on a two-minute headway.

Figure 1

So, What's Wrong with Urban Trains?

Urban trains can achieve the performance objectives of high people flow and, for many people, a competitive average trip time. If costs do not present an economic roadblock, then these performance capabilities are why urban trains are the system of choice today. However, as discussed below, our current train systems fail to provide the benefits necessary to compete with personal vehicles. Therefore, much time and effort has been spent over the years to find a better solution.

Because urban trains can move large numbers of people from place to place in a given time period, they have for decades been the dominant and only viable mass transit option. Notwithstanding that capacity, most Americans avoid trains, opting to fight rush hour traffic in their personal automobiles. Why?

Consumers in today's increasingly hectic world want convenience, accessibility, safety, security and comfort. Personal vehicles, despite their own limitations, meet these requirements better than trains. Put another way, the various undesirable facets of the train ridership experience drive the vast majority of Americans away from trains.

Convenience and Accessibility

When traveling, consumers today want convenience and accessibility. For people to use mass transit, stations must be located reasonably close to both the place where the consumer is beginning his or her trip and the ultimate destination. Trains have trouble meeting this consumer need. Train routing is limited to linear corridors. In Atlanta, for example, there is a North-South line (corridor) and an East-West line. The two lines cross in the downtown area, often referred to as the Central Business District (CBD). This typical line layout may be convenient for those potential passengers who live along the corridors, but great masses of the population are left without easily accessible stations. If stations are not conveniently close, consumers must drive a car or take a bus, at times over very long distances, in order to catch a train. Then, if the consumer's ultimate destination is not near a station along the corridor, he or she must catch another bus or cab to reach the final destination. For some passengers there is the added problem of having to travel to the CBD, exit the train, go to another level and transfer to another train. These problems of inconvenience and inaccessibility often make train travel undesirable.

A History of Modern Mass Transit

For more than 150 years in the United States and most other developed countries, trains have provided a major means of transportation between cities for both freight and passengers. In Boston 100 years ago, trains driven by electric motors were introduced for the first time in this country as a means of urban mass transportation. New York City shortly followed suit. The objective in those days of extremely slow and very limited automobiles was to provide a better means of public transportation – primarily for getting to and from work.

Nearly 50 years ago, San Francisco embarked upon a comprehensive study of urban mass transportation systems to determine what kind of system could best fulfill their needs. Overtly, the requirements were the same — efficient transportation of people within the metro area. However, another dimension of need had arisen, the ability to entice people from using their automobiles in order to alleviate the projected vehicular traffic demands in the Bay Area. As before, the time of day when the need was greatest was during those weekday rush hours when people were traveling to and from work. The decades were different, the objectives were the same, but the system requirements had been broadened. Nonetheless, the answer came out the same . . . trains.

Over the next few decades, Washington, D.C., Miami and Atlanta built similar mass transit systems. Recently, Los Angeles began operation of its new 17.4-mile, $4.7 billion system. Looking to the future, the metro Atlanta area just approved a $36 billion, 25-year transportation plan where the majority of the funds are designated to support additions to the city's heavy rail system (MARTA), light rail and commuter rail service.

In 1969, the federal government created within the Department of Transportation (DOT) the Urban Mass Transportation Administration (UMTA). The initial charter of this new agency was to encourage development of new capital-intensive mass transportation systems as opposed to labor-intensive buses and expensive trains. Given congressional approval, the UMTA had the authority to fully fund the demonstration of new systems. As of yet, no suitable solutions have come from this initiative.

The New York City Subway: Not the Ultimate Consumer Experience

The greater the traffic problems, the more like the city of New York our major metropolitan areas will become. New York's City's subways are sometimes cited as an example of a successful urban mass transit system. In this case, success is measured primarily in terms of dollars and in moving millions of people daily. For the most part, New York subway riders are a captive population to the system since rush hour traffic on the streets borders on the unbearable. In addition, the costs of daily parking – if you can find an empty space – is prohibitive for most New Yorkers.

There is nothing more impersonal than riding a New York subway during rush hour. Upon entering a station, patrons join one of the crowds waiting for the next train.[3] When the train arrives, there is a forward shift of the crowd to get close to the doors. Then commences a push-and-shove contest of passengers exiting against those entering the train. In the most crowded stations on a line, there may be "packers" required to stuff the passengers into the cars so that they can close the doors and minimize the delay time of a train in the station.

If a patron is boarding from a few stations downstream of the first station on a line, the seats are often already filled upon arrival and the objective of being one of the first to board is to acquire an overhead strap

New Systems during the 20th Century

The *Carveyor*

In the 1960s, the Goodyear Corporation was promoting an upgraded version of its *Peoplemover* installed in Disneyland's Tomorrowland in Anaheim, California. Called *Carveyor*, the operational process of this system appears, at first glance, to be the same as the train-type process in that passengers can board or exit at each station on the line. However, the process of the Carveyor is fundamentally different in that the vehicles are much smaller and do not stop at each station, but slowly "creep" through. Passengers exit and board from a platform moving at the same speed of in-station vehicles. Due to a low people flow compared to trains and the concern of the smaller vehicles having to travel at high speeds between stations in order to achieve acceptable average speeds, the Carveyor system was never implemented in the United States.

