Back-in/Head-out Angle Parking

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Introduction

In recent years the use of back-in/head-out angle parking has increased steadily in cities across North America. There are several reasons for this development. Kulash and Lockwood (2003) state that:

"Back-in/head-out diagonal parking is superior to conventional head-in/back-out diagonal parking. Both types of diagonal parking have common dimensions, but the back-in/head-out is superior for safety reasons due to better visibility when leaving. This is particularly important on busy streets or where drivers find their views blocked by large vehicles, tinted windows, etc., in adjacent vehicles in the case of head-in/back-out angled parking. In other words, drivers do not back blindly into an active traffic lane. The back-in maneuver is simpler than a parallel parking maneuver. Furthermore, with back-in/head-out parking, the open doors of the vehicle block pedestrian access to the travel lane and guide pedestrians to the sidewalk, which is a safety benefit, particularly for children. Further, back-in/head-out parking puts most cargo loading (into trunks, tailgates) on the curb, rather than in the street."

The growing presence on American streets of sport utility vehicles (SUVs), with their bulky rear ends and (frequently) tinted windows may have spurred the trend toward back-in/head-out angle parking: when using conventional angle parking, drivers increasingly find themselves beside an SUV, with more difficult sightlines.

This report briefly discusses the design and benefits of back-in/head-out angle parking and shows where the design has already been implemented.

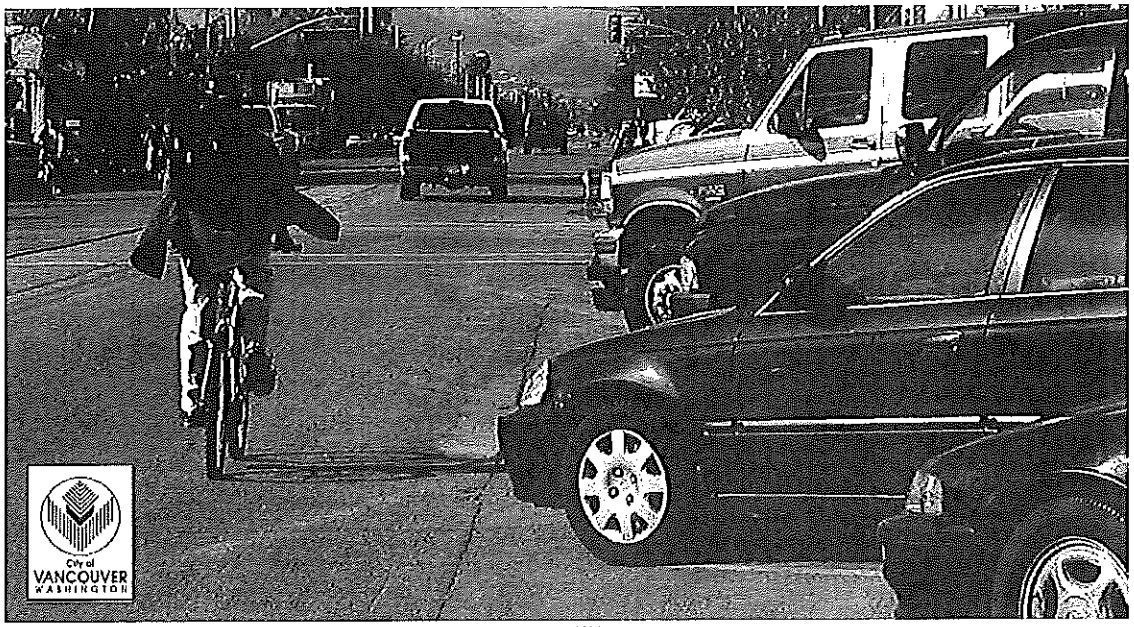
Some examples

In Tucson, AZ, two blocks of reverse diagonal parking have been installed along the University Boulevard Bikeway (see Figure 1), which leads into the west entrance of the University of Arizona (~36,000 students). In the two years of reverse diagonal parking, there have been no accidents along the segment, despite the large number of cyclists using the bikeway.

