Major Activity Center PRT Circulator Design: Hacienda Business Park

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ABSTRACT:

The design of a comprehensive mobility system for a suburban San Francisco East Bay Area office park exposes a number of new transit circulator implementation challenges. Original system design perspectives are provided regarding:

- “Horizontal mixed use” and how resident out-commuters will generate more trips than employee in-commuters.
- Line haul transit capacity constraints loom as an obstacle to rapid spread of PRT circulators
- PRT station placement challenges with office park “superblocks”
- Design methodology to allocate PRT stations to workers and residents
- Ideal office park characteristics for PRT alignments
- Problems with generating too much PRT circulator ridership solved by semi-independent loops
- Multimodal transit hubs at the edges of the PRT alignment
- PRT alignment “style choices”
- The need for folding grocery carts (and other solutions) when the car is left at home

1. BACKGROUND

1A. Personal Rapid Transit (PRT)

Proposed is a 47-station personal rapid transit (PRT) "shuttle" system for Pleasanton’s Hacienda Business Park (HBP) major activity center and surrounding area, complementing and significantly increasing the attractiveness of rapid transit, carpool, vanpool, bicycle, and bus commutes. PRT provides elevated, electric, demand-responsive, non-stop, medium capacity, no-wait, 30 mph service for the commute's last two miles, and services mid-day shopping and recreation trips. In addition to PRT, the proposal includes a comprehensive service with carsharing, guaranteed ride home, and improved carpool ridematching. PRT is an emerging technology under development in the United Kingdom, Sweden, Korea, and Minnesota.

The 25-kilometer (15-mile) PRT circulator system consists of approximately 700 lightweight, driverless, three-person electric vehicles traveling on elevated "rail" 16' above the ground. Transit stations are located near building entrances. Frequent stations are situated along the route to minimize walking once the trip ends. Station guideway is separated from the main track - vehicles turn off onto a siding to pick up and drop off passengers. Because of these turn-offs, vehicles travel non-stop to the destination at 30 mph, bypassing intermediate stops.

Vehicle weight minimization greatly reduces the size of the elevated rail and supporting columns, while also dramatically reducing construction cost and right of way acquisition. Vehicles flow through the guideway somewhat like data packets on the Internet, anticipating demand so that wait time is eliminated. In addition to improving commute alternatives, the PRT circulator eliminates mid-day stranding caused by many commute alternatives, by providing efficient transit to adjoining shops and restaurants.

1B. Office Parks

Two hundred large office parks (with 15,000 or more employees) exist in the United States. (1) A substantial majority of these workers commute via Single Occupancy Vehicle (SOV). Hence, many acres of paved parking are provided for these workers. Traditional office park Transportation Demand Management (TDM) techniques only provide small changes (less than 10% nominal change) in commute mode share. (2)

The U.S. Environmental Protection Agency’s Collaborative Network for Sustainability program supports the research in this paper (the study is entitled “Transforming Office Parks into Transit Villages”), with dual goals of reducing air pollution and climate impact. This research looks at achievable, “near-future” mobility scenarios aimed at achieving very sizable reductions compared to traditional TDM.

Past research on PRT, office parks, and comprehensive mobility has examined the Palo Alto (California) Stanford Research Park (SRP) and the Redmond (Washington State) Microsoft (MS) Campus. For SRP, a five-mile PRT system with 18 stations
was studied to service 20,000 workers. A dramatic decrease in SOV mode share was forecast, from 89% down to 45%. (3,4,5)
For MS Campus, a 9.5-mile, 29-station PRT system was designed to service 30,000 MS employees. (6)

1C. Hacienda Business Park (HBP) & East Dublin BART Transit Village

HBP is a twenty-year-old, 9.6-million square foot, 875-acre mixed-use office park, located in the city of Pleasanton, within Alameda County, in the San Francisco East Bay Area. In Figure 1 below, PRT stations 1-36 encompass HBP. Stations 37-47 comprise the East Dublin BART transit village. HBP is located near the intersection of two interstate highways: I580 and I680. There are currently 19,000 workers, with plans for 27,000 within a few years. Most workers are college educated “knowledge workers” employed in computer, communications, financial, bioscience, or medical fields. There are 3,500 residents, with planning efforts under way to add as many as 1,200 additional housing units. Initial studies have shown the park could accommodate 2,400 or more additional units.

HBP also has four hotels (In Figure 1, see stations labeled: S2, S10 [serves hotels to North and South of station], S12), four retail shopping centers (S8, S9, S31, and East and across the street from S20), and a middle school (S18). The San Francisco Bay Area Rapid Transit District (BART) Dublin/Pleasanton station is located at the Northern edge of the office park and is the eastern terminus of BART’s blue line (S3, S4). Five-story campus buildings abut the BART station, with two-story buildings located on the periphery. A proposed expansion program, the HBP Specific Plan, is undergoing government review. Compared to the single use SRP and MS office parks, HBP has a comparatively rich mix of uses (office, hotel, retail, residential, and recreation). Three flood control canals cross HBP: Chabot (parallel to and East of Chabot Drive), Arroyo Mocho Canal (parallel to and South of West Las Positas Boulevard), and Tassajara Canal (forking in a Northeasterly direction from Arroyo Mocho Canal, just Southeast of S17).

