ABSTRACT

An emerging automated transit system, PRT can provide exactly the solution that has been sought to create fully walkable sustainable communities. This advanced technology allows for the full integration of walk-ability and the mix of other low tech solutions such as the bicycle. PRT (personal rapid transit) is currently either being implemented – such as at Heathrow airport or in the planning stages linking airport and surrounding transit village concepts such as at Sam Mineta airport in San Jose, California. PRT not only brings a greater level of service to the user due to its point to point movement pattern, but smaller driverless automated vehicles can provide linkages to sustainable energy sources and provide smaller more frequent stations for a fully compact walkable community. This paper shows how this critical balance between machine movement patterns, the built environment and the pedestrian can occur can occur with the application of PRT.

FULL PAPER

A 1970’s vision of modern transit technology is currently becoming reality around the world due to advances in computer technology. PRT (Personal Rapid Transit) now sometimes called ATN (Automated Transit Network) is currently available at Heathrow airport with systems in various planning stages in Suncheon City, South Korea; San Jose, CA -Sam Mineta Airport and Mazdar City, Abu Dhabi, United Arab Emirates - and studies for multiple other locations. PRT provides the opportunity to create walkable transit friendly environments by allowing more compact and interconnected ways to move through space due to its small size and new transit moment paradigm – point to point – providing service similar to a cab. This technology has the ability to move more people faster to their destination – even more time-efficiently than a car and more time-efficient than the standard transit loop or line systems; therefore they can encourage and hopefully increase transit use.

This technology offers another important design feature – its ability to interface three-dimensionally both inside and outside of buildings. This capability allows for many right-of-way issues to be approached in various ways especially in existing urban fabrics by providing choices both on the ground and with air-rights. PRT can link multiple transit and automobile systems and connect with sustainable energy sources changing transportation’s relationship with urban design and architecture. New integrated solutions that address multiple overlapping issues such as energy sources, the environment and persons of disability can now be easily addressed due to its small size and relative scale. PRT provides a lower cost and better energy use as documented for the modern Heathrow system. (FIGURE 1)

There are many benefits for the application of PRT in our built world such as more affordable land use patterns, cost effective transit, ability to connect all current forms of movement, ability to be constructed in existing and historical environments, simultaneously used as a freight application and cost-effective interconnected station design.
Integrating a new way to move through space is a more sustainable solution that allows for stations within easy walking distance encouraging walking. Initially these systems are being implemented in two areas – local existing environments such as airports and entirely new cities, however multiple studies are underway around the world for implementation into existing cities and towns. This paper will examine the potential linkages for the Southern Polytechnic Campus of 2050 using PRT to create a more fully accessible walkable sustainable campus design.

![Figure 1: Chart showing energy usage and cost comparisons. ULTra: PRT Sustainable Transport Source: Martin Lowsen of ULTra](image)

PRT was first implemented in the United States at Morgantown, West Virginia at West Virginia University using a 25 people capacity (now known as group rapid transit) point-to-point driverless vehicles (a system where you go directly from your point of origin to your final destination – no stops in between) called PRT, although not in full original vision. The dedicated elevated track system is still functioning today providing unique transportation choices for the university and the town and is in the process of studying expansion. Although at the time due to its groundbreaking nature the system was developed with extensive cost overruns slowing the further development of this paradigm changing movement technology.

The modern PRT systems, based on the original concept provides an on demand, point to point service; a small transit vehicle (optimal number is around 4 people) offers many positive benefits along with greater capabilities to move more people more time efficiently. The off-line station concept that is crucial to the efficient functioning of the on demand, point-to-point system presents unique opportunities for station design. The system also allows for expansion of use as needed with only the cost of additional vehicles. The original vehicles upfront costs could be limited to a small fleet; expansion as appropriate.

This newly emerging movement system will allow easier access for all ages as station design can now be integrated within buildings at multiple levels. Navigating steep topography and dealing with poor weather as well as connecting multiple other forms of transit to create a seamless system will allow faster and smoother access for all. Linking spaces and places in entirely new ways, the architects’ unique spatial training will become essential in allowing this new technology to be implemented to
its full potential.