Figures 2-4 illustrate some of the benefits of back-in/head-out angle parking. In Figure 2 the driver is able access her trunk from the curb rather than from the street. Figures 3 and 4 show that the driver can have eye contact with oncoming traffic, in this case a bicyclist.

Figure 5 shows typical signage used to introduce drivers to back-in/head-out angle parking. For more examples on back-in/head-out angle parking, see Appendices A and B.

Figure 1 Back-in/Head-out parking in Tucson, AZ.



Source: T. Boulanger, Transportation Services, City of Vancouver, WA.

Figure 2 With back-in angle parking you can load your car on the curb, rather than in the street (Vancouver, WA).

Source: T. Boulanger, Transportation Services, City of Vancouver, WA.

Figure 3 An 'eye-to-eye' line of sight between parker and approaching road-user (Vancouver, WA).

Source: T. Boulanger, Transportation Services, City of Vancouver, WA.

Figure 4 The parker's view of the on-coming traffic (Vancouver, WA).

Source: T. Boulanger, Transportation Services, City of Vancouver, WA.

Figure 5 **A traffic sign showing the three steps of back-in angle parking, in Kelowna, BC, Canada.**

Source: City of Kelowna, British Columbia, Canada.

Advantages

Back-in/head-out angle parking is similar to both parallel and standard angle parking. As with parallel parking, the driver enters the stall by stopping and backing, but need not maneuver the front of the vehicle against the curb. When leaving the stall, the driver can simply pull out of the stall, and has a better view of the oncoming traffic.

Bicyclists

This type of parking provides a safer environment for bicyclists using the roadways. The driver is able to see the cyclist easily when exiting the stall. Several cities where back-in angle parking has been implemented have seen a reduction in number of accidents compared to the number of accidents at regular parallel parking schemes. Matt Zoll at

Tucson-Pima County Bicycle Advisory Committee says that after implementing the back-in/head-out angle parking scheme in Tucson they "went from an average of 3-4 bike/car accidents per month to no reported accidents for 4 years following implementation."

Visibility

In contrast to standard angle parking the visibility while exiting a back-in/head-out angle parking into traffic is much improved. When the driver is backing up (into the stall), the driver is in control of his lane: traffic behind either waits, or changes lanes.

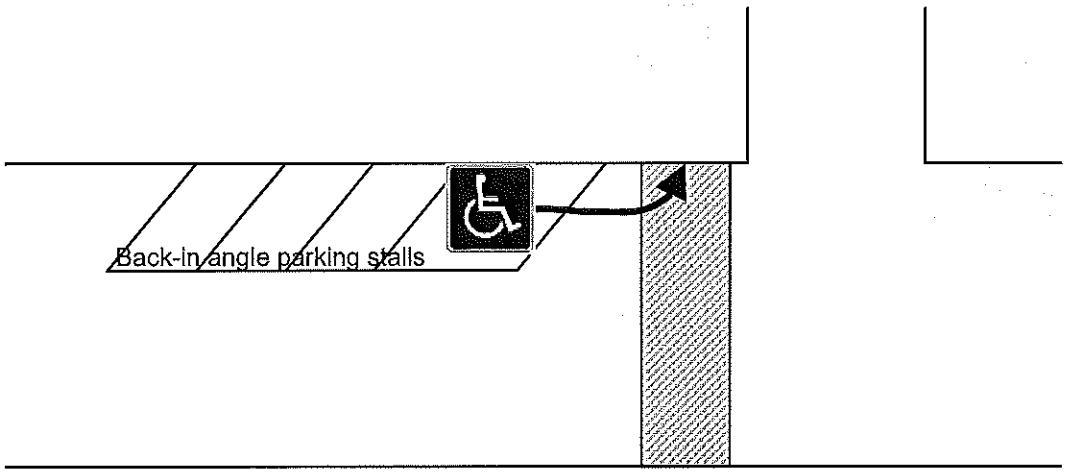
Steep terrain

Back-in angle parking can also be useful on steep terrain: if used on the correct side of the street, it causes drivers to automatically curb their wheels, which in turn prevents runaway autos. Used on the wrong side of a steep street, however, it is likely to cause more runaways.