Within the office park there are high, medium, and low-traffic streets as follows:
  - High-traffic streets: Hacienda Drive, Owens Drive, Stoneridge Drive, Hopyard Road, and Santa Rita Road.
  - Medium-traffic streets: West Las Positas Boulevard, Willow Road
  - Low-traffic streets: Gibraltar Drive, Inglewood Drive, Chabot Drive, Coronado Lane.
FIGURE 1  HBP PRT Alignment. For on-screen PDF viewing, zooming to 200% and 400% magnification is encouraged. (15)
Up to 1980, Pleasanton was beyond the “outer ring” of suburban East Bay Area expansion, as it was separated from Oakland by foothills (please see Figure 2 below). Now, Pleasanton has arguably been folded into the inner ring. The 2020 Metropolitan Transportation Commission growth forecast predicts 220,000 daily “extreme commutes” coming from beyond the nine-county Bay Area, many coming from the large central valley cities of Tracy, Stockton, Modesto, and Manteca.

Straddling both sides of I580, the BART station services HBP to the South, and East Dublin (S37 in Figure 1) to the North. Approved development at the East Dublin BART station area includes 1,800 housing units (S38, S45, and S46), 600,000 square feet of retail (S39–S41), and a 3,000-car, seven-story parking garage. Directly east of this BART station area development lies Hacienda Crossings (S42-S44), one of the Bay Area’s best performing shopping malls. All of this East Dublin retail attracts regional clientele. Acres of free surface parking await customers. Few urban design elements have been included to encourage BART station residents to walk to the adjacent retail.

The local area comprising the cities of Dublin, Pleasanton, San Ramon, and Livermore (please see Figure 2) is growing much more rapidly than the rest of the Bay Area. Thirteen thousand new housing units have been approved for construction in Dublin, with an additional 6,000 units approved for San Ramon.
2. PRT ALIGNMENT

2A. Expansion Beyond HBP Boundaries

In June 2006, a first HBP PRT alignment was drawn, with 31 stations serving within the boundaries of HBP. Stations were placed with intent to serve approximately 1,000 workers per station (to generate 1,000 or more PRT rides per day to meet a typical business case profitability objective. (5) ). James Paxson, General Manager of the HBP Owners Association, oversees the overall operation and planning of HBP. He had always felt that the best PRT system would also serve the East Dublin BART transit village, and, as research progressed, evidence gathered that the PRT system would improve with this addition. Thus, the July 2006 second version PRT alignment was drawn (Figure 1), encompassing a larger area, adding 16 PRT stations and addressing some of Paxson’s alignment preferences.

Additionally, Paxson added in service for Valleycare Medical Center (S34), a significant trip generator just outside of HBP’s Eastern boundary.

2B. Superblock Challenges

HBP was not designed with PRT in mind. The hypothetical exercise of building an office park from scratch for PRT would provide the opportunity to create pedestrian pathways and allow space within landscaping design for PRT guideway to pass through. In contrast, retrofitting an existing office park for PRT creates a series of challenges. In addition, to access some offices from some PRT stations, pedestrian street crossings are required. Traditional office park design features fast, wide streets with little attention given to pedestrian mobility or safety.

In order for a single PRT station to service a series of office buildings built on multiple land parcels within a large suburban block (or “superblock”), pedestrians will have to be allowed to cross parking lots. Currently, such crossings may be considered trespassing, but PRT will force a relaxing of the boundaries between offices to enable pedestrian access. Pedestrian paths through parking lots may be controlled by striping on the ground and signage. There are only a few fences within HBP, and a few of these may require some adjustment.

When it comes to PRT guideway and station placement, all office parks have different challenges. SRP had the fewest stations and simplest guideway shape (a figure eight), followed by MS campus, then HBP. Both MS campus and HBP alignments rely on a series of connected loops, creating a serpentine travel path for PRT passengers. One of the first examples of these connected PRT loops can be found in the Bellevue, Washington alignment created in 1994 by one of University of Washington Professor Jerry Schneider’s classes. (6)

Of the three office parks, SRP has the largest superblocks (a single SRP superblock encompasses about eight normal sized city blocks), accommodating easy pedestrian mobility within the superblocks, because no pedestrian street crossings are required. MS campus places dense concentrations of workers together on medium-sized superblocks, reducing the need for pedestrian crossings. PRT for MS campus created the largest conflict with trees, requiring the moving of many trees to accommodate PRT guideway. Uniquely, HBP has the three long flood control canals, creating the need for pedestrians to cross these canals.