Instead of batch station operations (groups of people exiting and boarding when the trains are stopped in the stations), exiting and boarding are continuous for the Carveyor-type process. Also, the vehicles operate in perfect lock-step unison with respect to one another because they use spatial control (physical spacing) as opposed to headway (time) control as with trains. In that sense, the operational process can be termed "synchronous." Urban trains try to maintain schedules, but the uncertainties of passenger loading and unloading operations create deviations from a precise schedule. As such, the train-type process can be termed "quasi-synchronous".[4]

Personal Rapid Transit (PRT)

When the Urban Mass Transit Association was first formed, a modest five-year trust fund was set up similar to that of the Federal Highway Administration. Industry reacted very positively. Dozens of major American industries invested tens of millions of their corporate (1970) dollars in pursuit of the new system the UMTA was promoting as the next generation of urban mass transit systems, the personal rapid transit system. PRT was designed to be a fully automated system in which the passenger would enter a station, get into a small transit car and "tell" that car its destination station. The car would then transport the passenger to his/her destination non-stop. All of the processes discussed above operate with on-line stations that are abutting and parallel to the main line. In this process, all stations are off line (similar to exits on interstate highways), thereby allowing the transit cars to bypass stations that are not their destination stations. From a passenger's viewpoint, the service would be ideal and almost immediately the site for a demonstration program was chosen – West Virginia University in Morgantown, West Virginia.

It is unfortunate that a thorough systems study was not conducted before committing to that demonstration program, for a simulation of the PRT process would have shown that it had no applicability to the nation's major traffic problems. Ultimately, the DOT's Transportation System Center in Cambridge, Massachusetts, published a report showing that the system would have a people flow of less than the equivalent of a single freeway lane (even if the vehicles could operate on a two-second headway). The upside of that demonstration program is that WVU has an automated six-station system that serves the university quite well. The downside is that the "rush-to-new-system-judgment" left the corporations disillusioned, and none of the original participating corporations are still in the exclusive guideway urban mass transportation business. At present, the United States imports urban trains from the Canadians, Japanese, Germans, French and Swedes.

on which to hang. If you are fortunate enough to get a seat you can read a book or newspaper, but for the straphangers, reading or relaxing becomes difficult. Of course, if you are absorbed in reading (or sleeping) it is easy to overshoot your destination station. Overall, when riding the New York subway system during the rush hours, it is hard not to feel like herded cattle.

In the off-peak hours there are other concerns: drunks, panhandlers and personal security. Muggers can enter and exit the train at any stop along the line. Long waiting times in the stations at night are common; all of the stations are long and many are poorly lit. The reason for dwelling on this unpleasantness is to paint a picture of what may lie ahead in urban mass transportation in other major metropolitan areas unless better solutions are found and developed.

SyncTrans . . . The Fifth Process

Attempts to describe different mass transit systems by name or by hardware differences result in a great deal of ambiguity while yielding no insight as to the system's performance. For example, someone may claim that a system is truly new because it runs on a monorail. That may sound sexy, but its operating characteristics are unchanged whether it rides on one rail, two rails, an air cushion or is suspended by magnetic levitation. The service is the same and the passenger would not know the difference (although it might run a bit quieter). If, however, a system is categorized by its operational process, one has a clear understanding of its basic performance capabilities. ***Figure 2*** shows the categories of exclusive guideway mass transportation processes.

At the bottom right is the fifth process: a synchronous process operating with off-line stations and given the name SyncTrans as an acronym for synchronous transportation. Among all the processes, the SyncTrans process has the distinction of having to be discovered. Operations of the other processes were considered intuitive, but in this case, one had to figure out how to make it work. This discovery resulted in the award of an uncommon all-method-claims patent that, according to the U.S. Patent Office, was the only patent of that type ever awarded in the field of urban mass transportation (***Figure 3***).

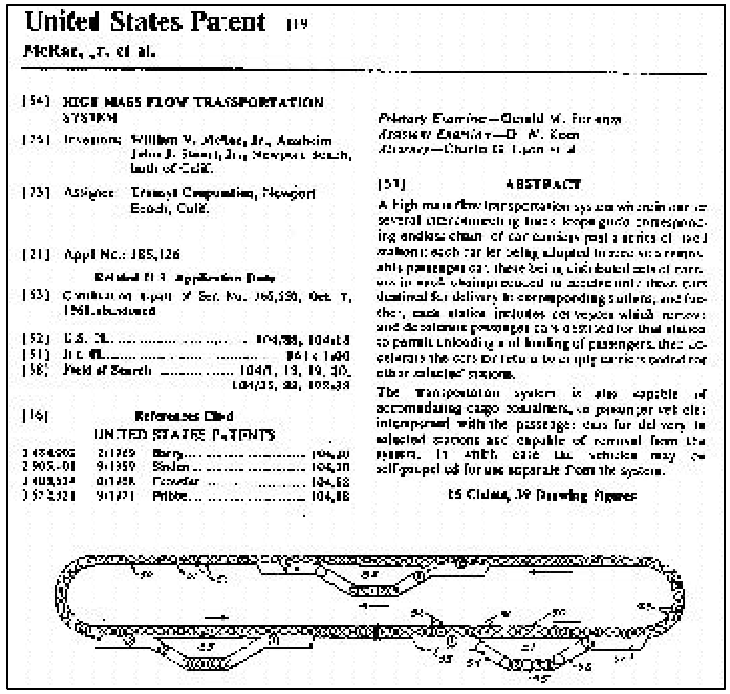
The SyncTrans process is a continuous process utilizing off-line stations. The synchronous operations allow the insertion of small vehicles into a *predetermined* position on the main line in a sequence that results in a repetitive cycle of nonstop, origin-to-destination opportunities for boarding passengers at every station in a system network.

