PUBLIC TRANSIT RIGHT-OF-WAY

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This paper deals basically with when, where, and how priority treatment for transit should be provided. It is suggested that total people delay be used as the criterion for developing standards. Several examples are cited of exclusive transit rights-of-way, particularly in Europe and western Canada. In addition, some examples are given of exclusive signals used in Europe and in Edmonton, Alberta. The Edmonton experience is described including public participation before and after an exclusive lane was implemented. The paper concludes that there is a need in transportation agencies for a more uniform basis of data collection before and after implementation so that better standards can be developed.

•HISTORICALLY the streetcar had the right-of-way over other forms of transportation, but, as there has been a changeover to buses, transit no longer has right-of-way privileges that are different from other vehicular traffic.

As the level of service becomes lower because of increased traffic density, the operating speed of transit will be reduced. This reduction in speed will mean that, to maintain the same frequency of service, more buses will be required. In other words, the productivity of transit is reduced at a time when costs are increasing greatly and the potential demand is the highest.

To overcome this problem, the solution of providing exclusive rights-of-way to transit or of giving priority treatment to transit should be considered. The problem is basically when, where, and how this priority treatment should be provided.

DELAY AS A CRITERION

To reduce delay is the basic reason for implementing exclusive rights-of-way for transit; therefore, one must determine the total people delay and see whether this delay can be reduced by providing exclusive lanes.

The traffic engineer generally uses vehicle delay as a tool, for example, in setting traffic lights. A more objective measure would be the criterion of people delay, which uses the occupancy of the vehicles as a weighting factor.

Measuring delay at an intersection has been studied as a result of improving signal timing at an intersection or in a network. There are two basic cases:

1. Where the arrival pattern of vehicles in the queue is not known. In this case an estimate of vehicle delay can be made by using the simplified expression (3)

$$d = \left[\frac{g}{10} \frac{c(1 - \lambda)^2}{z(1 - \lambda\chi)} + \frac{\chi^2}{2q(1 - \chi)} \right]$$

where

d = delay in seconds,
λ = green to cycle time ratio = g/c,
g = green time in seconds,

c = cycle time in seconds,
q = actual flow in passenger cars per second,
s = saturation flow in passenger cars per second, and
χ = degree of saturation = $q/\lambda s$.

Field tests in Edmonton show that this expression gives results within 5 percent of actual delay.

2. Where the arrival pattern is known, as in the case of a simulation model of a signalized network or by actual counts. Departures are computed by assuming that the vehicles will leave the queue at the saturation flow during the green time.

Delays based on the arrivals and departures in the queue are shown in Figure 1 (4). The area below the arrival curve and above the departure curve will give the total delay.

To get the people delay, an average occupancy per vehicle has to be determined, preferably with occupancy counts. People delay is, therefore, vehicle delay weighted by the average occupancy per vehicle.

For an exclusive transit lane, the transit vehicles and their occupancy have to be excluded from the lanes available to other vehicles. The transit vehicle delay weighted by its occupancy can then be added to obtain the total people delay.

If the people delay occurring now is compared with the delay that would occur if there were traffic separation, an assessment can be made about whether the scheme is desirable or not. This type of evaluation is often better than the rules that specify number of buses per hour, number of lanes available, and total traffic volume. There is no reason why, on roads that are overdesigned or wastefully used, exclusive transit lanes should not be implemented. The big problem, however, is to obtain hard data and reliable methods of predicting the delay of mixed or separated traffic. In fact, the greatest benefit of an exclusive transit lane is the predictability of the speed of transit operation; this means that the reliability of the schedule can be assessed. This reliability of service is often more important on routes with an infrequent service than on those that have a frequent service.

WHERE TO USE TRANSIT LANES

In Europe there are now many examples of exclusive lanes for transit. Generally, these lanes have been established where the traffic congestion was severe and the delay became unbearable.