Street Crossings

Given the HBP alignment in Figure 1 and the desire to serve approximately 1,000 workers with each PRT station, three traffic-calmed pedestrian street crossings are required:

- South of S17 (Trapeze), crossing West Las Positas Boulevard (medium traffic)
- East of S6 (Marriott), crossing Chabot Drive (low traffic)
- West of S12 (Roche), crossing Willow Road (medium traffic)

A number of street calming remedies are possible: signage and striping, speed bumps, “bulb-outs” and plantings to narrow street width, flashing crosswalks, and new stop lights.

Canal Crossings

Given the HBP alignment in Figure 1 and the desire to serve approximately 1,000 workers with each PRT station, three Chabot Canal pedestrian crossings are required:

- East of S5 (State Comp)
• East of S10 (Summerfield)
• East of S13 (Brittania 1)

Measures may be taken to minimize resistance to such canal crossings by affected landowners. For the S5 canal crossing, the
same tenant occupies parcels on both sides of the canal, so a bridge facilitating pedestrian access should be welcomed. For the
S10 and S13 canals, bridges may be placed along the natural intersection of property lines, crossing on more “neutral” ground,
or along Public Service Easements, which contemplate pedestrian access.

Successful office park PRT circulator economics depend on cost minimization, thus inexpensive bridges should be sought,
provided requirements of the Americans with Disabilities Act are met. PRT station costs are quoted at approximately $250,000
per station (7). Rather than serving employees with two PRT stations, one on either side of the canal, it is envisioned that a
single PRT station and a $50,000 canal crossing will suffice. Sturdy, inexpensive wooden bridge kits and prefabricated steel
bridges are readily available on the web.

PRT is not envisioned as linked to single family home neighborhoods. Below Arroyo Mocho Canal lies the residential
neighborhood encompassing Parkside Drive and Pleasanton Sports Park (with its 13 baseball diamonds). These residents have
an isolated street network, requiring significant travel West to Hopyard Road or East to Santa Rita Road to connect to HBP.
Arroyo Mocho Canal pedestrian crossings are being considered South of S17 and South of S15. These crossings would
provide superior bike and pedestrian access to PRT stations S17 and S15 (and to the PRT system’s 45 destinations) compared
to circuitous auto routes. It is expected that affected employers and residents will voice concerns over undesirable access to
their property; however, this concern may be outweighed by the lure of easier access to recreation and shopping destinations
served by PRT. In addition, research has shown a direct relationship between a property’s value and its proximity to rail
transit, hence PRT may increase property values. (8)

2C. People Map

The creation of the HBP and MS campus alignments began first with a spreadsheet of buildings with the number of employees
in each building. From this table, adjacent buildings/parcels were grouped on a map to approach 1,000 or more employees per
PRT station. Station locations were hand drawn atop the map, and then guideway was sketched in to connect the stations, with
careful consideration of guideway direction to create the series of connected loops. The guideway was then created digitally in
the Taxi 2000 PRT software application, Trakeditmax. Given high resolution 2005 Pleasanton aerial photography available
from Windows Live Satellite and Google Satellite (both presumably from U.S. Geological Survey source), Trakeditmax
allowed 0.25 meter per pixel resolution for fine-grained guideway placement. A GIS layer showing underground Pleasanton
utility location was available, but PRT guideway and support column placement has so much flexibility within a parking-lot
laden office park that avoiding utilities is not seen as a significant obstacle. The resultant PRT alignment is conceptual in
nature, and requires microsimulation to verify capacity before serving as a specification for a precise civil engineering
alignment design.

A sample of the resultant employee counts per HBP PRT stations at offices is: 615, 630, 700, 724, 730, 772, 822, 850, 996,
1,020, 1,194, 1,275, 1,364, 1,400, and 1,700. MS campus was found to have higher employee density with fewer pedestrian
issues, facilitating reaching 1,000 employees for a greater percentage of PRT stations. Overall, the 45 HBP PRT stations serve
29,000 employees and 9,500 residents, with an additional, sizable shopping population.

For HBP, 15 miles of guideway serves 38,500 people, plus additional shoppers. For MS campus, 9.5 miles of guideway serves
30,000 workers. For SRP, 5 miles of guideway serves 20,000 workers.

Figure 3 below shows how the blue 200-meter walking radius circles around the PRT stations leave only a few unserved places
in HBP. A 300-meter walking radius is not shown, but it covers up most of the 200-meter holes.
Regarding the walking radius, the alignment drew conflicting comments from James Paxson and another expert, Cambridge Systematics' Chris Wornum. Paxson felt the series of connected loops made the alignment too complicated, and asked for fewer stations, broaching the subject of whether suburban knowledge workers would walk up to 1/3 of a mile from a PRT station to their office. Contrastingly, Wornum questioned whether 47 stations would provide sufficiently short walking distance to compete with SOV driving. Office parks generally provide an inconsistent walking environment, with limited visual interest. The streets are wide. Parcels greet pedestrians with acres of parking at the edges with buildings set well back from the property line. The asphalt-centered design reduces employee willingness to walk. Hence PRT station walking radius has to be small. HBP does have some pleasant segments for walking, and, as envisioned in the HBP Specific Plan, portions of HBP will be in-filled with some pleasantly walkable New Urbanist mixed-use development. Further walking improvements are envisioned beyond the Specific Plan.