	VEHICLE OPERATIONS CONTROL ON GUIDEWAY		
	ASYNCHRONOUS OPERATIONS Independent Control on a Dedicated Line	QUASI-SYNCHRONOUS OPERATIONS Time Separation via "Headway" Control	FULLY SYNCHRONOUS OPERATIONS Physical Separation with Space Control
STATIONS ON-LINE Station-to-station operations. Passenger can enter or exit at any station.	**SHUTTLE PROCESS** (Any horizontal "elevator" type)	**TRAIN-TYPE PROCESS** (NYC's subway, Atlanta's MARTA)	**CONTINUOUS PROCESS** (Goodyear "Carveyor")
STATIONS OFF-LINE Passenger travels non-stop from origin to destination station.	(Non-sensical)	**PRT PROCESS** (University of West Virginia in Morgantown, WV)	**SyncTrans**

Figure 2. System Processes

Vehicles

A full scale mock-up of a possible SyncTrans vehicle is depicted in ***Figure 4***. Built to ensure room for large passengers (97 percent male in particular), the vehicle's seats have armrests with rocker switches for overhead reading lights. Each compartment is heated and air-conditioned. Other features include overhead compartments and space for hanging bags. Appropriate and desired electronics will also be incorporated into each vehicle. If there is a need for increased passenger capacity, such features could be removed.



United States Patent [19]

McRae, Jr. et al.

[54] HIGH MASS FLOW TRANSPORTATION SYSTEM

[73] Assignee: Transyt Corporation, Newport Beach, Calif.

[21] Appl. No.: 185,126

[56] References Cited

UNITED STATES PATENTS

[57] ABSTRACT

[illegible]

15 Claims, 39 Drawing Figures

Figure 3

Stations

Figure 5 illustrates the in-station experience of a boarding passenger. Upon entering a SyncTrans station, a patron sees a line of vehicles moving slowly (two feet per second or less than 1.5 miles per hour) and quietly through the station. Each vehicle's destination is shown on an electronic display screen above the doors. The station platform, meanwhile, moves at the same speed as the vehicles. Since the station is by design the destination of the incoming vehicles, passengers will be exiting the vehicles as they enter the station. The boarding passenger steps onto the platform and enters the empty vehicle that will transport him or her to the destination desired. Toward the end of the boarding area, a voice will announce that the vehicle doors are about to close. If unobstructed, the doors will close and the vehicle will accelerate and join the main line. In the event of an obstructed door, the vehicle will continue to the end of the platform where the vehicle will come to a stop offline so that it does not interrupt service on the network.

A more comprehensive overview of station operations is provided by ***Figure 6***. The single lines with arrows represent the paths and directions of travel the vehicles would follow.[5]

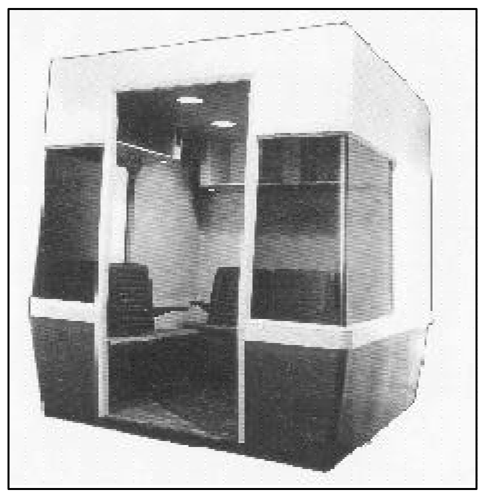
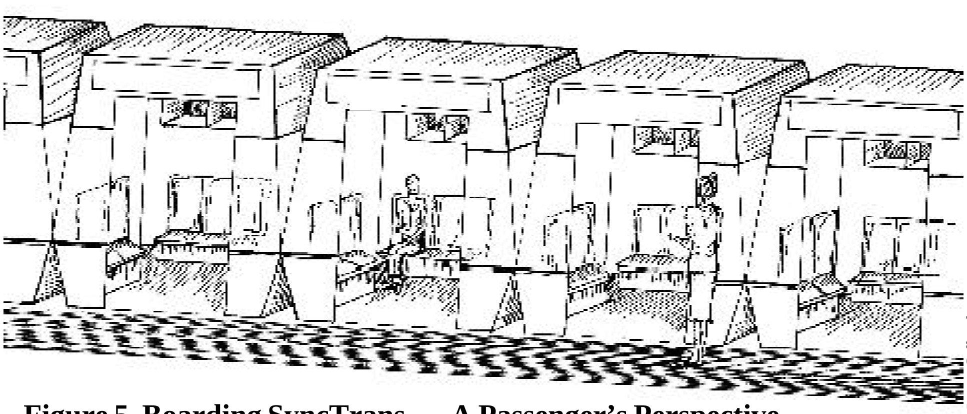