There is a direct relationship in the ability to move around our built environment in a timely, accessible, and sustainable way and to the success of that living environment. Providing choices and options for each user can create the greatest success in achieving this goal. Finding long term sustainable energy, environmental, planning and financial solutions that can work for all and across our diverse country is difficult especially if depending on one form of movement – the car. Relying on the private car fueled by gasoline also poses the issues of parking and roads that spread out the distances between buildings in villages, towns and cities. Adding transit brings more cost into the equation while frequently extending travel times due to the combination of travel time of car and transit - discouraging transit use. Walking only is a good option if the center is designed within distances that the user will accept and that also link to multiple flexible transit options, however weather, carrying items, persons of disability and aging population concerns can make this approach not feasible for all. Concurrently addressing the full environmental impact adds even more challenges to finding appropriate solutions. Not incidentally the amount of land consumed for parking cars can be at least 54% of the total land area coverage in a typical commercial development as documented in a study by the public works department for the City of Olympia, WA. Parking for business and housing as well as for multiple other daily needs adds to the complexity for solving full accessibility movement issues. Add into the mix the need for delivery and freight in a timely way so that business can prosper and the complexity is overwhelming and the sustainable solutions hard to find. Many focus their research on one or two aspects; however this is starting to change as it is in the combination of the issues where better solutions can be found. The architect is trained to balance and resolve the multiple complex issues typically also “customizing” for the specific site, owner and location with training in synthesizing this spatial complexity. However, the architect is frequently consulted for the purpose of designing the station or to focus on what the built environment “looks like”. While aesthetics is one key concern to an architect, how that is obtained is by finding solutions that balance all of the design needs.

Creating walkable transit friendly environments requires more compact and interconnected ways to connect the movement systems that we have for new design and movement through space and place.

Image 1: Japanese Bicycle Commuters
Modes of Transportation

The “standard” modes of transportation choices are: walking, bicycle, motorcycle, car, plane and multiple forms of transit. Walking offers some solutions within certain distances however, will not address the full range of human needs. Bicycling extends this distance and is used in Japan as part of the commuters experience from home to parking/transportation centers. (IMAGE 1)

Motorcycle extends this distance even further. The car can now come in various sizes such as the electric cart all the way to the largest delivery vehicle with various ranges in-between, while transit can involve a bus or trolley to heavy and light rail. Depending upon each situation all forms of transportation can be found to serve different movement distances and needs. Movement needs are complex and interconnected and PRT can allow for these connections and interconnections to occur. (FIGURE 2)


SOUTHERN POLYTECHNIC CAMPUS ANALYSIS 2009

The architecture students at Southern Polytechnic State University were excited about the idea of designing the SPSU campus of 2050 implementing new ways to move around an expanded campus. They proposed how the University could expand in academics and student enrollment, proposing new courses of study and a physically enlarged campus, while contemplating how education might be delivered. They were given one requirement: to integrate newly emerging movement technologies into the campus plan. They began by analyzing the history, evolution and existing campus conditions.

University History

As part of the design process it is important to understand the history of the site and area -- as the past always holds seeds for the future. As SPSU was founded as a technical institute and continues today to emphasize technology education this
University appeared the appropriate place to embrace and utilize PRT. Upon further research the University also has historic and current research with movement technologies such as automobiles, submarines, and aircraft. Currently research with electric vehicles, Formula One cars, and submarines provided the core for embracing a 2050 vision. Solar power and nuclear plant technology are the core energy research areas for the campus. The University also historically had an unusual activity – the bathtub races, where bathtubs were converted into vehicles and then raced on the campus ring road. A great campus to think about new movement technologies! A very brief history:

1948 - SPSU was founded as the Technical Institute
1958 - SPSU became the Southern Technical Institute
1961 - Hoyt McClure/Acting Director led to the movement of building 8 buildings on 120 acres of land.
2009 - Southern Polytechnic State University expanded and now encompasses more than 230 acres and 35 buildings.

**SPSU Figure/Ground**

The campus is a “typical” ring road campus with the original buildings constructed with the typography in mind. The first buildings were nestled into the hillside and oriented for passive heating and cooling - a very progressive environmental approach at the time. Over the years new development has expanded the ring round outward to, however the new buildings have not been oriented with either the topography or environment as part of the design strategy.

