Back in Angle Parking in the Central Business District

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ABSTRACT

In many CBDs, the lack of available parking is seen as deterrent. One methodology to provide more parking is creation of traditional, pull-in angle parking. However, in order to properly implement traditional angle parking, a substantial amount of ROW is necessary to provide the proper maneuver space for vehicles to back out.

With traditional angle parking the width of the street and subsequently pedestrian crossing distances become excessive. At signalized intersections, the pedestrian crossing times can be excessive, leading to decreased vehicle mobility. More typically, the width of available ROW is insufficient.

While the angle of the parking can be reduced to narrow the required width, as the parking angle becomes more acute, the angle parking yield approaches that parallel parking. Ideally, angle parking without the wide maneuver space would address the problem.

One solution is back-in angle parking. The biomechanics necessary to position a car into a back-in angle space is not much different than that required for parallel parking. Leaving the back-in angle space is no more different than pulling into the street. Furthermore, no maneuver space is typically required for a parallel parking space. Without the need for a maneuver space, the back-in angle parking provides the necessary additional parking without the need for the excessive or unavailable ROW.

Pottstown, Pennsylvania, USA commissioned a study of back-in angle parking as part of a Downtown revitalization. A number of other cities were studied with similar parking including Wilmington, Delaware; Seattle; Indianapolis; Salem, Oregon and Washington, D.C.

INTRODUCTION

In many community's central business districts (CBD), the lack of available parking, close to the to the retail and commercial establishments is seen as deterrent to continued retail development and reinvestment into the CBD. In many instances, the CBD is also bisected by an urban arterial, or "Main Street" if you will. The competing needs of parking versus efficient vehicle movement can impede mobility and sometimes compromise safety.

Since the middle of the 1990's, the Borough of Pottstown, Montgomery County, Pennsylvania, has struggled to revitalize and reinvigorate its downtown core. The Borough's 1994 Downtown Comprehensive Plan identified several goals to accomplish this aim specifically dealing with the creation of a more pedestrian friendly, multi-modal environment while maximizing the amount of available parking and its proximity to the retail establishments that line the downtown core. Through leveraging of and improvement to the existing transportation infrastructure, the community has attempted to realize these goals.

Borough History & Location

Located in the Philadelphia, Pennsylvania metropolitan area, the fifth largest metropolitan area in the United States and situate on the Schuylkill River, the Borough of Pottstown traces its routes to 1752. Founded by an ironmaster, the Borough was at one time an active industrial center hosting iron and steel production. Soon the Reading Railroad came to town, further increasing Pottstown's prominence in the region and along the River. Pottstown's furnaces were instrumental in completing the locks for the Panama Canal and portions of the Golden Gate Bridge. Like many of the older, industrial communities in the Philadelphia suburbs, however, population and regional prominence peaked after World War II, followed by a steady decline as the region shifted from industrial production to that of a bedroom community to support the growing service industry. At 5.5 square miles, (14.25 square kilometers), Pottstown population is 21,859 (2000 census).

At 40 miles (64.4 kilometers) from downtown Philadelphia, Pottstown was served by one of the original 'turnpikes' radiating out from the City. Ridge Pike essentially parallels the Schuylkill River, along its eastern shore, linking many of the older industrial communities along the River between Philadelphia and Pottstown. Within the Borough, Ridge Pike is called High Street. As the Borough developed, the central business district (CBD) also developed, centered along High Street, essentially making High Street the Borough's 'Main Street'. Like many other local communities, Pottstown also hosted a trolley operation in the early 1900's. Through the CBD, the trolley, of course, traveled down the center of High Street and was double tracked reflecting Pottstown's prominence in the region's economy. Given the presence of the trolley and importance in linking Pottstown with the rest of the region, the High Street corridor cut a wide path through the CBD.

Current Existing Conditions

With the abandonment of the trolley service and the increase in automobile traffic after World War II, the High Street cross section was reconfigured to maximize automobile mobility. With 68 feet (20.74 meters) available between the curb lines, two 11 foot (3.35 meter) through lanes and a 7 foot (2.14 meter) parallel parking lane were created in each direction along with a 10 foot wide (3.05 meter) center turn lane/painted median. This is the configuration that presently exists. Combined with a 16-foot (4.88 meter) sidewalk on each side, the face of the buildings on each side of the street are 100 feet (30.50 meters) apart, creating a very wide corridor through the CBD. The width of the corridor in and of itself is visually perceived by some to be a deterrent to downtown redevelopment.