2D. Rough-cut Ridership Guesstimate
As part of this EPA research, a very unscientific “working PRT ridership forecast” is created simply as a number to work with. Later on in the research, a more scientific forecast will be created. Early on in SRP research, a rough-cut forecast was created that, three years later, ended up within 10% of the final forecast. (4)

Current ridership assumptions will presumably be proven incorrect, but they are:
- 3 PRT trips per day per resident, encompassing shopping, recreation, and commuting
- 0.5 shopping/recreation PRT trips per day per employee
- 0.5 commute-related PRT trips per day per employee

Thus, for 9,500 residents and 29,000 workers, daily PRT ridership totals 57,500 trips.

A few other potential sources of ridership are ignored for now: a) trip capture for adjacent residents outside of the alignment boundaries, and b) trip capture for regional shoppers originating from outside of the alignment boundaries, who park and use PRT to access stores.

2E. The Ideal PRT Office Configuration

The 30-story office buildings in the Tyson’s Corner (Virginia) major employment center provide one easy way to assure 1,000 people per PRT station. For office parks with a maximum building height of five stories, such as HBP and MS campus, one group of four MS buildings stands out. These four five-story buildings hold 600 workers apiece, all within easy walking distance. Rather than acres of surface parking surrounding the buildings, all parking is provided underground in two stories of continuous (and cavernous) parking that spans all four buildings. Dramatic density of 2,400 workers for a single PRT station is provided, with PRT riders enjoying a more pleasant experience than underground SOV parkers who experience significant underground walk-time. Such density makes very effective use of the developed land.

2F. Semi-independent Loops for Higher PRT Capacity

The guesstimate of 57,500 PRT trips per day may require a peak hour capacity of 12,000 passenger trips. Realistic (not theoretical) capacity for single PRT loops running at ½ second headways is given at about 4,000 passenger trips-per-hour, comprised of 2,600 vehicle trips with 1.5 passengers per vehicle trip.

Depending on the actual distribution of originations and destinations, achieving higher than 4,000 passenger trips per hour capacity on an office park alignment requires careful design. Complex alignments should be simulated against forecasted origination/destination patterns to identify and remedy system bottlenecks.

Assuming hypothetically large PRT demand generation at the BART station, increasing hourly PRT capacity from 4,000 to 12,000 may be brought about by creating three semi-independent 4,000 passenger-per-hour PRT loops connecting to three separate PRT stations at BART:
- S3 Loop: S1, S5, S2, S6, S12, S11, S10, S13, S14, S15, S16, S11, S9, S8, S7, S35. (S18 is also served)
- S4 Loop: S23, S24, S22, S21, S26, S34, S30, S33, S31, S25 (S27, S28, S29, and S32 are also served)
- S37 Loop: S38, S46, S39, S40, S41, S42, S43, S44, S47, S45

The S3 and S4 loops are connected at the BART station, upstream of S3 and S4. In the original June 2006 alignment, the S3 and S4 loops merged down into a single guideway before connecting to BART, creating a bottleneck at that point. Care should be taken to avoid such bottlenecks. The term “semi-independent” is used because the stations in the S3 loop can independently access BART without any conflict with the S4 loops’ demand to/from BART, while still serving trips between stations on either loop (the “semi” part).

In addition to the S3-S4 loop connection at the BART station, these two loops are connected via S36, via S20, and via the merge before S17. The S4 and S37 loops are connected over the Hacienda Drive overpass above I580. A direct BART station connection between S37 and S3 underneath I580 is also envisioned, but not shown in the Figure 1 alignment.

For other areas of high demand generation, additional sets of semi-independent loops may be created to provide high capacity.

BART PRT stations S3 and S4 are separated by a significant distance for purposes of graphical depiction in Figure 1. For actual implementation, more space-saving treatments will be considered, including parallel stations on a single, large station platform and a two-level station design with S3 at 16’ and S4 at 26’.
2G. Transit Hubs

The PRT stations at the “edges” of the alignment, S15, S34, S43, and S38, could serve as multimodal transit hubs providing:

- parking dedicated specifically to carsharing, emergency-ride-home vehicles, and/or rental cars (people access carsharing cars by taking PRT to these transit hubs);
- bike lockers for casual bike commuters who ride a short distance and then transfer to PRT; and
- bus stops. (Bus routes would be reconfigured to avoid serving areas in HBP that are accessible by PRT.)