Figure 4



Laura Culbreth

Figure 5. Boarding SyncTrans . . . A Passenger's Perspective

1	Passenger Loading/Unloading Platform	9	Loading Abort Platform Extension
2	Elderly/Handicapped Stationary Boarding	10	Path of Exiting Vehicle (Right)
3	Elevators	11	Path of Incoming Vehicle (From Right)
4	Emergency Vehicle Landing Area	12	Path of Incoming Vehicle (From Left)
5	Paths of Exiting Vehicles (Left)	13	Main Line Guideways (Pass Underneath)
6	Active Buffer Paths	14	Stairs
7	Escalators	15	Up to Storage
8	Restrooms	16	Down from Storage

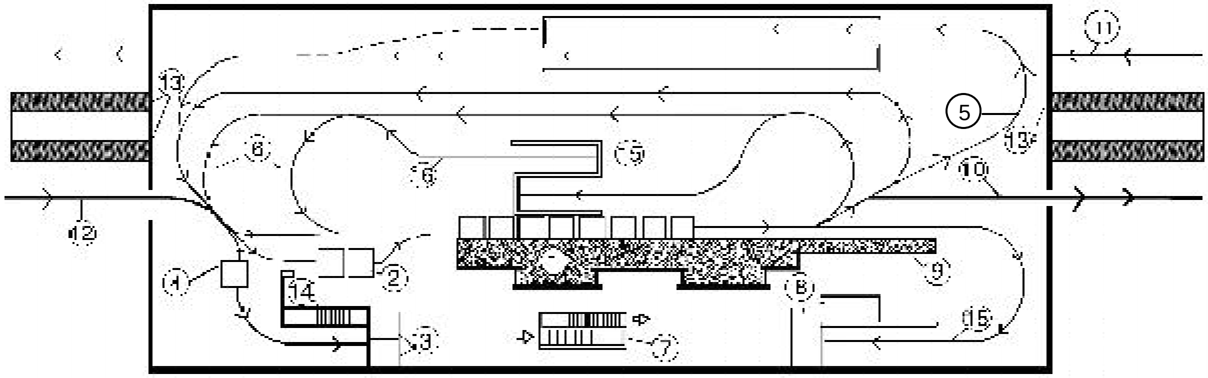
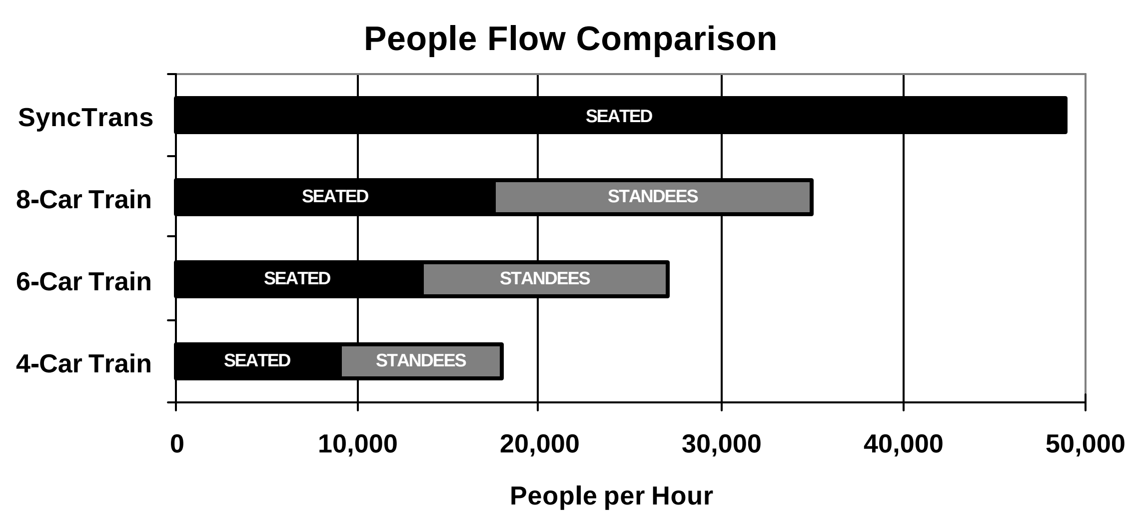


Figure 6. SyncTrans Bidirectional Station

Performance

One of the great advantages of a non-stop origin-to-destination system, as opposed to traditional trains, is that high-speed operations between stations are not needed to achieve a good *average* speed. If the main line speed of a SyncTrans system is say, 45 miles per hour, then each passenger's trip will nearly average that speed since there are no stops in between.

People-flow comparisons versus trains are more difficult. System networks for urban trains are typically relegated to corridors, whereas routing for SyncTrans is not constrained. (Picture a spider web of lines throughout a city, rather than the necessarily linear routing of train lines.) As mentioned earlier, the MARTA train system that serves metro Atlanta operates over two corridors, one north-south, the other east-west, crossing near the center of the city. Obviously transfers are required if one wishes to change direction.



Each 10,000 people per hour is equivalent to four lanes of freeway traffic. Train calculations based on 75 seats per car operating on a two-minute headway. SyncTrans calculations based upon no standees, a mainline speed of only 45 miles per hour, and using only 25 percent of total seating capacity.