By the late 1960's however, it was clear that High Street and Ridge Pike were quickly becoming inadequate. To serve the ever-increasing traffic demand, the Pennsylvania Department of Transportation (PENNDOT) undertook the construction of a four lane, grade separated, limited access freeway along the western side of the Schuylkill River. This new roadway, U.S. Route 422, on the opposite side of the River from the Borough, essentially bypassed the CBD and drew a large amount of the existing through traffic volume from High Street. Combined with a general decline in shopping within the CBD in favor of regional malls (the King of Prussia Mall,

the United States Second largest indoor shopping mall is 20 miles (32 kilometers) south of the Borough via Route 422), High Street quickly became an underutilized transportation asset.

With the reduction in traffic demand, vehicle speeds increased as the number of vehicles using High Street decreased. A 1995 study commissioned by the Borough indicated that the 85th percentile speed along High Street was 27 miles per hour (43.2 kilometers per hour). The same report indicated an average daily traffic volume (ADT) of 9,228 vehicles per day (vpd). Year 2001 PENNDOT data places the ADT volume at 8900 vpd. The 1995 study also indicated that the signalized intersections within the corridor, and High Street itself, were typically operating at a level of service (LOS) B during peak periods. High Street is classified as an urban arterial by PENNDOT.

PROBLEM STATEMENT

Strictly speaking as a highway facility, High Street was an operational success. The 85th percentile speeds were within 5 miles per hour (8 kilometers per hour) of the posted speeds and an attractive level of service was being maintained for vehicles. However, High Street was failing to meet more recent and progressive economic development and transportation goals endorsed and promoted at the local, state and national levels.

Increasing pedestrian traffic is one of the key objectives in the Borough's efforts to revitalize the CBD. However, High Street's current configuration impedes these efforts. With four lanes of rapidly moving traffic, it is neither pedestrian nor shopper friendly. High Street's 68-foot (20.74 meter) cross-section is intimidating and discourages pedestrians and shoppers from crossing the street. Pedestrian injuries and deaths have not been uncommon. In addition, the vehicle traffic along High Street moves too quickly to allow passengers adequate time to identify shopping opportunities and find a parking space.

A perceived lack of parking was also identified as a concern of the downtown business owners. Although metered, parallel parking was available on both sides of High Street throughout the CBD, it was generally 50 % utilized and, therefore, considered to be insufficient in addressing the full potential needs of the downtown businesses, considering the number of vacancies. While a number of small surface lots had also been created along High Street, the linear nature of the CBD makes this parking convenient to only the adjacent businesses with long walks necessary for all other businesses.

Another key consideration within the CBD is public transportation. Both the Borough (Pottstown Urban Transit (PUT)) and the Southeastern Pennsylvania Transportation Authority (SEPTA) operate bus service within the Borough. And, as in the past with the former trolley system, High Street serves as the spine of this local bus system. It is thought that creating a safer pedestrian environment will also lead to increased transit usage further reducing the overall traffic demand, particularly among senior citizens who account for one-third of Pottstown's transit riders.

One of Pennsylvania's and the region's transportation goals is to encourage the use of bicycles as an alternative to the automobile. High Street has been designated by Montgomery County as an

official Bicycle Route connecting Pottstown with other communities along the Schuylkill River corridor. But, in its current configuration, High Street is not conducive to bicycle travel with no dedicated bike lanes and swiftly moving vehicular traffic.

State and regional plans recognize the connection between revitalizing our older communities and solving the problems of traffic congestion on our roads and highways. Encouraging people to live, work and shop in denser, walkable communities fosters the use of existing public transportation, helps reduce sprawl and relieves the pressure on our road system. Creating vibrant downtowns in our cities and smaller urban communities ensures a growing demand for public transportation. The general thinking was, therefore, that reconfiguring and calming traffic on High Street would address Pottstown's own economic development goals, and would have a positive impact on regional transportation and growth issues.

ANALYSES

Clearly if the Borough is to increase pedestrian traffic and attract new business to the CBD, while not reducing available parking, the existing automobile and truck traffic would have to be calmed. It should be noted however, that High Street is a state highway (State Route 4031) and any improvements or changes to High Street would have be subject to the review and approval of the Pennsylvania Department of Transportation. Given the arterial classification of High Street, it was also unlikely that meaningful traffic calming could occur or would even be permitted with conventional techniques and measures.

The CBD study area generally encompassed a 1.1-mile (1.76 kilometer) corridor centered along High Street. Within this corridor, there are 10 signalized intersections. Of those, however, only two are equipped with pedestrian push buttons. In general the side streets are not actuated. All signals are currently uncoordinated and operate on fixed time cycles with side street phases sufficient to also support the lengthy pedestrian times required to cross High Street. Because of the width of High Street, these crossing times approach 17 seconds. At the two intersections with pedestrian push buttons, exclusive pedestrian phases are initiated upon activation with expected detrimental impacts to the levels of service.