Disabled parking

In Pottstown, PE, a 13-foot wide handicap accessible stall has been incorporated into the angle parking as the last space, intersection nearside, of each block. This places each disabled parking stall close to the existing curb ramps, and allows the wheelchair-using drivers to unload out of the way of traffic (see Figure 6). By contrast, the street's previous parallel parking arrangement could not be safely used for disabled parking, and conventional angle parking raised safety concerns for the street's proposed bicycle lanes.

Figure 6 **A disabled parking stall located right next to the pedestrian crossing and the curb ramp.**



Safety

As SLCTrans (2004) states, "one of the most common causes of accidents is people backing out of standard angled parking without being able to see on-coming traffic. Reverse angled parking removes this difficulty." It also improves safety for cyclists, and for loading/and unloading the trunk of the car. Similarly, the *Urban Transportation Monitor*'s recent article on back-in angle parking reported reduced accidents and benefits for bicyclists in several communities. In all, back-in/head-out angle parking is a good choice when compared to conventional head-in angle/back-out parking and parallel parking.

Cities using back-in/head-out angle parking

The list of cities in North America that use back-in/head-out angle parking is growing. Figure 7 lists some of these communities.

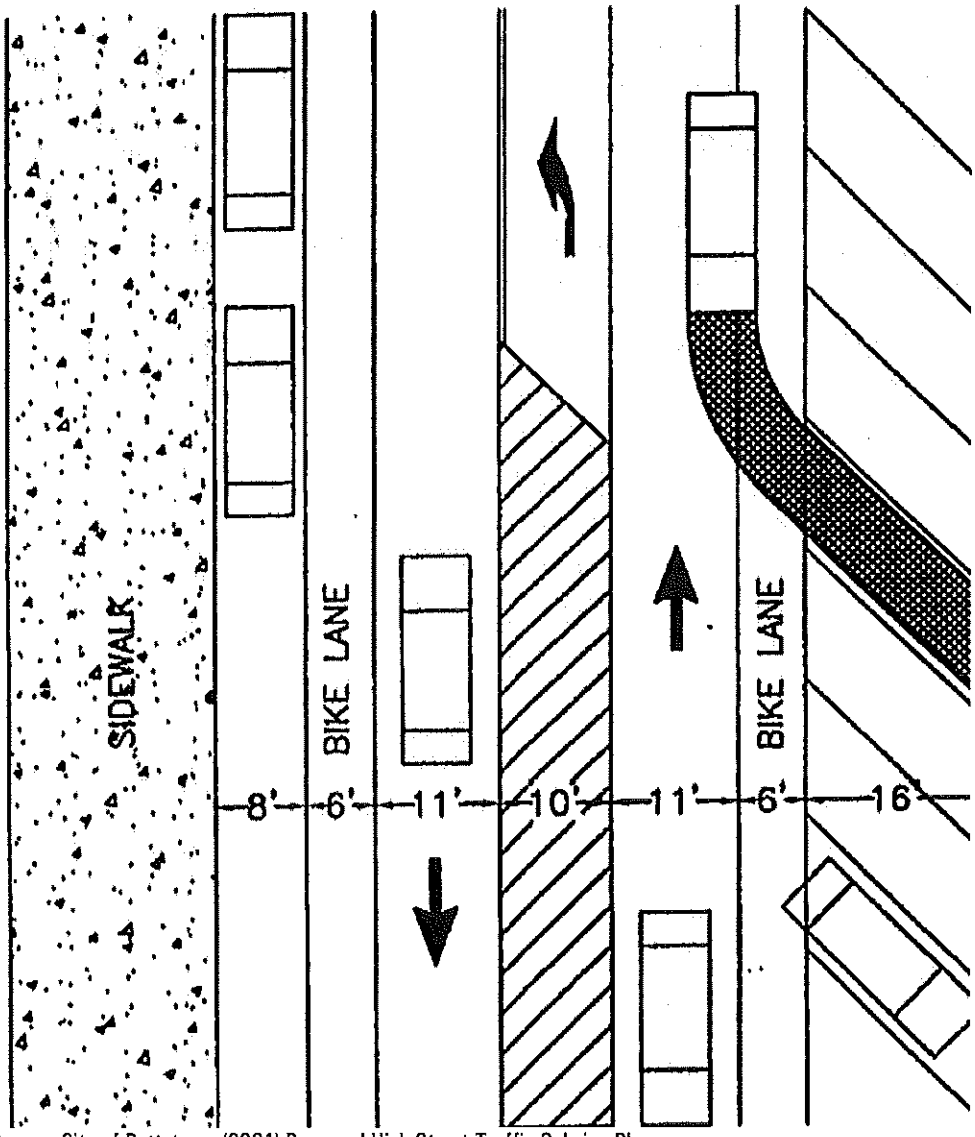
Figure 7 Cities using back-in/head-out angle parking.