Figure 7

The full complement of entrained cars travels to each station up and down the line. At the end station on each line, the trains start out empty, with passengers boarding first at the end station, then at each station along the line as they head to the downtown area.[6]

Figure 7 shows a comparison of the capacities of SyncTrans versus a traditional urban train. Note that the capacity of a SyncTrans system (with only a quarter of possible seats filled) is nearly equal to more than 16 freeway lanes. This does not include the additional capacity of standees, however, the SyncTrans process is designed to offer superior performance without the crowding of traditional urban trains.

Passenger Appeal

So far, the discussions have centered on the performance requirements of an urban mass transit system in terms of people flows and average trip times. The concept of *high people flow* has no meaning to the typical passenger except to suggest crowding in the station while waiting for a train, or crush loads while riding during the rush hours. Therefore, if some form of mass transit is going to entice enough people out of their private vehicles, it must respond to their "desirements" other than just trip times. The SyncTrans process holds the potential of unparalleled passenger-oriented performance in this regard. A listing of these capabilities includes:

- ***More accessible stations*** . . . at origins and destinations
- ***Continuous boarding*** . . . no crowded platforms
- ***Equitable service*** . . . first-come-first-served at every station
- ***A seat*** . . . ride and relax . . . listen to music, read, work on your laptop
- ***Non-stop, origin-to-destination travel*** . . . no transfers
- ***Very good average trip times*** . . . no need for high speeds between stations
- ***Schedule adherence*** . . . trip times never vary
- ***Excellent personal security*** . . . off-peak hour "Close Door" button, with emergency backups (see below)
- ***Quiet service*** . . . lightweight vehicles, elevated guideways, no rumbling train noise
- ***Frequent service*** . . . short in-station wait time (approximately two minutes) to any destination, 24 hours a day
- ***Enclosed stations*** . . . smaller . . . clean and quiet

Security

Personal security is a universal concern. SyncTrans service is frequent — average waits are anticipated to be approximately two minutes anytime day or night. Since all the passengers entering the station will be exiting the cars, every car will be empty for boarding. During off-peak hours, a passenger can enter an empty car and close the doors to ensure privacy. If a car is boarded by another patron, the passenger can decide to wait for the next car. If an emergency occurs en route, a panic button in the car will give the passenger access to a voice-activated connection to the central station. The vehicle can then be switched off at the first station with medical, fire and/or police facilities. Criminals, therefore, would have a very high probability of being caught — an effective deterrent. Additionally, since the boarding area of a SyncTrans station is comparatively small and vehicle operations are non-stop from origin to destination, station surveillance cameras would be able to record all activity for future reference.

Community Appeal

Ideally, an urban mass transit system should satisfy both users and non-users in a community. Indeed, the hope of increased routing flexibility and superb passenger appeal greatly enhances the potential of use. Small, family-sized vehicles running at modest speeds on elevated guideways should not add appreciably – if at all – to the background noise of a community. In addition, because the cars do not exit the stations unless occupied there are no empty trains constantly running up and down the line at night. Since the guideway system would be powered by electricity, the overall level of air pollution would be reduced.

Costs

It is anticipated that capital costs will be lower than existing mass transit train systems, but specific costs cannot be developed until a phased procurement study (discussed later) is undertaken. Lighter-weight vehicles and nominal operating speeds should result in the economic use of modular, lightweight, elevated structures that could be installed in most median strips of multilane highways and freeways. Guideway installation could be likened somewhat to tinker toy assembly, erected rapidly and possibly at night. The use of off-line stations could negate the need for tunneling, especially in downtown areas. And the smaller stations, where the vehicles enter and exit at only two feet per second, would be very quiet and could be integrated into new buildings or high-rise structures. Finally, economy-of-scale costs will apply to vehicle production and most likely to the guideway structures.

As to operating costs, SyncTrans is a capital-intensive system and will have minimal personnel requirements. The vehicles have no drivers and fare collection will be automated. Maintenance and repair crews will be needed, as well as a small staff to oversee system operations.

Routing Flexibility

Two example SyncTrans networks shown in ***Figure 8*** demonstrate the routing versatility available with this process. In both cases, recall that passengers travel non-stop from an origin station to their destination station. In each example, the number and location of stations is variable as are the shapes and sizes/ lengths of the circles and radials. Once a SyncTrans network has been specified in terms of numbers of stations, boarding platform speed, car dimensions, main line speed and car spacing, then maximum seat flows can then be calculated throughout the network. (The term “seat flow” is used to account for the fact that every seat may not contain a passenger.)

The concentric circle routing shown is also more flexible than urban train routing, which is often constrained to providing service in corridors converging upon a central business district. In the radial example below, calculations would result in a maximum flow of 30,319 seats per hour entering the CBD loop from each radial for a 60 m.p.h. system. If one were to assume an occupancy factor of 20 percent during the rush hours, then the mass flow into the CBD area would be 6,064 seated passengers per hour, or the equivalent of more than 2.4 freeway lanes of traffic per radial. (By changing the number of stations and/or certain other system design factors, there is the capability to easily triple these numbers within the same network routing if higher passenger flows are desired – see “Additional Capabilities.”) For some metropolitan areas, the concentric circle configuration would represent a highly desirable network and is shown to illustrate the routing flexibility of the SyncTrans process.