The Hague has no rapid transit system and relies on both streetcars and buses for its transit service. The city has a business center, two railway stations, a government center, and a seaside resort and has progressively extended exclusive transit lanes, usually in the median of the road. These transit lanes are used by streetcars, city transit buses, and interurban buses. The plan is to provide grade separation in the downtown core for the streetcars; hence the term premetro. New rail transit lines are also built to the outlying areas. This city pioneered in Holland an integrated route and fare system with the railways and interurban bus system.

Rotterdam has a rapid transit line linking both sides of the harbor. The surface system, as in the Hague, provides the remainder of the network. One line going north has an exclusive grade separation over an arterial road, a canal, a railway line, a freeway, and another road.

Delft not only has reserved transit lanes but also uses exclusive signal control. Loop detectors are buried below the exclusive lane and give a 4-sec transit phase whenever it can be fitted in the signal timing program. If there is a near-side stop, a double stop line is used because the loop detector is between the stop lines. The same principle is often applied at congested intersections where an exclusive approach lane is provided for transit.

Paris now provides many miles of curb lane that are reserved for buses or taxis. Usually these lanes replaced curb parking.

Edmonton, Calgary, and Vancouver in western Canada have implemented exclusive bus lanes; other bus lanes are in operation in Toronto. There are many bus lanes in the United States and in other countries in Europe.

Other schemes give priority to transit, such as permitting left turns by buses in locations where such turns are generally prohibited.

In Edmonton, bus crossing signals have been tried in a few locations since June 24, 1974. These signals are installed at a STOP approach and are actuated by the bus driver using a small transmitter. The signals are similar to a pedestrian crossing signal and in fact work in conjunction with a pedestrian crossing. The green time allowed for the bus is 4 sec, and the walk time for pedestrians is 10 sec; a clearance time of 6 sec is added to these times. Currently these signals are still experimental. Installation of traffic signals at these intersections may be justified based on traffic warrants but would encourage traffic detouring through residential areas. The locations are generally at a collector-arterial road intersection.

When first tried, the signal indication of the main arterial road was flashing yellow, which would change to steady yellow and then to red. However, flashing yellow means caution and a speed limit of 20 mph (32 km/h). The flashing yellow was changed to a normal green light; therefore, on the main road the signal looks no different than a normal traffic light. The side street, however, has a stop sign and pedestrian signals and the special transit T-signal.

Numerous other examples are given elsewhere (1) for many locations in the world.

Invariably all these schemes were implemented so that buses could bypass traffic congestion. The methods used varied: exclusive curb lanes, median lanes, contraflow lanes on freeways, contraflow lanes on one-way streets, or exclusive roads for buses (e.g., in Runcorn, England).

The suggested warrants of the Institute of Traffic Engineers for bus lanes are too restrictive:

1. A curb lane is practical under normal circumstances only during peak traffic periods when curb parking and stopping regulations can be implemented;
2. A minimum of 60 transit vehicles/hour should use the transit lane;
3. The width of the roadway must be sufficient for at least two lanes of travel in addition to the transit lane in the direction of the transit lane; and
4. The number of transit patrons should equal or exceed 1.5 times the drivers plus passengers carried by other vehicles in the peak hour.

Other criteria that should be considered, however, are as follows:

1. What is the present lane use? In Edmonton on 109th Street, one traffic lane was used by a few left turners. An exclusive bus lane along the curb could be created by banning the left turns in the peak hour and by moving the two other traffic lanes over. The seven-block length is peculiar in that the road is an approach to two river crossings, both of limited capacity. The buses now bypass the traffic lineup (Figure 2).
2. What is the total people delay now, and what will it be if traffic is segregated into bus and car lanes?
3. What is the total vehicle delay now and after implementation of a bus lane, and can this delay be reduced with a revised signal timing plan?

Implementation of exclusive bus lanes does not necessarily produce dramatic savings in time. However, the reliability of bus travel time will be greatly improved because schedules will become reliable, which, in turn, will mean shorter waiting times at the bus stops.

Figure 1. Delay based on arrivals and departures in the queue.