City	Source	
Arlington, VI	Dan Burden	Walkable Communities, Inc.
Birmingham, AL	Russ Soyring	City of Traverse City, MI
Burnaby, Canada	Dan Burden	Walkable Communities, Inc.
Charlotte, NC	Dan Burden	Walkable Communities, Inc.
Chico, CA	Patrick Siegman	Nelson\Nygaard
Everett, WA	Michael M. Moule	Livable Streets, Inc
Honolulu, HI	Dan Burden	Walkable Communities, Inc.
Indianapolis, IN	Michael M. Moule	Livable Streets, Inc
Knoxville, TN	Michael M. Moule	Livable Streets, Inc
Marquette, MI	Russ Soyring	City of Traverse City, MI
Montreal, Canada	Michael M. Moule	Livable Streets, Inc
New York, NY	Dan Burden	Walkable Communities, Inc.
Olympia, WA	Dan Burden	Walkable Communities, Inc.
Plattsburgh, NY	Dan Burden	Walkable Communities, Inc.
Portland, OR	Michael M. Moule	Livable Streets, Inc
Pottstown, PA	Michael M. Moule	Livable Streets, Inc
Salem, OR	Todd Boulanger	City of Vancouver, WA
Salt Lake City, UT	Dan Burden	Walkable Communities, Inc.
San Francisco, CA	Michael M. Moule	Livable Streets, Inc
Seattle, WA	Dan Burden	Walkable Communities, Inc.
Tacoma, WA	Dan Burden	Walkable Communities, Inc.
Tucson, AZ	Michael M. Moule	Livable Streets, Inc
Vancouver, WA	Todd Boulanger	City of Vancouver, WA
Ventura, CA	Todd Boulanger	City of Vancouver, WA
Washington, DC	Dan Burden	Walkable Communities, Inc.
Wilmington, DE	Michael M. Moule	Livable Streets, Inc

Typical dimensions

Particularly when accommodating bike lanes within the roadway, back-in/head-out angle parking is useful. Figure 8 shows the cross-section of such a roadway in Pottstown, PA. Appendix C and D shows Vancouver's, WA, and Seattle's, WA, choices of dimensions for this type of parking.

Figure 8 Cross-section of a roadway accommodating both bike lanes and back-in/head-out angle parking.



Source: City of Pottstown (2001) Proposed High Street Traffic Calming Plan.

References

City of Pottstown (2001) Proposed High Street Traffic Calming Plan.

City of Pottstown (2004) Back In Angle as a Way to Improve Pedestrian Circulation in the Central Business District High Street, Pottstown Borough, Montgomery County, Pennsylvania, USA.

City of Vancouver, WA (2004) Angle Back In Parking Striping. Standard Plan Number T29-62.

Kulash, W. M. and Lockwood, I.M. (2003) *Time-saver Standards for Urban Design*, 7.2—5, McGraw-Hill Professional, New York, New York.