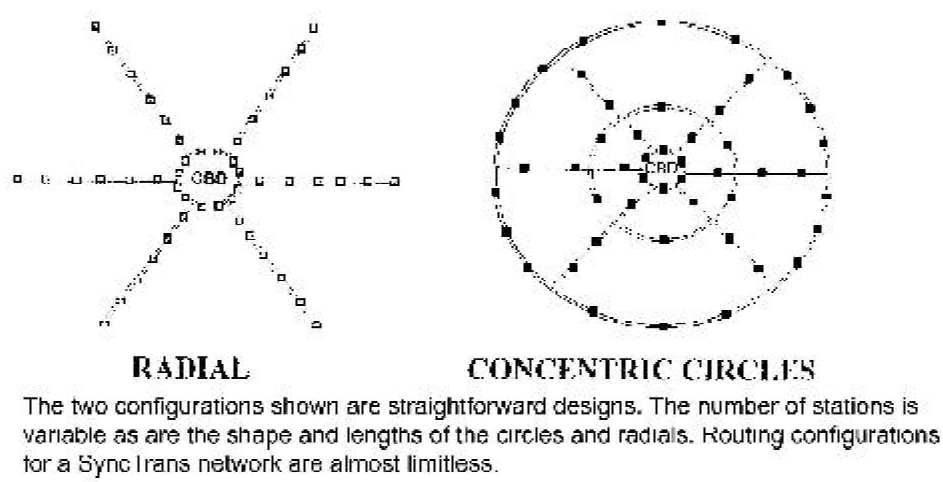


Figure 8. Example SyncTrans Routing Configurations.

Another example of SyncTrans routing that is quite different from the above is shown in ***Figure 9*** for the North Carolina Raleigh-Durham-Chapel Hill Metropolitan Statistical Area (MSA). The objective of this example was assumed to be twofold: First, to alleviate the extremely heavy and ever-growing traffic congestion on the Interstate corridor (I-40) between the state capital, Raleigh, and the Research Triangle Park (RTP); second, to provide an area distribution capability throughout the MSA that included services to the Raleigh Durham International Airport (RDU), the bedroom community of Cary and to and between Durham and Chapel Hill.

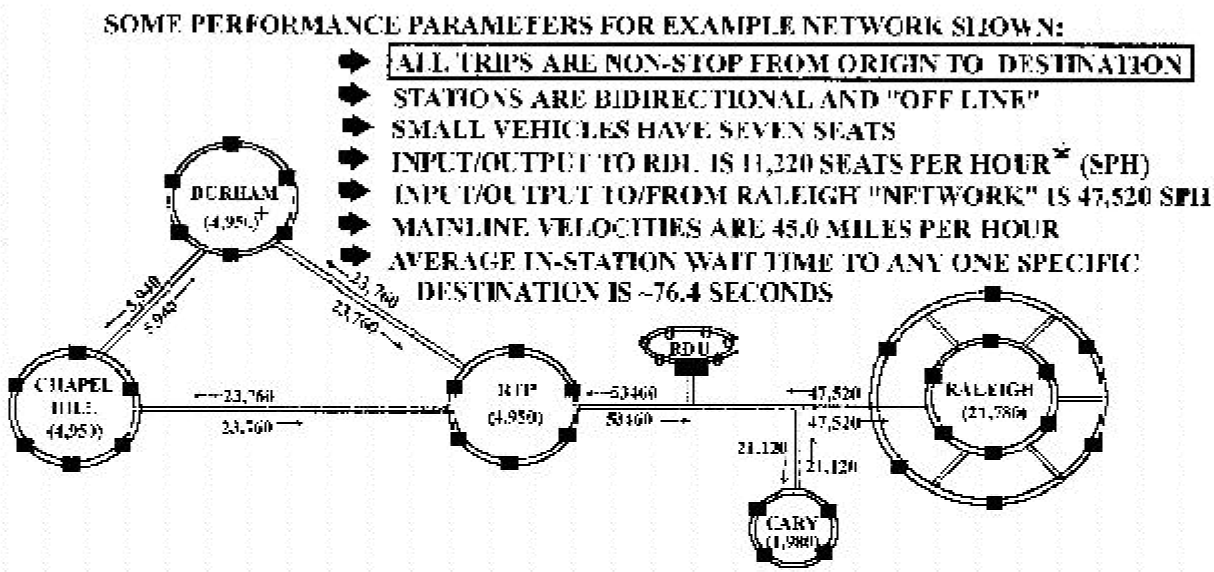


Figure 9. A Representative 36-Station Area Distribution Network

Seat flows, main line speed and average in-station wait times are noted on the figure. The major objective of traffic alleviation on the I-40 corridor between Raleigh and the RTP is well served, providing available flows in the 50,000-seat realm in each direction. If it is assumed that only 20 percent of the seats are filled during the rush hours, that is the equivalent of accommodating the equivalent of almost four freeway lanes of traffic while still providing unprecedented service throughout the entire network. Of special note: There are two stations at the airport. When the SyncTrans cars arrive, they are routed around to the different airport terminals in the station-to-station process (Process No. 3). This capability does not interfere with any other operations and can be added anywhere in a network, such as an airport (as shown), a stadium, a regional mall, a university, etc. These examples show the adaptive versatility of SyncTrans routing while providing excellent people flows.