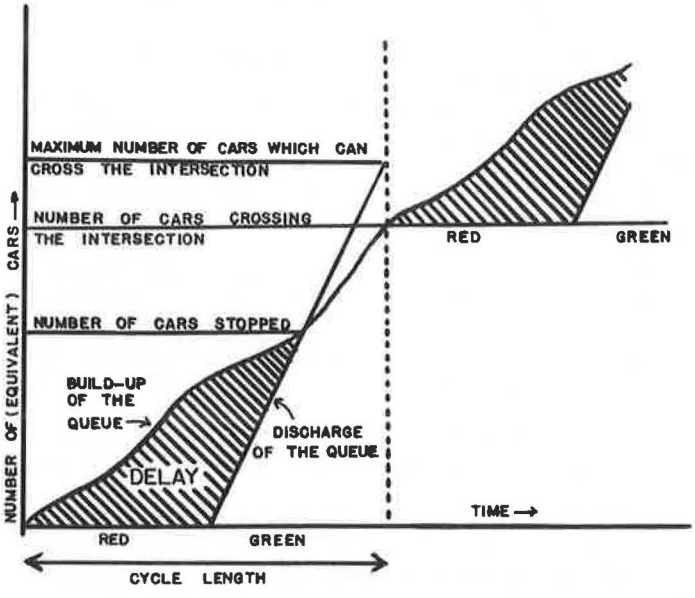


Figure 2. Exclusive bus lane project on 109th Street.

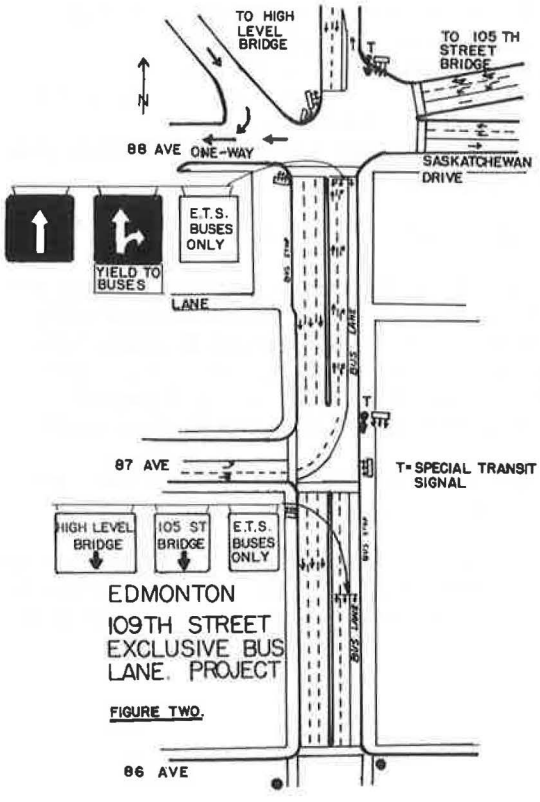
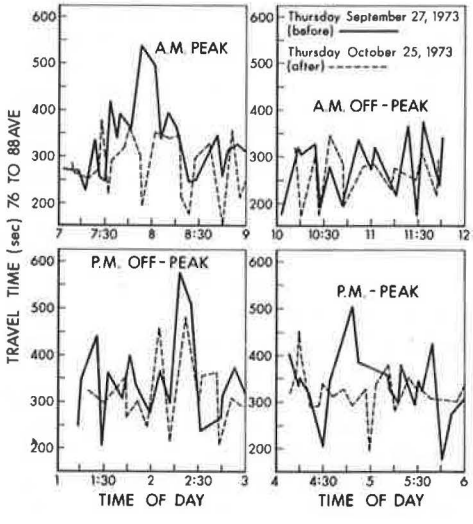


Figure 3. Bus travel times before and after implementation of exclusive bus lane.



HOW TO GIVE PRIORITY TREATMENT

Curb Lane

The exclusive curb lane will work well when (a) there are few right turners, (b) parking can be prohibited, and (c) alternate traffic lanes are available for vehicular traffic.