2H. Future Expansion

The Tassajara Road / I580 interchange lies one-half mile East of S43. To the Northeast of this interchange lies the 2.4 square mile Dublin Ranch development, planned and under construction for 9,000 housing units. Density varies from 1 single family home per acre to 35 apartments per acre, yielding roughly 7,800 residents per square mile. There is currently no provision for transit in this area. The creation of the Figure 1 PRT alignment would justify the institution of bus service to connect Dublin Ranch to PRT which would then connect to BART. It is also expected that PRT system expansion to service Dublin Ranch will eventually be warranted.

2I: PRT Alignment Style Choices

Whereas the downtown Bellevue alignment created by Jerry Schneider’s class is limited to following the street grid for 95% of the alignment (6), PRT guideway layout within office parks is very flexible. One style of design chooses to follow existing streets as much as possible, maximizing straight guideway segments. This results in a smoother ride for PRT passengers, as there tend to be fewer curves in the alignment.

The design style in this research prefers to weave in and around office buildings, to ease the placement of stations near office entrances. This results in reduced guideway length and more curves. In addition, attempts are made to eliminate circuitous paths for travel between all pairs of stations. For realistic implementation, the design shown in Figure 1 requires additional maintenance and vehicle storage. Optimal vehicle storage placement will result from iterative simulation runs where storage placement is modified.

At Paxson’s instigation, the guideway near S22 (Terrace) was moved from the West side to the East side, to allow for improved access by the residents across Gibraltar Drive. PRT stations have been placed at the edges of the New Urbanist housing planned for S35 and S36. There is some chance that urban designers will integrate the PRT guideway more directly into these developments.

The Figure 1 alignment is considered unsatisfactory between S6 (Marriott) and S12 (Roche) as the parcels in-between are crossed by PRT guideway without benefiting from advantageous PRT station placement. This may be remedied by the addition of a PRT station for the affected parcels, or by routing the guideway along the streets in this area.

The guideway serving S28-S29 runs though the parking lot of a dense apartment complex. The guideway is separated from the adjoining single family home (SFH) residential area by a long strip of park land. Thus the SFH area is served by PRT while being buffered from PRT visual impact.

3. HBP RESIDENTS

3A. Horizontal Mixed Use for Residents

One vision of New Urbanism and Smart Growth is for four-story buildings with first floor retail and office/residential above. The uses are mixed vertically as well as horizontally. The majority of SOV trips that are de-generated by such development stems from the retail being just a convenient walk away.

As previously shown, the greater HBP area is not consistently walkable. The PRT-led transformation of greater HBP is based on providing car-free access to a compelling mix of shops and recreation. Each parcel has a single land use, but PRT allows quick trips to be made to access a wide variety of retail. Thus, the term “horizontal mixed use” is an apt description. PRT allows people to travel above the pedestrian-hostile areas, and land in small pedestrian-friendly pockets. The HBP Specific Plan will begin the process of increasing walkable areas within HBP.
The inclusion of East Dublin in the PRT alignment created a PRT alignment serving more than 1.5 million square feet of retail, creating compelling retail scale. In addition, residents take many more daily short trips to shops and recreation than do workers (the ITE Trip Generation Manual lists average weekday household trip generation rates of 10.0 trips per single family home and 6.6 trips per condominium). Thus, East Dublin also provided sufficient residential scale to make the PRT mixed use thrive. The retail component includes:

- National chains such as IKEA, Best Buy, Pier 1, Barnes and Noble, Bed Bath and Beyond, and Old Navy
- Recreational opportunities including: gyms, spas, creekside hiking/biking trails, city parks, and a 20-screen multiplex cinema with IMAX
- A diverse selection of shops and restaurants at varying price points
- Services such as daycare, bank, copy-making, financial, real-estate, dry cleaners, dentist, doctor, optometrist, children’s educational centers, tanning, and nail salons

It may be possible to change two car SFH households into one car households, supplemented by PRT, BART, carsharing, and biking. Residential TDM policies such as unbundled parking (where condominium and apartment dwellers must pay a separate monthly fee for each parking space they require) and carsharing membership could be used to incentivize this car ownership reduction.

3B. Out-commutes & Half-mile Argument.

A recent study looks at travel mode share for suburban East Bay residents, both for suburbia overall and for transit village residents living within ½ mile of a BART station. For work trips, overall suburban auto work trip mode share is 94.7 percent, versus only 66.3 percent for transit village residents. Likewise, the difference is large for non-work trips, 82.2 percent auto for overall East Bay suburban, versus only 63.6 percent for transit village residents. With PRT transforming the entire alignment area into a very large transit village, all residents are within ½ mile of high quality PRT transit providing a great connection to BART (most are within 300 meters of PRT). One of the advantages of living near PRT, but not within a short distance of BART is the residential experience suffers less from BART train noise. Because HBP is at the Eastern end of BART’s blue line, greater HBP residents are assured of finding a seat on BART, allowing for a pleasant and productive commuting experience. (9)