The campus is located with direct highway access to downtown Atlanta and Chattanooga TN. The students were also very interested in the connectivity between their campus and these locations as well as to both Georgia Tech and Georgia State in downtown Atlanta and The University of Georgia in Athens, GA. *(IMAGE 2)*

**IMAGE 2:** Topo map of Campus and surrounding area and figure ground with sidewalks and roads
University Planning and Goals
This is a commuter campus although on-campus housing is expanding as more
traditional students are attending. The campus also provides training and continuing
education programs mainly at night. Multiple types of parking therefore is required as
part of the mix for the suburban Marietta, GA campus of Southern Polytechnic State
University. The campus recently constructed its first parking structure – a typical
stand alone structure. The majority of the small lots close to existing buildings
remain (the historic pattern); however the plan moving forward is to construct more
parking facilities on the ring road.

One student documented the congested area of traffic and they were located at
the entry points to the campus- not where any parking structures have been built or
are planned. This actually decreases the walkability due to the topography and the
needs of the users and no attempt was made to address handicap accessibility within
these plans. This is a common development strategy for many Universities to place
parking on the periphery, however often implemented without any overall planning
looking at all the pedestrian and vehicular movement patterns and structure of the
campus. (FIGURE 3)

FIGURE 3: Southern Polytechnic State University student, Katie McCulloch
analyzing vehicular traffic and projected parking.

The University has joined the American College and University Presidents
Climate Commitment to sustainability and implementing PRT would be one way to
address these goals. One student documented all of the natural existing conditions,
sunlight, orientation, weather among others so that the original approach to
sustainability could be understood and new buildings could address these concerns.
Other students documented the potential student growth of the campus and every
student suggested new areas of study that would fit with a technology campus.

Walking and Inter-Site Movement
The campus is however quite walkable for the mobile, except if you are
carrying many items, walking late at night or dealing with bad weather. The students
documented these times as well as the areas of campus that received the most foot
traffic. The students also documented the vegetation and walking paths. The new
bus circulator was also tracked for the arrival and destination times to compare this to
walking. (FIGURES 4 and 5)

The one-way loop system at SPSU was rarely used due to the time required to
go from one point to the next on the bus shuttle was in almost all cases excessive in
comparison to the walking time through other campus paths. This is not an unknown condition for other existing one way loop transit system and travel times; as adding a shuttle is the first response when enough parking is available but not within walking distance to destinations without any analysis of the actual usefulness of such a system. While the intent was appropriate - the integration with the existing environment with movement patterns was not explored. Creating small strategically placed multi-modal parking facilities can assist in linking sustainable power sources for multiple efficient uses of building and machine. These new technologies are the perfect systems to begin to connect all of the possibilities to create more sustainable power and energy sources due to its new paradigm of smaller vehicles. The weather, topography of the land (hilly versus flat) also contributes to a successful design strategy if a fully accessible environment is to be created.

![FIGURE 4: Southern Polytechnic State University student, Katie McCulloch analyzing existing pedestrian density and pedestrian traffic areas.](image)

**FIGURE 4:** Southern Polytechnic State University student, Katie McCulloch analyzing existing pedestrian density and pedestrian traffic areas.

**FIGURE 5:** Southern Polytechnic State University student, Kira Melville analyzing walking and shuttle times.

**Handicap Accessibility**

One student thoroughly studied accessibility on campus; mapping and photographing the entire campus. This campus is basically not accessible and has many needs in meeting this goal. If PRT were to be implemented all of the issues related to solving this complex problem could be addressed. (**FIGURE 6**)

Accessibility is about more than providing for the persons of disability and meeting a set of safety rules; it is about providing mobility for all of us over our lifetime – Universal Design. As at some point in our lives all of us will face challenges in order to be mobile. Transportations’ future will be dependent on the ability to provide access for everyone at every stage or point in their lives, especially as our population ages. This comprehensive view of transportation accessibility requires a broad vision for how many different systems can work together in combination with our existing built world to meet this goal, as one specific system can never meet all of our needs. The United States due to its size, breadth and
complexity of living environments from urban to rural and everything in between demands that we embrace and support a comprehensive network that interconnects all of us within our living places, from our starting point to our destination -- for every stage in our lives. Interweaving architectural solutions with transportation technological advances can address the full meaning of accessibility even for people that do not physically require it but their existing living environments do – such as traffic congested edge cities. Building upon the existing transportation systems that are now evolving to meet today’s sustainable challenges and the varied architectural environments that currently exist; if we embrace emerging viable technological solutions that are called “people movers”, then we can learn the meaning of bold ideas to meet big challenges -- total accessibility for all.

