# RE-ENGINEERING URBAN BUS TRANSPORT

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Experience with re-engineering suggests that if a better model can be developed consumers will embrace it willingly and job quality can be improved. Many examples of re-engineered systems exist; a familiar one that has created a new oxymoron is "adult paperboys".

Until recently, adolescents delivered newspapers after school. Competition from other media forced the newspapers to shift to morning editions. Paperboys became difficult to find for early morning delivery hours and with few productivity gains, the costs of the distribution system were increasing. Finally the newspaper publishers examined their logistics systems and realized that they could re-engineer the distribution system by hiring adults to make early morning deliveries in cars. Re-engineering newspaper deliveries reduced cost and improved service. Increased wages for the adult paperboys were traded off against savings in the costs of paper drop-off depots.

As part of the re-engineering process the method of payment was modernized from cash collected by the paperboy to electronic billing. From the perspective of the newspaper consumer the service became more reliable, and the weekly nuisance of finding the right change for the paperboy disappeared. Re-engineering the logistics system allowed the newspapers to regain market share and profitability.

Like the delivery of newspapers, any logistical or transportation system that remains unchanged for 50 years is a candidate for process re-engineering. Urban bus transit systems in North America fit this profile. The physical expansion of the city over the past fifty years has been poorly served by conventional transit systems. "While transit has retained much of the downtown oriented trips that it has traditionally been designed to serve, it has not risen to the challenge of serving the rapidly growing number trips in suburban and other low density areas. Moreover, it has not adapted to serving the growing number of non-work trips that occur between dispersed origins and destinations, which are typically shorter than work trips but too long for non-mechanized transport, and thus are virtually the sole domain of the private automobile" (Morlok et al., 1997, p.1)

The failure of the fixed-route/fixed-schedule model in the suburbs is no mystery. Nelessen (1997) observes "Most people know what's wrong with suburban transit. Simply stated, it does not go where people need to go when they need to go."

The purpose of this article is to present the case for re-engineering urban bus transit to serve suburban demand and increase overall ridership. The next section sets out the problems of the publicly owned, monopoly transit services in Canada. This is followed by a brief sketch of how a minibus transit system could improve productivity and attract ridership in competition with the privately owned automobile. Key elements of the fixed-route/fixed system are compared with the mini-bus proposal.

**The Urban Transit Model is Broken**

Canada added nearly 7 million people to its population over the past 20 years. The majority of these new Canadians settled in large urban centers that have the largest transit markets. Despite this 25 percent increase in the population, bus ridership has scarcely changed. Figure 1 presents the population increase for the period 1985 to 2005, and the trend in transit riders. Bus ridership actually fell to 1,350 million passengers in the mid-1990s before recovering to 1,660 million by the end of 2005. The failure of the fixed-route/fixed-schedule transit system to attract riders from this growing population base resulted in a loss to market share, principally to the automobile.

Recent ridership growth has given the transit authorities some encouragement. Transit systems in Canada have increased ridership 4.7 percent in the past year that suggests that the upward recovery is continuing.[i] However, most of this growth may be explained by the 20 percent increase in gasoline costs that encouraged car owners to use transit.[ii]

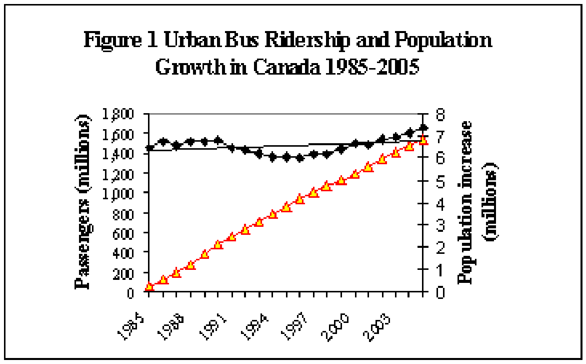



Figure 1 Urban Bus Ridership and Population Growth in Canada 1985-2005

Sources: Transport in Canada 2006 Table A7-7
Statistics Canada, CANSIM tables 051-0004 and 052-0004

A low cross-price elasticity between car and bus demand has multiple causes. The monopoly operators' inattention to customer service deters switching from cars to buses. Inferior customer service includes a lack of comfort (e.g. freezing at a bus stop), fear for personal safety, unreliable/long travel times, and infrequent weekend service. For the majority of car owners the transit system simply fails to offer a competitive alternative to the private automobile.

### Causes and Effects of Fixed-route/Fixed-schedule Model Failure

The dispersed, low-density pattern of suburban land settlement is difficult to serve with traditional transit systems. Consequently, the failure of transit is often blamed on consumers and land developers. The implicit assumption of transit operators is that the public should modify its behaviour to fit the bus system, rather than change the bus system to be more attractive to consumers. Public ownership and subsidization of transit has allowed these systems to function with a flawed model despite the absence of consumer appeal. Customers have a take it or leave it choice (monopoly offering) so they put up with bad service, or vote with their wallets and buy a car.

### Internal Factors

Subsidies for public transit exceed the fare-box revenues in most North American cities. Any transit authority that can obtain even half its revenues from paying customers is considered to be doing very well. Unlike the deregulated freight and airline sectors of transportation, urban transit systems in Canada have experienced productivity declines for many years. Table 1 provides a measure of efficiency changes for transit from 2001 to 2005. A small productivity gain was recorded in 2003, but in all other years the losses were two to four times larger.