One methodology used to provide for more parking is creation of traditional, pull-in angle parking. However, in order to properly implement traditional angle parking, a substantial amount of right-of-way is necessary to provide the proper maneuver space for vehicles to back out of the spaces without impeding traffic flow on the adjacent roadway.

With traditional angle parking in place on both sides of a "Main Street", the width of the street and subsequently pedestrian crossing distances become excessive creating a non-unified downtown unattractive to pedestrians; pedestrians which are also critical to the success of the retail and commercial establishments in the CBD. At signalized intersections, the pedestrian crossing times can be excessive, leading to decreased vehicle mobility and progression. More typically, the width of available right-of-way is insufficient to support angle parking.

While the angle of the parking can be reduced to narrow the required width of street, as the parking angle becomes more acute, the angle-parking yield becomes not much more than that

with parallel parking. Ideally, angle parking without the wide maneuver space would address the problem.

The 1995 Study

A key purpose and subsequent finding of the 1995 study of High Street commissioned by the Borough was that the existing through lanes could be reduced to one lane in each direction and, primarily through coordination of the signals, the resultant levels of service with one lane in each direction would be no less than the existing levels of service with two lanes in each direction. Other recommended improvements included actuation of the side streets and installation of pedestrian push buttons at all intersections, not to create an exclusive phase, but to sufficiently extend the side street phasing to support the pedestrian crossings on the actuated side streets. Exclusive left turn bays were also recommended at each intersection.

Upon determination that only one through lane in each direction was necessary, the study then analyzed a number of alternative parking and lane scenarios for the CBD. The alternatives studied included three angle parking scenarios and two parallel parking scenarios. It should also be noted that while one solution could have been simply widening the sidewalks, it was deemed cost prohibitive due the length of the corridor. Observations also indicated that widened sidewalks were not necessary to attenuate the pedestrian volume and the business owners were not inclined to agree to maintain additional sidewalk upon completion of the project.

Head or Pull In Angle Parking on Both Sides of High Street

At the time of the 1995 study, the use of Back In Angle Parking was not considered. Furthermore, since PENNDOT criteria did not permit and general traffic engineering practice did not recommend backing out of parking spaces into live traffic lanes, a 10 foot (3.05 meter) maneuver lane was considered necessary adjacent to the parking.

The analysis concluded that even with a minimal 22.5 degree angled space; the angle parking on each side of the street would require a total of 50 (15.25) of the available 68 feet (20.74 meters) [15 feet (4.57 meters) for a 9 x 18 foot (2.74 x 5.49 meter) space plus the 10 foot (3.05 meter) maneuver lane]. The remaining 18 feet (5.49 meters) would be insufficient to support at least one lane in each direction let alone any exclusive turning lanes. This alternative, therefore, was dropped from further consideration.

Head or Pull In Angle Parking on One Side of High Street with Parallel Parking on the Other

The analysis of this alternative indicated that there was sufficient width on High Street to support the 22.5-degree angled space and associated 10-foot (3.05 meter) maneuver lane on one side of the street and accommodate a 12 foot (3.66 meter) travel lane in each direction, an 11 foot (3.35 meter) painted median and an 8 foot (2.44 meter) parking lane on the other side of the street. While this alternative was considered for further investigation it was eventually eliminated by the Borough when it was determined that there would be minimal additional increase in parking with the 22.5 degree angled space.

Head or Pull In Angle Parking Down the Center of High Street

An alternative was considered that included an interlocking angle parking module down the center of High Street. However, it was determined that a total of 57 feet (17.38 meters) would be required which would leave only 11 feet (3.35 meters) available for both directions of travel. Furthermore, the Borough was not interested in encroaching onto the existing sidewalk, essentially making the street wider, when the crux of the issues was the width of the street. This alternative was not considered further.

Parallel Parking Along Both Sides, Each Direction

This alternative was initially investigated because it had the potential to provide for additional parking and, through the construction of the necessary center island, provide a pedestrian refuge island, which would aid in crossing the wide street. This alternative would provide parallel parking both left and right of each single travel lane along with the aforementioned center island. However, with two, 8-foot (2.44 meter) parallel parking lanes on each side and a 4 to 8 foot (1.22 to 2.44 meter) median, only a 14 to 16 feet (4.27 to 4.88 meter) travel lane, per direction, would be available. While certainly adequate to handle through traffic, there was no efficient way to handle bus stops, delivery vehicles, etc., without blocking the only available through lane. Also, only eliminating some of the parking spaces at the intersections could accommodate left turns. Finally, the potential of parking maneuvers on both sides of a through lane, coupled with potential pedestrian presence and vehicle entry and exit on both sides of the through lane was deemed more appropriate for a parking lot but not conducive to traffic safety, pedestrian safety or the efficient movement of traffic on the arterial highway. This alternative was not recommended for further consideration by the consultant.