Nawn, J. (2003) Central Business District Back In Angle Parking. November/December *PE Reporter*, pages 11-13.

SLCTrans, Salt Lake City, UT (2004) Back-in or Reverse Angle Parking - FAQ. http://www.slcgov.com/transportation/Aboutus/FAQ.htm.

Urban Transportation Monitor. Back-in Angle Parking. June 11, 2004, page 1.

APPENDIX A

NAWN, J.A. (2003) CENTRAL BUSINESS DISTRICT BACK IN ANGLE PARKING. *PE REPORTER*, NOVEMBER/DECEMBER ISSUE, P. 11-13.

Central Business District Back In Angle Parking

John A. Nawn, P.E., PTOE

In August 2003, the Pottstown borough completed back in angle parking along the main street thorough its central business district (CBD). This is the first such application of back in angle parking in the Commonwealth of Pennsylvania.

In many community's central business districts, lack of parking close to retail and commercial establishments is seen as a 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." Competing needs of parking versus efficient vehicle movement can impede mobility and sometimes compromise safety.

Since the middle 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 for revitalization, specifically dealing with creation of a pedestrian friendly, multi-modal environment while maximizing the amount of parking and its proximity to retail establishments that line the downtown core. Through leveraging of and improvement to the existing transportation infrastructure, the community attempted to realize these goals.

Located in the Philadelphia, Pennsylvania metropolitan area and situated on the Schuylkill River, the Borough of Pottstown traces its routes to 1752. As the Borough developed, the CBD developed centered along High Street, making High Street the Borough's main street. At 5.5 square miles, Pottstown population is 21,859 (2000 census). Following the increase in automobile traffic after World War II, the High Street cross section was reconfigured to maximize automobile mobility. With 68 feet available between the curb lines, two 11-foot through lanes and a 7-foot parallel parking lane were created in each direction along with a 10-foot wide center turn lane/ painted median. Combined with a 16-foot sidewalk on each side, the face of the buildings on each side of the street are 100 feet apart, creating a very wide corridor through the CBD. The width of the corridor is visually perceived by some to be a deterrent to downtown redevelopment.

As a highway facility, High Street was an operational success... however, High Street was failing to meet more recent and progressive economic development and transportation goals.

In 1972, a four lane, grade separated, limited access freeway, U.S. Route 422, was constructed along the opposite side of the river from the Borough, essentially bypassing the CBD and drawing large amounts of the existing through traffic volume from High Street. High Street quickly became an underutilized transportation asset.

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

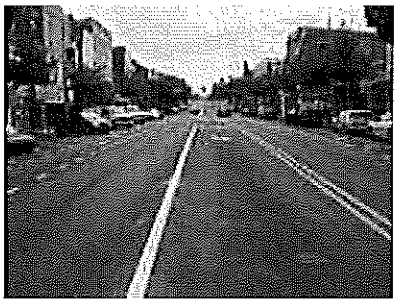
Increasing pedestrian traffic is one of the key objectives in the Borough's efforts to revitalize the CBD. However, High Street's configuration impeded these efforts. With four lanes of rapidly moving traffic, it was neither pedestrian nor shopper friendly. High Street's 68-foot cross-section was intimidating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

Downtown business owners identified a perceived lack of parking as a concern. Although metered, parallel parking was available on both sides of High Street throughout the CBD, it was generally 50%

"Back-in" continued on p. 12

"Back-in" continued from p. 11

utilized and, therefore, considered to be insufficient in addressing the potential needs of the downtown businesses, considering the number of vacancies. While a number of small surface lots had been created along High Street, the linear nature of the CBD makes this parking convenient to only adjacent businesses with long walks necessary for all other businesses.