3C. Traffic Reducing Housing Preference Further Reduces Auto Trips

Traffic Reducing Housing Preference (TRHP) is a residential occupancy selection policy used to reduce car ownership, car trips, and commute distance. TRHP works especially well as a means to prioritize new TOD housing for incoming residents with fewer cars who will drive less while simultaneously discouraging potential residents intending to log substantial annual vehicle miles traveled (VMT). The California cities of Santa Barbara and Stanford have implemented successful TRHP programs providing very large auto trip reduction. For Santa Barbara’s 42-housing-unit Casa de Las Fuentes downtown TOD project, only 16 cars are parked. Stanford’s 550-housing-unit Stanford West project reduces annual commute VMT by three million miles. TRHP is readily imposed on new housing projects before they are approved, and could naturally be applied to housing by S45, S35, and S36. There is also some chance of applying the program to approved East Dublin housing under construction at S38 and S46, but the City of Dublin will have to provide compelling financial incentives for developers to adopt TRHP. It may also be possible to bring about TRHP for new incoming residents (not for current residents) near S28-S29, but the City of Pleasanton will also have to provide financial incentives. A July 2000 Pleasanton City Council Resolution is sympathetic to the TRHP concept, “the City desires to place a priority on providing housing opportunities for Pleasanton employees.” TRHP is an effective residential TDM program that would serve to increase demand for BART and PRT. Part of the observed increase in TOD transit mode share is attributed to resident self-selection, whereby transit-oriented residents are more likely to seek housing within TOD. TRHP takes the concept of voluntary self-selection one step farther by ensuring that transit-loving residents are not “crowded out” by higher VMT households. (10)

3D. Adjacent Resident Capture

As previously mentioned in the Canal Crossings section, there is potential to connect the adjacent Parkside Drive SFH neighborhood below Arroyo Mocho Canal to the HBP PRT system. Additional residential pockets are scattered about at the edges of greater HBP, such as the higher density housing between S34 (ValleyMed) and S32 (CarrAm1), as well as the condominium community South of S34. These pockets should also generate additional PRT ridership.
3E. Grocery Carts

In suburbia, people tote groceries and goods from shops to home using the trunk of their car. With greater HBP PRT providing access to shopping, other means of goods transport are required. Depending on total walking distance and the weight and volume of goods, various means will be deployed, including a) large backpacks and duffle bags, and b) sturdy, reusable canvas shopping bags with handles. The horizontal mixed use lifestyle may encourage multiple, small-volume grocery trips per week. For large volumes of groceries, the well-balanced “Hook & Go” foldable, wheeled shopping assistant supports the hooking of up to 12 shopping bags with maximum load of 70 pounds onto a bar with eight hooks. (11)

4. HBP WORKERS

4A. Journey to Work

For a PRT office park “last mile” solution to work well in serving commuters using SOV alternatives, sufficient line haul transit capacity should be provided. For SRP, 47% of workers live within a two-mile radius of Caltrain commuter rail. (12) For MS campus, a regional radial bus transit network serves commutes to downtown Seattle, but Redmond is underserved. For HBP, located directly on the BART system, transit options are better than those of MS campus, but are disappointing compared to SRP.

From Census Transportation Planning Package (CTPP) 2000 census tract flow data, a fine grained analysis of the commute to HBP has been created. Commute to HBP mode share is: 83.7 percent drive alone, 11.1 percent rideshare, and 1.7% transit. 980 people live and work within Hacienda’s 4507.22 census tract. (17)

Bay Area commutes to HBP generally represent a “reverse commute,” where commuters enjoy free flow trip during peak hour on freeways where the opposite direction is backed up. However, the HBP SOV commute does have some problems. Westbound I580 from Livermore to Pleasanton is part of the AM peak direction commute and experiences severe traffic. I680 South from Walnut Creek has two “choke points” that experience regular backups.

This research study created “Commute to Pleasanton” data by both county and city from Census Transportation Planning Package (CTPP) 2000 data. 82.5 percent of Pleasanton workers commute from the two immediate East Bay counties, Alameda and Contra Costa. The four closest cities for workers are Pleasanton, Dublin, San Ramon, and Livermore. These fast-growing cities serve as residence for 48.3 percent of Pleasanton workers. For these four-city close-by residents, BART is not an option and bus service is not time-competitive with short SOV commutes.

Eight percent of workers reside in the Central Valley cities of Tracy, Stockton, Modesto, and Manteca. For these long-distance commuters, direct bus service, vanpooling, and carpooling represent a popular way to lessen the burden of long commutes. Whereas overall SOV commute mode share is 83.7 percent, SOV commute mode share from these Central Valley cities is only 77.2 percent.

Because of HBP’s location at the end of BART’s blue line, a number of BART commutes follow indirect paths and are not time-competitive. These circuitous commutes originate as follows: on the yellow line from Lafayette to Pittsburg, on the yellow line from South San Francisco to Millbrae, and at Fremont and Union City stations. 10.5 percent of HBP workers reside in cities with uncompetitive BART commutes. 17 percent of HBP workers reside in cities with competitive BART commutes, where BART trip time is within 30 percent of congested peak-hour SOV commute time (per unpublished “Net LOS to TAZ” MTC database provided by Chuck Purvis).