Creation of an Exclusive Bus Lane

The final alternative analyzed in the 1995 Study was conversion of the right hand through lane on each side to an exclusive bus lane. It was proposed that the exclusive bus lane could also serve as a short duration location for delivery vehicles and provide a maneuver area for drivers accessing the parallel parking lanes. Allowing bicyclist to use the bus lane was also discussed. A possible bus priority system, in conjunction with the exclusive bus lane, was also discussed but was eventually dropped from consideration due to the high cost for the installation of the equipment, the relatively large headways (30 minute peak) and the fact that the signals were already operating at a relatively high level of service. This alternative was put forth as the preferred alternative, but did not meet with the acceptance of the Borough as it failed to address the pedestrian crossing issues and the time necessary to cross High Street as a result of the still wide street width.

Nonetheless, the 1995 Study did confirm that traffic volumes on High Street could safely and efficiently be handled with only one through lane in each direction.

The 2001 Study

Following the completion of the 1995 Study, a number of meetings were held and presentations were made to better ascertain the needs and desires of the downtown stakeholders. It was clear that the Borough still wished to leverage additional parking and a friendlier pedestrian environment as a means to revitalize the downtown area and that conventional methods and thinking would not likely meet those goals. The concept of employing reverse angle or back in angle parking was actually initiated by the Borough's Planning Commission and upon request from the Commission, the Borough commissioned a new study to evaluate the appropriateness of back in angle parking on High Street. The new study was to be a follow-up to the previous 1995 Study, as back in angle parking was not considered previously.

New to the study parameters this time was also Montgomery County's designation of High Street as a Bicycle Route. There was now a strong interest in also accommodating dedicated bike lanes on High Street in response to the County's designation and as a means of also attracting more interest and patronage to the downtown as there exists a strong interest in bicycling along the Schuylkill River corridor.

The initial approach to the study was to establish t he minimum required lane widths for the conventional elements of the roadway cross-section. In accordance with PENNDOT's criteria for an urban arterial, the minimum acceptable width for through lanes was 11 feet (3.35 meters). It was also determined that the center median/turn lane would remain as it was critical to maintaining the necessary levels of service. PENNDOT's minimum criterion for auxiliary lanes is 10 feet (3.05 meters), therefore leaving 36 feet (10.98 meters) of the 68-foot (20.74 meters) width available to support the parking and bicycle lanes.

PENNDOT has detailed regulations governing the implementation of angle parking on state highways including requirements for performing an Angle Parking Study for review and approval by the Department prior to permitting installation. PENNDOT criteria actually specifies a minimum width for the parking and the maneuver space as follows: *"The parking and maneuver area adjacent to the near edge of the nearest travel lane equals or exceeds 30 feet for parking spaces at a 45 degree angle."* With 36 feet (10.98 meters) available, it would, theoretically, be possible to implement angle parking on one side of the street only with 6 feet (1.83 meters) available for a single bike lane. The downtown stakeholders were, however, not inclined to accept the elimination of parking on one side of the street. Furthermore, with parking only provided on one side of the street, questions were raised as to how drivers proceeding in the opposite direction would be able to utilize the spaces. Additionally, there was little interest in reducing the angle of the spaces as the additional yield, as noted previously, was not sufficient to justify the installation of the angled spaces.

Having determined that angle parking would likely only be possible on one side of the street, the decision was made retain parallel parking on the opposite side. PENNDOT's minimum criterion for the width of parallel parking along an urban arterial highway is 8 feet (2.44 meters). It was also determined at this point to set a minimum width for the bicycle lane. In accordance with American Association of State Highway and Transportation Officials (AASHTO) criteria, the minimum recommended width for two directional travel is 10 feet. This width was also

consistent with PENNDOT's criteria. With all the other minimum widths established and agreed upon, this left 18 feet (5.49 meters) available for angle parking. In order to maximize the amount of parking, it was decided to utilize an 8 foot, 6 inch (2.59 meter) wide space, which is consistent with National Parking Association (NPA) criteria for a 45-degree angle space.