Additional Capabilities

Throughout this discussion, only half of the capability of the SyncTrans process has been considered. In the patent, one of the method claims describes what can be termed as a mirror image of the basic process. That is, the other half of SyncTrans could be used to double capacity employing the same guideway. This extra capacity could be used to support the transport of freight or to provide additional service between heavily used nodes in the network. A more innovative future use of the extra capacity would be to carry personal dual mode vehicles. Many people need some form of transportation at work or may not wish to walk during inclement weather. In these situations, a small commuter vehicle would provide a solution that could make the use of mass transit more feasible for those who need greater mobility during the day. Although these types of vehicles primarily exist as prototypes today, developing technology could make them more prevalent in the future.

Development

It is important that any new system undergo a rigorous feasibility and cost analysis. The evolution of many systems concepts has taken the path employed by NASA and the Department of Defense called Phased Procurement. The Apollo lunar program and the development of the B-2 bomber followed the procedures outlined in this methodology. A simplified diagram of the steps involved is shown in ***Figure 10***. Although some are confident of the feasibility of the SyncTrans concept, skipping this important step would be unwise and irresponsible.

Basically, the phases represent a logical progression of decision-making steps, beginning with establishing the feasibility of a concept and progressing on until hardware is developed, tested and proven in

PAPER PRODUCTION…THE "HOMEWORK"			HARDWARE DEVELOPMENT
PRE-PHASE A	PHASE A	PHASE B	PHASE C/D
Concept Feasibility System Applicability	Concept Selection Technology Choices	System and Subsystem Design Specifications	Component Hardware Development and Demonstration Program

Figure 10. Phased Procurement

a demonstration program. The reason for taking this approach is because of the high costs associated with the development of hardware for any sophisticated system. Typically every new system starts with an idea. The Pre-Phase A effort is to conduct a study to evaluate the merits of that idea; to determine if it is feasible, applicable, and within the realm of realistic costs; and to search out any "show-stoppers" that would make further study fruitless.

Sometimes in Pre-Phase A studies, no show stoppers are found, but the results are not sufficient to justify continuing to Phase A. In such instances, the Pre-Phase A study can be repeated. This makes economic sense since the costs of the study escalate by at least an order of magnitude in progressing from one phase to the next. The Phase A effort also is a study, but in far greater depth and detail. Ultimately, after many configurations are evaluated and hardware trades are conducted, a concept is finalized and the major hardware elements of the system are chosen.

An example Pre-Phase A study schedule with task subjects is shown in **Figure 11**. Support from universities, research institutions and the state and local DOTs would be very helpful since it is assumed that federal agencies would not become directly involved until after completion of the Pre-Phase A study.

As noted earlier, the original charter of the DOT/UMTA (now the DOT/FTA) allowed for the full 100 percent funding for the demonstration of new, capital-intensive urban mass transportation systems given congressional approval, as was done for the PRT demonstration at West Virginia University. The first step on the path to acquiring that approval will be to present the results of a successful Pre-Phase A study to the appropriate Congressional Transportation Subcommittee, and to the DOT/FTA. Congressional approval will take time and during that time, the Phase A and Phase B studies will be conducted. It is anticipated that the funding for these follow-on efforts will be primarily through grants from the DOT/FTA.