Because of the circumstances already described, the curb lane operation in Vancouver on Seymour Street (a one-way street) does not work well because too many right turners interfere with the transit movements.

Median Lane Operations

Median lane operation is similar to that for tramways or streetcars and can be used when wide rights-of-way are available. This method should be considered if the city is intending to use lightweight rapid transit since it can be one of a number of intermediate stages in the development of rail rapid transit.

The problems of median lane operation are the transit stops, which must be well designed. Also, left turns generally should either be banned or guided through with separate signals.

Reversed Flow

On One-Way Streets

The operation on Seventh Avenue in Calgary is a good example. This self-enforcing operation has all the advantages and few disadvantages. The major disadvantage is that pedestrians must be made to look both ways before crossing. The other problem arises at the start and finish of this lane.

Cities that contemplate using exclusive bus lanes should view the reversed flow on one-way streets as their first desirable alternative.

On Wrong Side of Median

Reversed flow on the wrong side of a median arises on freeways or wide arterial roads with tidal peak-hour flow. If the traffic lanes (three or more) in the off-peak direction are underused, then one lane next to the median can be reversed. A lane width of 15 to 17 ft (4.5 to 5 m) and traffic cones to separate opposing traffic flows are desirable. There are numerous applications for reversed flow (1).

Exclusive Approach Lane

The exclusive approach lane can be used where the frequency of bus service or the roadway width makes a continuous exclusive bus lane impossible. The method requires widening of the approach at the intersection or having buses use an exclusive right-turn lane to go straight through. If the signal timing plan is combined with the exclusive approach, transit vehicles can be guided through the intersection with priority treatment. The system is particularly valuable where there is a multiphase timing plan. A transit vehicle requires 4 sec for the first vehicle and 2 sec for each subsequent vehicle. The maximum number allowed through depends on the transit stop capacity. For example, in Delft, since only two transit vehicles can be accommodated at the transit stop, the maximum is 6 sec.

Exclusive Transit Signals

There is also a need for separate, exclusive transit signal indications with or without exclusive lanes or approaches. In Edmonton, the yellow T-signal is used, and in Holland a whole series of signals is used. There is a need for standardization here. In Edmonton, the transit signal is placed higher than the normal signal so that the motorist is not confused. At the project on 109th Street, one such signal is located at a T-intersection (87th Avenue is the side street). Bus traffic can proceed after the bus has stopped and pedestrians have crossed the street. The only other restriction is that buses must yield to other buses coming from 87th Avenue and going into the bus lane (Figure 2).

Similar signal indications are used with the bus crossing signal at 57th Avenue and 111th Street. A special transit signal would also be more useful than the normal green indication for reversed flow.

GENERAL APPROACH TO EXCLUSIVE LANES

Data Before Implementation

The difficulty with assessing the effectiveness of exclusive bus lanes is the lack of data about the before situation. The data needed should include

1. Travel time for both transit (Figure 3) and cars,
2. Delay time at intersections for both transit and cars,
3. People volumes of both transit and cars, and
4. Vehicle volumes of both transit and cars.

These data should be supplemented with photographs and film or television tape.

Public Participation Before Implementation

In Edmonton, a public hearing was held before the exclusive lane was installed. Anyone for or against installation could express an opinion about the desirability or nondesirability of an exclusive lane.

The main opposition came from the merchants on the west side of 109th Street, who felt that their businesses would be adversely affected by the all-day banning of left turns on 109th Street for six blocks.