Back In Angle

The available 18-foot (5.49 meters) width clearly did not meet PENNDOT's minimum criteria. Even the NPA guidelines recommended a 9 foot, 2 inch (2.80 meter) maneuver area to access the space, which would require a minimum of 27 feet, 2 inches (8.29 meters) which, while less than the PENNDOT required minimum space, still exceeded the available space. However, in meetings with the Department, it was pointed out that PENNDOT standards did not specify whether the angle parking criteria applied to traditional pull in or back in angle parking and, since there were no examples of back in angle parking in Pennsylvania, it was clear that the PENNDOT criteria only applied to pull in angle parking. It was agreed that a maneuver area was necessary for traditional pull in angle spaces so that vehicles can re-enter the roadway safely. When backing up from a pull in angle space, an operator, temporarily, has no view of the approaching traffic for a period of time dependent upon the length of his or her vehicle and the length and composition of the vehicle to the right. The maneuver area is necessary to provide the operator a safe place to back into during this essentially blind reverse maneuver. However, with back in angle parking, it was argued that no such maneuver area was necessary since vehicles exit forward from the space.

The human biomechanical motion necessary to enter a back in angle parking space is similar too, if not easier than entering a parallel parking space. The prescribed method for entering a parallel parking space entails three distinct steps. First, the operator pulls past the parking space. Second, the operator proceeds in reverse into the space, on a diagonal, as far as possible. Third, the operator pulls forward while turning toward the right to bring the vehicle parallel to the curb. The second step, wherein the operator pulls backwards into the parallel space, typically places the vehicle at an approximate 45-degree angle with the travel lane. For a 45 degree back in angle space therefore, the operator only needs to complete the first two steps of the typical parallel parking maneuver wherein the operator pulls past the space, than proceeds in reverse into the space, completing the move. When leaving the space to re-enter the highway, the back in angle space has a clear advantage over the parallel parking space. When exiting a parallel parking space, an operator must turn his or her field of vision up to 180 degrees and look backward to be able to view approaching vehicles and identify gaps in which to re-enter the traffic stream. In pulling out from a 45 degree angle space, the maximum that the operator must turn his field of vision is 135 degrees to be able to see approaching vehicles from his left. Furthermore, this movement requires only that the operator turn sideways, not backwards presenting a slightly more 'comfortable' position for the operator.

Based on the above discussion, it was successfully presented to the Department that given the fact that it is theoretically easier to enter and exit a back in angle parking space than a parallel parking space, and no maneuver area is typically required for parallel parking lanes in an urban zone, accordingly, no additional maneuver area would be necessary nor should be required for back in angle parking.

Accommodation of Bicycles

As discussed previously, the accommodation of bicycles within the roadway cross section was of key importance to the stakeholders, and sufficient width was planned for their presence. The question at this point then, was where to accommodate the bike lanes within the cross section. There was some consideration given to placing a two-directional bike lane adjacent to the angle parking spaces, thereby also providing the much discussed maneuver space, however, this concept was not advanced further since it would place bicycle traffic adjacent too and traveling in the direction opposite of the primary flow of traffic on the side that the angle parking was installed which would violate standard practice and Pennsylvania's Vehicle Law. In general, bicycles traveling within roadways shared with other vehicular modes should travel in the same direction of the primary flow of traffic.

It should also be noted that, in general, traditional pull in angle parking and bicycling do not mix well, especially when the bike lane is installed behind the parked vehicles or shares the maneuver space for the parked vehicles. Whereas backing into moving vehicular traffic can be dangerous, backing into moving bicycle traffic can be even more dangerous, especially for the cyclist which present a smaller profile and are harder to see for the backing motorist. Back in angle parking, on the other hand, can co-exist well with cyclist and other forms of non-motorized vehicles. When entering a space during the backing maneuver, the cyclist can see the backing vehicle in sufficient time to take alternate action, even if the vehicle operator fails to see the cycle. When leaving the space, the vehicle operator has sufficient sight distance to the left to see approaching cyclist. Analyses for the High Street project demonstrated that a vehicle operator looking toward the left from the parked position could seen a minimum of 14 feet (4.27 meters) down the bike lane which is sufficient stopping distance for a cyclist traveling at 10 miles per hour (16 meters per hour) on a wet pavements surface. This analysis assumed that there was an adjacent parked car to the left and that car completely blocked the vehicle operator's field of view, which is not always the case. Of course, as the operator begins to pull out of the space, the field of view opens up substantially.

Ultimately, is was decided to locate a single 6 foot (1.83 meter) bike lane to the right of each travel lane, adjacent to the parallel and back in angle parking, respectively. The combined 12-foot (3.66 meter) width was 2 feet (0.61 meter) more than originally allowed for in the design, which required shortening the back in angle parking spaces by 2 feet (0.61 meter) to 16 feet (4.88 meters). Analysis was performed as to the impact of this shortening on the amount of available parking space and resultant impact to the bike lane and it was found that for the current, average car/light truck length of 17 feet, 8 inches (5.39 meters), up to 1 foot, 8 inches (0.51 meters) would encroach into the bike lane, assuming there was no vehicle overhang at the curb line. The remaining 4 feet, 4 inches (1.32 meters) exceeded PENNDOT's minimum criteria for a one directional bike lane and therefore, was acceptable. The final cross section is illustrated in Figure 1.