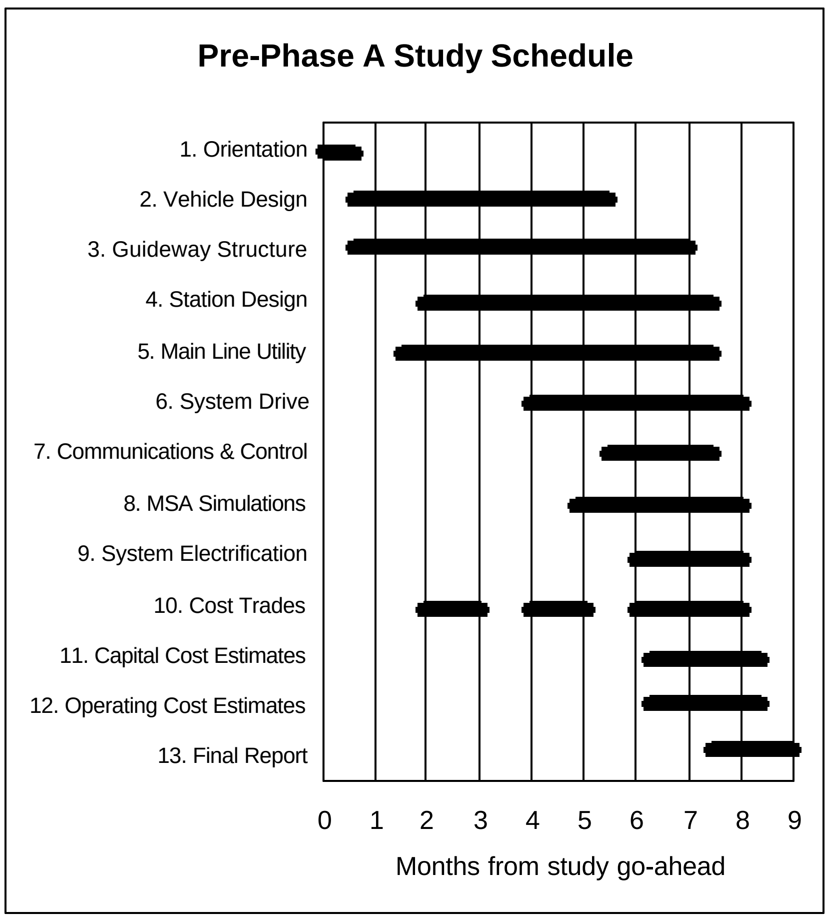


Figure 11

Conclusion

Mass transit systems employing the SyncTrans process offer a number of unique features anticipated to be highly attractive to consumers. These passenger "desirements" are a critical prerequisite to enticing many people from using their private vehicles, and are simply not afforded by train-type systems.

By offering passengers non-stop, origin-to-destination direct travel to all stations, SyncTrans systems will offer unmatched convenience for most riders. The unusually flexible routing capabilities of systems employing the SyncTrans process will allow riders to travel much shorter distances to stations, possibly avoiding cross-town traffic gridlock. It is hoped and anticipated that such convenience will result in much higher ridership than the mass transit systems currently in place.

People traveling on a SyncTrans system will be able to ride in family-sized vehicles and will have the luxury of uninterrupted, safe travel without the repeated stops and starts at stations accompanied by the flow (and, possibly, crush) of entering and exiting patrons. Since travel is non-stop, the SyncTrans rider will know before departing a station with whom they are riding. SyncTrans riders will also have the ability during off-peak hours to close the vehicle doors after entering, ensuring privacy and safety. Additionally, SyncTrans vehicles will contain electronics that will enable passengers to reroute vehicles directly to facilities containing medical or police facilities in an emergency.

Simulations based on realistic design criteria have shown the potential of offering performance capabilities equal to or better than urban trains, e.g., greater people flows and higher average trip speeds. The community of both users and non-users will find a quiet, non-polluting, visually pleasing and highly integrateable system for their urban areas.

The SyncTrans system has the capability of dramatically improving the benefits offered by mass transit. It also provides the opportunity for the United States to become the leader in the international market for urban mass transportation systems. Given these opportunities, a feasibility study should immediately be conducted to test the validity of these arguments.

About the Author

William V. "Mac" McRae has forty-plus years experience in the engineering field with Rockwell International, Gerber Scientific Instrument Company and Transyt Corporation. His responsibilities included management and supervision, operations analysis and advanced systems engineering. His projects include the design, simulation, analysis and evaluation of military systems (aircraft, missiles, countermeasures, conventional and nuclear weapons), space systems (manned, unmanned, earth and space propulsion, lunar and planetary), and civil systems (mass transportation; urban area distribution, point circulation and intercity).

[1] Shown on the chart is a reasonable overload number (100 percent) for standees. A maximum number of standees in a car might increase the occupancy of that car by a factor approaching four, but the ebb and flow of demand over an hour's time and the variation in per car loading in a train will more nearly average the doubling of capacity as indicated. However, forcing people to stand is hardly an inducement to get them out of their private vehicles.

[2] During off-peak hours, average speeds may increase slightly since station wait time is less because of fewer passengers.

[3] Although rare, there have been a number of instances where a person is inadvertently knocked into the open pit in front of the station platform. Numerous movies have depicted the hazards encountered there, e.g., being run over, or touching the "third rail."

[4] The operations of a vehicle or a group of connected vehicles operating on a dedicated line, with no other vehicles sharing the line, would represent an *asynchronous process*. An elevator is an analog inasmuch as the car operates independently of time or spatial constraints. Studies have been conducted to determine if "horizontal elevators" would serve the public in some manner. Except for very specific and limited applications where people flow is not an objective, such systems have no application to urban mass transportation.

[5] It can be anticipated in a reasonable network of SyncTrans stations that over a thousand origin-destination pairs will be served, but not every pair will be served all the time and only occasionally all at the same time. Since there is no need to put empty vehicles out on the main line, yet always present a full array of vehicle destinations available for boarding, a vehicle buffer is incorporated in the station. The purpose of the buffer is twofold: First, to temporarily store the unneeded vehicles, especially in off-peak hours, and, second, to fill in voids of incoming empty spaces with vehicles.

[6] The calculation of an urban train's operational maximum mainline people flow was described earlier with the assumption that as the train progressed, boarding at each station would eventually fill all the seats and add an equivalent number of standees. The calculation of SyncTrans people flows requires a count of the number of cars that can leave a station (an exact number) in a specified unit of time. This number is multiplied by the number of seats in a car, then times the number of stations "feeding" a specific area (by examination of the routing). The resulting number will be very large when compared to trains, but only because every seat in every car for all destinations is counted as if filled. That will not represent reality; therefore, a reasoned assumption must be made as to the expected occupancy. Since the major objective is to alleviate traffic, it is imperative that the design of the SyncTrans network reflects this objective in both the selection of routing paths and in the predicted people flows. Example networks will demonstrate these capabilities.