As far as ridesharing is concerned, small peak-hour HOV freeway time savings may be achieved for commutes from Richmond, San Francisco, and South Hayward.

4B. BART Commutes: Capacity and Attitudinal Issues

Given that 17% of HBP workers have a competitive BART option, why do less than two percent of HBP workers commute via BART?

Limited Seat Availability
Commuting from some BART stations during peak hours requires standing in crowded trains. Knowledge workers value productive commute time where they can find a seat, read, and relax. BART is so popular that this is often precluded. Knowledge workers are only willing to endure these conditions for a few minutes or a few BART stops.

Two other major Bay Area employment centers (in South San Francisco and Emeryville) are well served by BART and are good candidates for PRT transformation. However, BART’s crowded conditions loom as a line haul limitation. BART spent $80MM on a failed effort to reduce headways and increase system capacity with Advanced Automated Train Control (AATC). The AATC project was cancelled in 2006. There is no known solution to increasing available seats on BART during peak hours. (16)

Limited BART Parking Availability

Of 20 BART station parking lots surveyed in Winter 2005 (unpublished BART parking study), ten were full by 8AM, and 16 were full by 8:20AM. Adjoining parking lots not owned by BART also fill up rapidly, and on-street parking is also scarce. Thus “park and ride BART” commutes are hindered by limited parking availability. BART’s commendable long-term parking policy is to a) charge more for parking and b) in-fill parking lots with residential TOD. These policies will further inconvenience commutes to HBP.

Comfort and Safety Attitudinal Issues

Well-educated knowledge workers are used to a safe, comfortable SOV commute in nicely appointed cars. Given their expectations from their pleasant SOV experience, they are very finicky about taking transit. (4)

SRP is served by Caltrain commuter rail, serving primarily middle to upper class neighborhoods. HBP is served by BART, a regional system that serves a more diverse clientele. Hence, for knowledge workers, BART has less appealing demographics.

BART customer satisfaction increased dramatically from 2000 to 2004. 86% of surveyed passengers felt either “very” or “somewhat satisfied” with BART. Passengers observed significant increases in reliability. (18) The BARTrage blog collects passionate complaints about unsatisfactory BART experiences. Many of the complaints highlight the demographic differences between two passengers involved in some sort of incident.

Triple BART Commutes?

It may be possible to triple BART commute mode share to HBP from 1.7 to 5.1 percent, provided a PRT-based comprehensive mobility system is implemented along with aggressive workplace TDM measures such as subsidized transit passes.

4C. Digital hitchhiking

Given that 48.3 percent of Pleasanton workers reside in Pleasanton, Dublin, San Ramon, and Livermore, a compelling short-distance commute alternative is necessary to de-generate these nearby commutes. “Digital hitchhiking” is one proposed solution to alleviate short SOV commutes. Dense worker distributions along arterial corridors are exploited. Longer distance SOV commuters (3 to 12 mile commutes) with empty seats travel in on an arterial and pick up shorter distance commuters (0 to 3 miles) living close to the arterial who walk to the arterial for pickup. Connection-making and perceived safety are enhanced with RFID (toll tags), cell phones, and tracking software. Half-hour bus service is also provided along the arterial as the “slower but guaranteed” transportation option for short distance commuters. The objective is to have sufficient longer distance hitchhikers to provide five-minute service along the last three-miles of the arterial.

For the HBP commute, promising arterials for digital hitchhiking are: San Ramon Valley Road, Doughtery Road, East Avenue – Stanley Boulevard, Niles Canyon Road - Foothill Road, Vineyard Avenue - Hopyard Road, and Tassajara Road. There is also the chance to pull some highway SOV commuters off the highway an exit or two early to provide more empty seats.

An early variation of digital hitchhiking was conceived by NextBus founder Ken Schmier, who believes drivers have latent “Good Samaritan-ism” (willingness to do good deeds to help others, provided the effort is small) and do not need incentives. Another expert, Chris Wornum, felt that incentives would be necessary to overcome knowledge worker attitudinal barriers to sharing their cars. Possible incentives include: preferential parking spaces at the workplace and discounted corporate cafeteria passes. (13)
4D. Bus route changes

The local bus system is called Wheels. Wheels provides short distance, shuttle-style service to major Pleasanton locations, and services Livermore-to-Pleasanton routes. Daily HBP ridership is probably under-reported, but is given as 445 passenger roundtrips (from unpublished Wheels-provided data), split between bus commutes directly to HBP and last-mile service to offices for BART commutes.

A number of Wheels buses take serpentine routes with multiple stops within HBP, in order to serve many of the offices. Finicky knowledge workers are known to loathe such slow “milk run” service. (4) PRT provides faster-than-bus service for ALL destinations within greater HBP, allowing bus routes to be re-configured for line haul service to the edge of greater HBP where PRT takes over. HBP milk-run bus service can be eliminated for Wheels routes such as 1, 7, and 54. For Route 54, the bus portion can be streamlined to 13-minute line-haul service from downtown Pleasanton to the S15 transit hub, eliminating 33 minutes of milk run within HBP. By shortening bus routes, PRT can reduce bus route headways.