The widening of the bike lanes and resultant shortening of the angle parking spaces was deemed necessary to retain some of the previous operational characteristics of High Street. Under existing conditions, delivery vehicles, mail vehicles, buses and the like sometimes stop in the

right hand travel lane, temporarily, to make deliveries, etc., with minimal impact to the through movement of traffic due the excess capacity of the current system. With the trough lane reduction, however, a vehicle stopped in the only available lane could adversely impact through movement. By providing a 6-foot (1.83 meter) wide bike lane, delivery vehicles can share this lane, temporarily with the cyclist, without adversely impacting through vehicular traffic. While it is recognized that the 6-foot lane is not wide enough to support most delivery vehicles, in combination with the adjacent 11-foot (3.35 meter) travel lane, the total 17 feet (5.18 meter) width would be sufficient for vehicles to pass safely around delivery vehicles. Furthermore, with the 10-foot (3.05 meter) median remaining painted and flush with the pavement surface, additional maneuver space is available for through vehicles to pass parked delivery vehicles. The wide bike lane also provides maneuver space for both the parallel and back in angle parking which reduces impacts to the through movements.

Experience of Others

As part of the effort, both the Borough's consultant and the Borough Planning Commission investigated locations that had back in angle parking to garner input into their experiences. This survey was completed after the Pottstown cross section had been established. Neither Pennsylvania nor neighboring New Jersey had any experience with or locations where back in angle parking had been implemented, however, neighboring Delaware and a few other locations across do have back in angle parking in place at this time.

Wilmington, Delaware, USA

The City of Wilmington Delaware has six blocks of 60 and 90 degree, back in angle parking dating back fifty years. By City Ordinance, Wilmington requires that all angle parking be back in. For 60 degree parking, regulations require 19 feet (5.79 meters), measured from the curb, for the parking space and a minimum 11-foot (3.35 meter) travel lane for a total width of 30 feet (9.15 meters) per direction. (Pottstown's one direction width, with the bike lane and 45 degree angle is 33 feet (10.06 meters)). The highest daily traffic for any block with angle parking is 6,500 vehicles per day and reports no significant problems with accidents of traffic flow resultant from the back in angle parking.

Seattle, Washington, USA

The City of Seattle Washington has about 280 blocks of angle parking, with the majority being back in angle parking and has employed the concept for over 30 years. Apparently, back in angle is preferred to pull in angle because it is perceived to be safer, especially for pedestrians.

Washington, D.C., USA

The City of Washington, D.C. has six blocks of back in angle parking dating back 15 to 20 years. The busiest location (2400 block of 18th Street NW) has an ADT of 9,200 with two lanes of traffic in each direction and no maneuver space in front of the parking.

Indianapolis, Indiana, USA

The City of Indianapolis Indiana has only one block of back in angle parking that has been in place for 15 years. The street, New York Avenue, is a one-way street with three through lanes and an ADT of 13,800. An exclusive right hand turn lane exists adjacent to the parking.

Montreal, Quebec, Canada

City of Montreal has had a pilot project for reverse angle, or back in angle parking since March 2001. To this date there has been no accidents reported. The project was apparently initiated as a method of traffic calming for the 12.7-meter (41.64 foot) one-way street and to increase parking for residents, their visitors and merchants (more parking meters at intersections). Angle parking on one side increased parking by 40% (48 to 67) and the travel lane was reduced from 7.7 meters (25.24 feet) to 4.8 meters (15.74 meters). Reportedly speed was also reduced 5 km/h. The parking angle was adjusted from the original 40% to 43%.

IMPLEMENTATION

The proposed layout was approved by the Borough Council and endorsed by three local, downtown organizations, the County, and Dan Burden of Walkable Communities, Inc., who reviewed the plan at the request of the Planning Commission. The plan was also conditionally approved by PENNDOT in a letter from the Pennsylvania Secretary of Transportation, pending implementation and a final review and report after installation. Design of the project was funded partially by a grant from the Delaware Valley Regional Planning Commission (DVRPC), the Philadelphia region's local Municipal Planning Organization (MPO), through their competitive Transportation and Community Development Initiative (TCDI) program. The implementation of the re-designed striping was carefully orchestrated to follow a planned maintenance resurfacing of High Street.