Movement technologies that we can directly access from within a building can provide a safe and accessible way for certain travelers such as the elderly and children to reach their destination safely. A true interweaving of man and machine will provide better access and flexibility while creating wonderful new spaces for nature and man to exist at multiple levels and in surprising ways. Providing these options in conjunction with walkable environments can be created optimizing our living solutions.

Downtown Minneapolis is an excellent example of how multi-levels are used for greater pedestrian access to the city. The “second” level of the city interconnected by the skywalk system is directly links parking facilities and the urban fabric of the city. The parking facilities are spaced appropriately for easily access from outside multiple points. Pedestrians can easily, quickly and safely move around the city as there are no traffic and road issues to interact with. A new way of connecting between places, is also created as a more “natural or flexible way to connect is achievable.

A more “natural” approach to pedestrian movement can be established while providing a safe interaction with machines. A more “natural” approach to movement can be described as a networked system. (Figure 7) This networked system opens up new locations for retail, parks and people places that were previously not available within the grid or spoke and wheel organizational patterns for such use. If the
networked system allows and encourages multiple spatial overlaps between levels even more possibilities and linkages are created.

**FIGURE 7:** Montana State University student, Matthew Killham abstract visualization of new ways to provide linkages.

**SOUTHERN POLYTECHNIC CAMPUS DESIGN 2050**

When working within the existing campus the current infrastructure of the road systems may handle a PRT type transit but typically would not allow the full development of its potential as a networked system. However, by starting with the existing road infrastructure, a base for the new PRT transit system can be established. PRT can function on the road based system reducing upfront costs, provide less congestion by eliminating individual drivers, and provide easy access to existing connection points while allowing for multiple destination points. This will provide for the user reduced travel time and therefore encourage transit use. Also due to the size of the vehicle and its on-demand capabilities, it can also reduce overall fleet size or at minimum allow for better management based upon demand.

Retrofitting the existing parking facility with charging stations can provide another energy source for these new technologies. Off-line vehicles can be charging as other vehicles are in use. This is the way that early electric car fleets operated. So integrating a small fleet of vehicles can provide the more cost-effective option for transit applications. Each student took different approaches to how all of these issues were combined. Here are just a few visual examples of solutions. Each student's unique solution could be developed into a full paper of its own, but the underlying consensus was that these small flexible new movement technologies can allow a new way to move around campus that complements walking, can resolve issues for persons with disabilities, provide a way for freight or delivery to occur on campus and provide options when needed for all of us. Sustainability occurs on many levels in transportation. Energy, time-efficiency, air-quality, land conservation, cost-effectiveness, and reduction of single occupancy vehicle use are the key points to take into consideration in defining transportation sustainability. Therefore it was viewed as a complementary system that would encourage walking. **(FIGURE 8)**

**Final Analysis Review**

Each architecture students’ specific analysis resulted in individual full power point presentations concerning each individual area of study showing in full detail the results of their work – all of this cannot be presented in this paper. The important factor is the physical integration of all of the daily life needs for a
student, employee or visitor so that walkability and accessibility for all can go hand and hand is currently not available. Parking facilities have been designed successfully linking with mixed use such as at the University of Pennsylvania, Philadelphia, 2002, were a parking facility/grocery store provides for the multiple needs of walkers, bike riders and car users in a University campus setting. These synergies create greater feasibility for multi-tasking, reducing automobile trips and providing integrated solutions for better time management. Integrating mixed-use to develop fully functioning living environments is a good approach to reduce multiple trips by automobile for daily living. In Des Moines, IA, one peripheral parking facility is connections can provide easier access for persons of disability and other user groups such as the elderly. Linking transit with these mixed-use centers further expands the ability to serve wider population needs as even without an automobile a person may be able to function independently in a safe and accessible way connected with the bus system of the city, a day care center, dry cleaning, video rental and other typical daily/weekly living needs. This allows the user to consolidate daily/weekly needs in a time and cost effective way. Allowing these multiple connections can provide easier access for persons of disability and other user groups such as the elderly. Linking transit with these mixed-use centers further expands the ability to serve wider population needs as even without an automobile a person may be able to function independently in a safe and accessible way.