As previously mentioned, the circuitous BART yellow line service in Contra Costa County from Lafayette to Pittsburg is not competitive. Wheels provides a fast, popular express bus service from Walnut Creek BART to HBP BART, creating a more competitive transit alternative North of HBP. The three buses currently run full and a fourth is being added.

4E. Advanced Ridesharing / Carpooling

For SRP, PRT increased the statistical probability of finding a carpool partner, by increasing the pool of potential ridematches to all employees within the PRT circulator service area. With traditional carpooling, ridematches are typically formed with commuters working in the same building, as knowledge workers are unenthusiastic about providing milk run service to unload passengers within an office park. This statistical argument also holds for greater HBP. In addition, finicky knowledge workers require additional “product features” to carpool, including:

- Anonymous web based carpool partner based on personal characteristics (similar to web-based dating services such as match.com)
- GPS cell phone connection making/tracking software to reduce AM rendezvous uncertainty stress
- GPS cell phone “safe arrival” verification to increase safety when riding with strangers (3,4)

Many knowledge workers with varying schedules are willing to carpool three days per week, but cannot participate in regular carpools. The Nuride dynamic ridematching service facilitates these “three times per week, rarely the same passengers” carpools, and provides retail shopping incentives of value to knowledge workers.

4F. Improved Biking

Biking paths within HBP are improving, with bike paths coming to Arroyo Mocho and Tassajara Canals, and longer-term potential for bike paths along the Chabot Canal (required street crossing height increases are already in the master flood control plan) and along the old Southern Pacific rail right-of-way, the Ironhorse Trail that follows a diagonal line of green created by connecting S3 to S28.

As previously mentioned, short bi-modal commutes will be enabled with a) biking in adjoining, pleasant residential areas, transferring to b), PRT for fast, safe, comfortable travel within greater HBP. There are two kinds of bikers: a) “hard-core” bikers who are willing to sweat, brave rain, jostle for space next to fast-moving cars, and travel in Winter’s darkness, and b) “casual” bikers who are the exact opposite of the former. Hard-core bike commuters have already achieved their maximum commute mode share, but casual bikers represent a substantial, untapped commute-alternative market, provided the “bike plus PRT” bi-modal commute is enabled. (5, pgs 95-97) Additional bike lockers will be necessary, but Paxson has found that BART has a surplus of unused lock inventory that is available.

4G. Parking policy

Charging for SOV parking at suburban office parks is known to be an effective TDM measure, varying in effectiveness with the cost of parking. (2) However there are zero suburban office buildings of less than seven stories in the U.S. that charge for parking.

BART is now charging one dollar per day for parking at the HBP BART station. Paxson believes this change could create more openness to small parking charges for office parking within a one-half to one-mile radius of the BART station. Wornum
further reinforces this idea by citing a survey that found workers willing to pay small amounts for SOV parking, provided the proceeds were dedicated to visible transportation improvements.

Recent improvements in license plate recognition technology coupled with the Bay Area prevalence of Fastrak toll tag RFID transponders reduce the implementation costs of automated, gated, small-charge paid parking systems within HBP. (14)

5. ECONOMICS

Capital costs for the 15-mile PRT alignment are estimated in the range of $150 million. (7) For perspective, the more than ten million square feet of real-estate served in the PRT alignment, valued conservatively at $300 per square foot, is worth more than three billion dollars. The compelling revenue stream from office park PRT transformation is the value of new in-fill development enabled by the reduction in car trips. For the $50 million SRP alignment, that in-fill was estimated to generate a $326 million profit. (5, pgs 179-186)

Annual PRT fare-box revenue is guesstimated at $13.1 million, based on the following assumptions:
- $0.75 PRT fare as was assumed for SRP
- 250 weekdays with 57,000 PRT passenger trips per day
- 115 weekends and holidays with 28,500 residential trips per day

Total guesstimated annual trips are 17.5 million.

6. CONCLUSION

This paper explored a number of system design perspectives for new transit circulator design, including horizontal mixed use, line haul constraints, station placement, allocation of stations to people, ideal real-estate characteristics, high demand, multimodal hubs, style choices, and new accessories.

As this research has progressed, the need for detailed “new technology product research” on horizontal mixed use for suburban resident customers has become apparent. Interview research, followed by Information Acceleration-style surveys is suggested.

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REFERENCES – (Web links last updated August 2006)


15. HBP PRT Alignment. Uses 2005 aerial photo as background. For higher resolution, please see: [http://www.cities21.org/HBP05_360dpi_24x30.jpg](http://www.cities21.org/HBP05_360dpi_24x30.jpg), 8,345 x 10,512 resolution, 25MB.