The design followed the established cross section. Parking was restricted for 20 feet (6.1 meters) in advance of the near cross walk line on approaches to signals per the Manual on Uniform Traffic Control Devices (MUTCD), 2000. Parking was also restricted within 20 feet (6.1 meters) of un-signalized streets and driveways per the Pennsylvania Vehicle Code. Pavement markings were designed consistent with PENNDOT requirements and the MUTCD with no special or otherwise non-standard markings necessary. A special R-series red on white, 12 inch by 18 inch (0.30 x 0.46 meter) "BACK IN ANGLE PARKING ONLY" sign was developed and installed behind every third space.

On additional advantage of the angle parking was the ability to provide for a handicap accessible stall in each block, something rarely provided for in downtown, on street parking. A 13-foot (3.96 meter) wide handicap-parking stall was incorporated into the angle parking as the last space, intersection nearside, of each block. This placed the space close to the existing curb ramps. The accessible space is identified with the appropriate stripe color, legend and signage to identify it as such. 50-foot (15.25 meter) long bus stops are also located at the far side of each intersection to accommodate bus boarding and bus layover if necessary, without blocking the through lane.

The decision as to which side of the street to locate the back in angle parking on was cause for much discussion among the stakeholders. Ultimately, the decision was based entirely on which side would yield the biggest increase in parking, and that was found to be the north side of High Street. The additional parking yield over the existing parallel parking, per block, varied greatly depending on the location of driveways, no parking zones and the like, with some blocks gaining as many as 23 spaces and some blocks as few as 2 spaces. Overall, the downtown area gained a total of 95 new spaces, a 21% increase over existing conditions.

As the back in angle parking was installed on only one side of the street, the centerline of the roadway was now offset from the centerline of the pavement surface. While this was not an issue due to the minimal cross sectional grades, it did require relocation of the traffic signal heads at each intersection, to better align them with the relocated through lane. On the south side of High Street, the traffic signal heads were moved inward on the existing mast arms, but on the north side of the street, new mast arms were required to accommodate the back in angle parking. At the same time, the existing electromechanical signal controllers were replaced with new, solid state controllers and coordinated with each other to accommodate the through lane reduction.

The revised parking also necessitated the relocation of the existing parking meters, of course. However, relocation of existing street trees, light posts, signage, street furniture and other sidewalk appurtenances were not deemed necessary at this time. By virtue if the wide, existing sidewalk, much of the typical downtown sidewalk fixtures on High Street are already located a few feet back from the existing curb face. Furthermore, do to the relatively shallow parking angle, not much overhang from the parked vehicles is expected. Therefore, the Borough has adopted a "wait and see" approach with regards to relocation or protection of existing sidewalk appurtenances.

Before finalization of the construction plans, the entire corridor was walked, with draft final plans in hand by representatives of the Borough Council, Planning Commission, Public Works Department, Borough Manager's office and the design consultant to better ascertain any design impacts of the proposed plans, and address any concerns and anticipated problems, proactively.

Future Phases

As of the end of April 2003, the resurfacing has been completed and the necessary signal work and revised striping is being installed. The Borough is reluctant to advance the project further at this point, until the functionality of the back in angle parking has been proven. At this point, if the back in angle parking did not meet with general public acceptance, than the Borough could simply re-stripe High Street to some other configuration at minimal cost. An article on the front page of the Philadelphia Inquirer describing the back in angle parking was entitled "*Inspiration or idiocy?"* so there is still some negative public perception that needs to be overcome with the back in angle parking. To that end, the Borough has been keeping the residents informed, through the regular Borough newsletter, including articles on how to utilize the parking.

The Borough, however, is anticipating the success of the project and acceptance by the public and, to that end, is planning for future, accompanying improvements. In the near future, the Borough, along with several adjacent municipalities, will be undertaking the design of a closed

loop traffic signal system, which will encompass the High Street corridor. At this time, the High Street signals will be further upgraded to incorporate separate left turn phasing at the intersections, actuation of the cross streets and incorporation of pedestrian push buttons which should further improve conditions for both motorist and pedestrians, alike.

It has also been the recommendation of the design consultant, that the Borough consider the construction of pedestrian 'bulb-outs' or sidewalk extensions at the intersections. The bulb-outs would shelter both the parallel and back in angle parking better and would decrease the street width and subsequent pedestrian crossing time by 35% at the intersections. The bulb-outs would also help reinforce the perception of a more intimate downtown setting and serve as an additional traffic calming measure. It was also suggested that consideration be given to a raised center median. However, considering the left turn lanes and the narrow width, the median would not extend all the way to most intersections, thereby providing no pedestrian refuge benefit and, for certain community events, the Borough closes High Street and it was thought that a raised median could hinder the ability to support these types of events such as parades and the like. It was also felt that a raised center median could adversely affect snow-clearing operations. Plus as noted previously, the flush, painted median provides some additional maneuver space around parked delivery vehicles.