Publicity

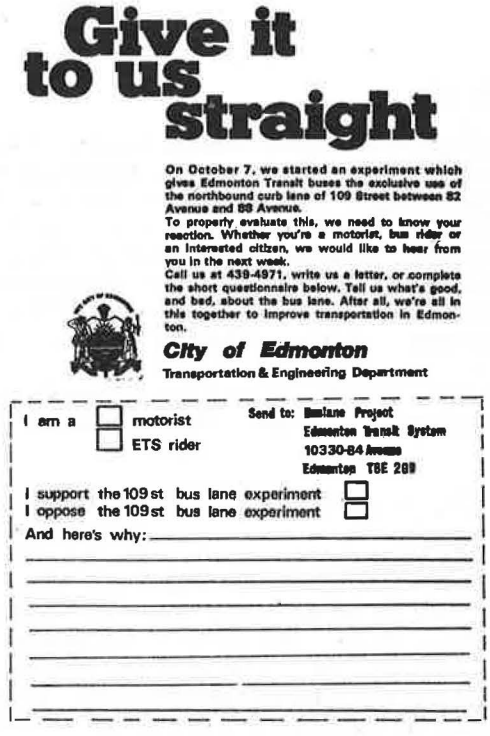
Publicity consisted of advertising in the local newspaper (Figures 4 and 5) and the university newspaper, and 30-sec radio advertisements in the peak driving time were also used. The signing used was overhead signs with one or two sets of lane signs every block. The white-on-black lane signs were used to conform with lane designation signs of the Canadian Uniform Traffic Control Manual.

Additional signs were placed on the side streets to advise motorists to enter into the center lane.

Data After Implementation

The data collected after implementation should include the same type of information as was collected before implementation. These data should be supplemented with photographs and film.

Figure 4. Advertisement before exclusive transit lane implemented.



Give it to us straight

On October 7, we started an experiment which gives Edmonton Transit buses the exclusive use of the northbound curb lane of 109 Street between 82 Avenue and 88 Avenue.
To properly evaluate this, we need to know your reaction. Whether you're a motorist, bus rider or an interested citizen, we would like to hear from you in the next week.
Call us at 439-4971, write us a letter, or complete the short questionnaire below. Tell us what's good, and bad, about the bus lane. After all, we're all in this together to improve transportation in Edmonton.

City of Edmonton
Transportation & Engineering Department

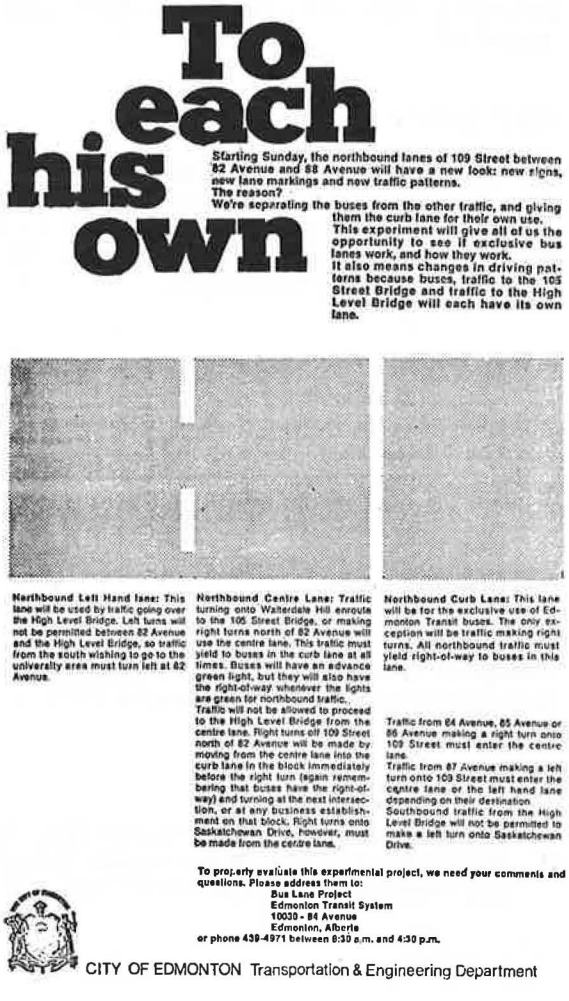
I am a ☐ motorist ☐ ETS rider

Send to: Bus Lane Project
Edmonton Transit System
10330-84 Avenue
Edmonton T6E 2G9

I support the 109 st bus lane experiment ☐
I oppose the 109 st bus lane experiment ☐

And here's why: _____

Figure 5. Advertisement after bus lane implemented.