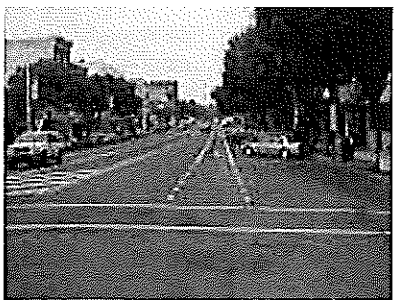


One of the region's transportation goals is to encourage the use of bicycles as an alternative to the automobile. High Street had been designated by Montgomery County as an official Bicycle Route connecting Pottstown with other communities along the Schuylkill River corridor. But, in its former configuration, High Street was not conducive to bicycle travel with no dedicated bike lanes and swiftly moving vehicular traffic.

State and regional plans recognize the connection between revitalizing 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. Therefore, the general thinking was that reconfiguring and calming traffic on High Street would address Pottstown's own economic development goals and have a positive impact on regional transportation and growth issues.

Clearly if the Borough was 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. The CBD study area generally encompassed a 1.1-mile corridor centered along High Street. Within this corridor, there are 10 signalized intersections. Of those, only two were equipped with pedestrian push buttons; side streets were not actuated; and all signals were uncoordinated, operating on fixed time cycles with side street phases sufficient to also support lengthy pedestrian times required to cross High Street. Improvements would include coordination of the signals and the addition of pedestrian push buttons to improve mobility and support the thorough lane reduction necessary to support additional angle parking.

One method used 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 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 who are critical to the success of the retail and commercial establishments in the CBD. At signalized intersections, 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.



It was clear that if the Borough wished to leverage additional parking and a friendlier pedestrian environment as a means to revitalize the downtown area, that conventional methods and thinking would not likely meet those goals. The concept of employing reverse angle or back in angle parking was 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 initial plan was to establish 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 is 11 feet. 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, therefore leaving 36 feet of the 68-foot width available to support the parking and bicycle lanes.

PennDOT has detailed regulations governing implementation of angle parking on state highways and specifies a minimum width for parking and maneuver space. With 36 feet available, it would be possible to implement angle parking on one side of the street only, with 6 feet available for a single bike lane. Downtown stakeholders were not inclined to limit parking to one side of the street. Furthermore, with parking provided on only one side of the street, the question was raised as to how drivers proceeding in the opposite direction would be able to utilize the spaces. 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. It was also determined at this point to set a minimum width for the bicycle lane, in accordance with AASHTO criteria, which

recommend a width for two directional travel of 12 feet. This width was also consistent with PennDOT's criteria. With all the other minimum widths established and agreed upon, this left 18 feet 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. The available 18-foot width, however did not meet PennDOT's minimum criteria. The design team, lead by John A. Nawn, P.E., PTOE, in meetings with the Department, 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 vehicles can re-enter the roadway safely. When backing up from a pull in angle space, an operator temporarily has no view of approaching traffic 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.

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. 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.

The proposed layout was approved by the Borough Council and endorsed by three local, downtown organizations, and the County. The plan was also conditionally approved by PennDOT. Design of the project was funded partially by a grant from the Delaware Valley Regional Planning Commission (DVRPC), through their competitive Transportation and Community Development Initiative (TCDI) program. Implementation of the re-designed striping was carefully orchestrated to follow a planned maintenance resurfacing of High Street.

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.

In addition to parking changes, existing electromechanical signal controllers were replaced with new, solid state controllers and coordinated with each other to accommodate the through lane reduction necessary to accommodate the new parking and bike lane.

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. ■

John A. Nawn, P.E., PTOE was the Project Manager for the Back In Angle Parking design and installation and had been associated with the project and the Borough's efforts since 1995. Mr. Nawn holds a Bachelor of Science Degree from Drexel University, and is currently employed by URS Corporation the Branch Manager of their Philadelphia Office. John, a licensed professional engineer in four states and a certified professional traffic operations engineer, has over 16 years experience in traffic engineering and has been a member of PSPE since 1990. John is currently the President of the Delaware County Chapter of the Pennsylvania Society of Professional Engineers.

The project was presented at and appears in the proceedings of both the Second Urban Street Symposium (a Transportation Research Board conference) and the 2003 Institute of Transportation Engineers Annual Conference.

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