SUMMARY

This context sensitive solution demonstrates that back in angle parking can be effectively integrated into the downtown environment and co-exist along an arterial highway employing current, minimum design standards. In addition to creating more parking over traditional parallel parking, back in angle parking can also be used as a traffic calming/street narrowing tool, can enhance pedestrian functionality and walk-ability within the downtown area and can work harmoniously with bicycle lanes, all resulting in a more attractive and intimate downtown corridor enhancing the downtown experience and leading to increased economic investment.

Traffic and Transportation Engineers must realize that our roadway and transportation systems are expected to serve all modes of travel, equally. And although traditional measures of effectiveness may suggest high mobility for certain modes, the true functionality of the roadway must address these multi-modal demands within the context of the roadway's location.

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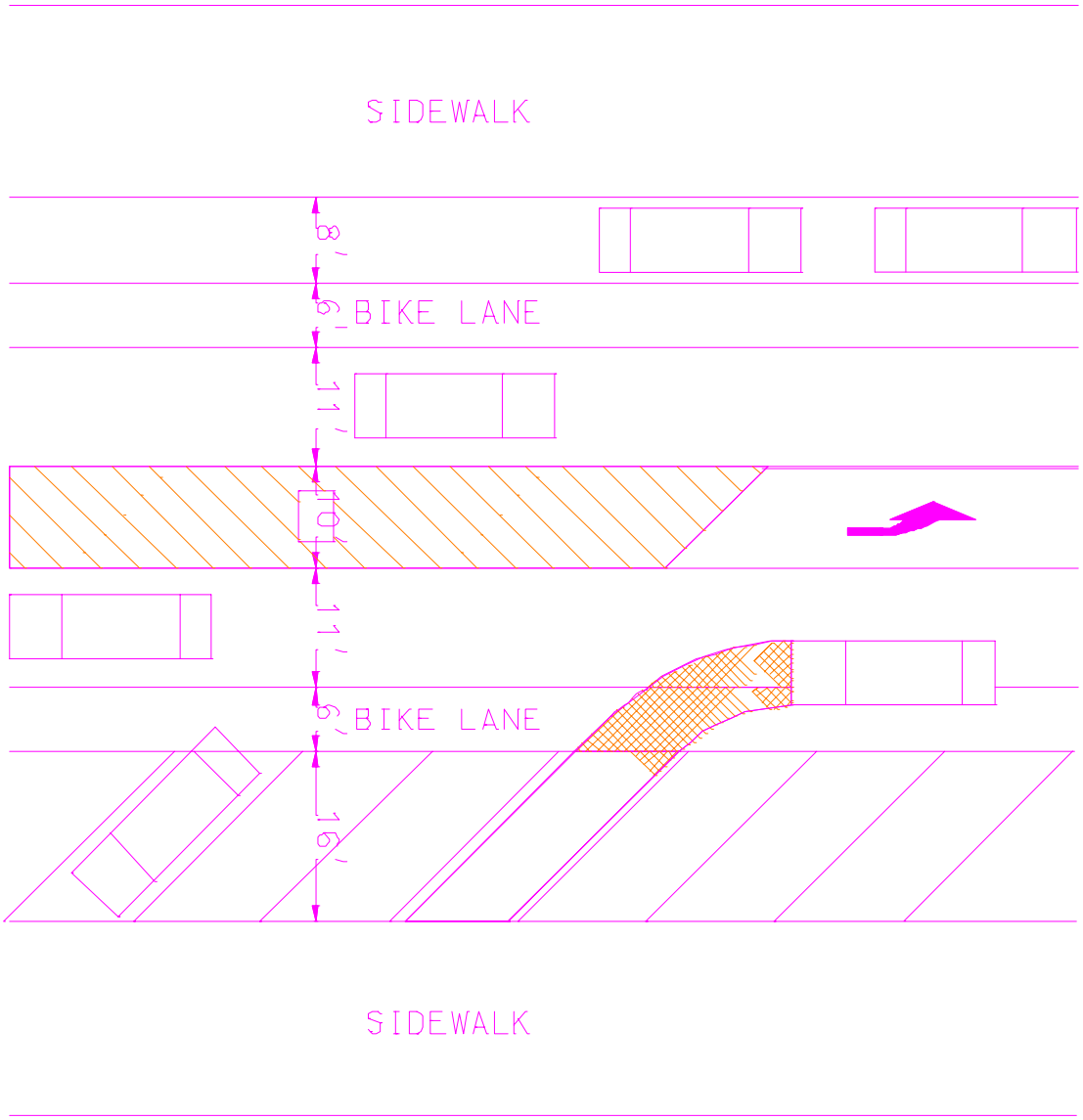

Not-to-Scale

Figure 1. Back in Angle Parking Diagram.