To each his own

Starting Sunday, the northbound lanes of 109 Street between 82 Avenue and 88 Avenue will have a new look: new signs, new lane markings and new traffic patterns.
The reason?
We're separating the buses from the other traffic, and giving them the curb lane for their own use.
This experiment will give all of us the opportunity to see if exclusive bus lanes work, and how they work.
It also means changes in driving patterns because buses, traffic to the 105 Street Bridge and traffic to the High Level Bridge will each have its own lane.

Northbound Left Hand Lane: This lane will be used by traffic going over the High Level Bridge. Left turns will not be permitted between 82 Avenue and the High Level Bridge, so traffic from the south wishing to go to the university area must turn left at 82 Avenue.

Northbound Centre Lane: Traffic turning onto Walterdale Hill enroute to the 105 Street Bridge, or making right turns north of 82 Avenue will use the centre lane. This traffic must yield to buses in the curb lane at all times. Buses will have an advance green light, but they will also have the right-of-way whenever the lights are green for northbound traffic.
Traffic will not be allowed to proceed to the High Level Bridge from the centre lane. Right turns off 109 Street north of 82 Avenue will be made by moving from the centre lane into the curb lane in the block immediately before the right turn (again remembering that buses have the right-of-way) and turning at the next intersection, or at any business establishment on that block. Right turns onto Saskatchewan Drive, however, must be made from the centre lane.

Northbound Curb Lane: This lane will be for the exclusive use of Edmonton Transit buses. The only exception will be traffic making right turns. All northbound traffic must yield right-of-way to buses in this lane.

Traffic from 84 Avenue, 85 Avenue or 86 Avenue making a right turn onto 109 Street must enter the centre lane.
Traffic from 87 Avenue making a left turn onto 109 Street must enter the centre lane or the left hand lane depending on their destination.
Southbound traffic from the High Level Bridge will not be permitted to make a left turn onto Saskatchewan Drive.

To properly evaluate this experimental project, we need your comments and questions. Please address them to:
Bus Lane Project
Edmonton Transit System
10030 - 84 Avenue
Edmonton, Alberta
or phone 439-4971 between 8:30 a.m. and 4:30 p.m.

CITY OF EDMONTON Transportation & Engineering Department

Evaluation

The evaluation afterwards should include all the agencies and people that were involved in the implementation: the traffic engineers; the police department; the transit operations, particularly the transit inspectors; and the public.

In Edmonton, the public was asked to express a viewpoint. Advertisements were placed in both the Edmonton Journal and the university newspaper. The advertisement in the newspaper asked whether the respondent was a motorist or bus rider, whether he or she supported or opposed the bus lane project, and what reasons there were for their opinions. A log was kept of telephone calls that were received regarding the project.

The final tally was 88 for and 55 against, which means that most people using 109th Street did not react at all. The respondents who were opposed had the following reasons:

1. The no-left-turn lane was in effect all day. As a result, the ban was changed to peak hours only.
2. The right turn was confusing. Initially right turns were allowed from the bus lane, except at 88th Avenue, where the exclusive signal was. The rule was changed to right turns from the center lane, but YIELD to buses along the entire length. Because there are few right turns except at 88th Avenue, this rule has not presented major problems, but a little give and take are still required.
3. There was a lack of enforcement. Because the police were not sure under what bylaw or act enforcement should take place, they gave advice and issued warnings. This worked well. Later, when Edmonton had a transit strike, the police occasionally parked a cruiser in the bus lane so that motorists adopted the habit of not using the bus lane at all.

TIME SAVING

The time saving for buses in the peak period was between 2 and 6 min, and there was a slight reduction in the car travel time.

The main result was, however, that the bus travel time became consistent regardless of traffic conditions. The public's perception of the time saved was far greater than it was possible to measure.

CONCLUSION

Although several exclusive lane experiments have been made, there is a lack of uniform data gathering. New criteria need to be developed about where to use exclusive lanes; the most useful criterion is to determine whether the separation of traffic will reduce the total people hours of travel time.

ACKNOWLEDGMENTS

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