**Table 1: Efficiency Indicators**
**Canadian Transit Industry, 2001 – 2005**

| | ***Productivity (annual per cent increase)*** | | | |
|---|---|---|---|---|
| | ***2002/01*** | ***2003/02*** | ***2004/03*** | ***2005/04*** |
| **Transit** | | | | |
| Labour | -1.8 | 3 | -3.3 | -1.9 |
| Fuel | -1.6 | 7.6 | -4.4 | -1.1 |
| Capital | -1.2 | -2.4 | -2.4 | -9.3 |
| **Total** | **-3.2** | **1.1** | **-2.5** | **-4.3** |

Source: Transportation in Canada 2006, Table A2 – 63

The deteriorating efficiency of mass transit in Canada is a function of inept management. Investment in new technology that might improve efficiency or attract increased ridership is constrained because so much public money is wasted subsidizing the service supply that most citizens never want to use.

The public perception of transit as an inferior service is well deserved and reinforced by a clumsy governance model. The autonomy of management is constrained by public ownership. Transit managers are forced to provide service where demand would not warrant and to charge fares that are determined politically. City councils are afraid to open up the common carrier rights to competition because they do not want to confront the driver unions, or be accused of abandoning the poor. Consequently, the transit monopoly persists with a mandate to supply a universal service, but without the means to make it attractive.

**External Factors**

High automobile ownership rates are encouraged by economic incentives to drive a car. Urban development sprawl has changed work trips, shopping patterns and visiting demands. “Job sprawl” has changed work travel demand because fewer people are employed in the Central Business District (CBD). “Big Box” power centres are designed for shoppers who can pull up in a car and are difficult for customers to access on foot or bus. Visiting patterns have changed with population diffusion. Mature children and parents are as likely to live in adjoining suburbs, as they are to stay in the family neighbourhood. Similarly, many interest group meetings and cultural events are car travel dependent, as are children’s sporting events.

Travel from suburb to suburb is the weakest link in bus transit systems. Highly centralized route structures based on 1950s traffic patterns do not work well in low-density settlement patterns. Low quality service characterized by long waiting times and slow travel speeds are accentuated by circuitous routing. The failure of urban bus transit systems to retain its share of the travel demand has narrowed their market to those who are too old or too young to drive a car, those too poor to own and operate a car, and the downtown commuters that still find the route structure acceptable.

**Re-engineering the Transit System**

The “Green Movement” is often quick to condemn the use of automobiles, but typically they overlook the obvious. “The automobile is the primary means of transportation [in the suburbs] because it is best suited to serving contemporary travel patterns. Public transit’s increasing operating costs, declining market shares, and diminishing productivity stem from the fact that traditional fixed-route, fixed-schedule, large vehicle transportation is unable to effectively compete with the private car given today’s settlement and travel patterns” (Taylor and Khan, p.288, 2003)

It is both naïve and foolish to think that any transit system can replace the family automobile. A more realistic goal is to develop a transportation system that allows families to maintain their current life-style with just one car. The substitution of transit for the second car would make a tremendous difference to congestion and air pollution, as well as the economics of the family. The annualized cost of driving 12,000 kilometers in a Dodge Caravan is $10,800 and a smaller second car, like a Cobalt costs $8,600 per year according to the Canadian Automobile Association[iii]. Clearly it is not the cost of a bus pass that is encouraging suburbanites to stick to their cars.

The opportunity to design a more flexible demand-pull transit system has been recognized independently by Nelessen (1997), Morlok, et al. (1997), Taylor and Khan (2003) and Foo (2004). The system these researchers have identified relies on intelligent transportation (IT) systems and decentralized minibus feeder service to lower costs and improve customer service.

Differences exist in the approaches taken by the various authors given their independent origins. Morlok et al (1997) discuss five different market segments that could be served by mini-buses: campuses, local community circulator, night replacement, pedestrian unfriendly arterials and feeder service to line-haul rapid transit. Mini-buses have advantages in each of these sub-markets relative to the conventional 40-foot long transit buses. All authors address the feeder service application of mini-buses that is the focus of this analysis.

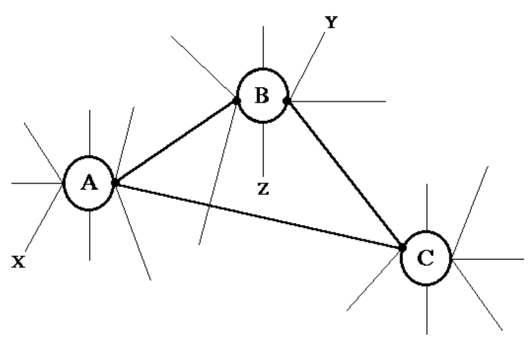
The minibus feeder service envisions the opportunity to utilize GPS and GIS navigation systems to guide the operators to their customers, and the use of electronic “smart card” payment and wireless communications to request and dispatch service. These systems could offer reservations for regular commuters and on-demand service for infrequent riders.

Access to the mini-buses could be within a short walk of the rider’s residence, or at their door. Nelessen (1997) envisions transit stops that could vary from a flag/sign to benches/bicycle racks where riders would wait. Taylor and Khan (2003) consider an automated callback system when the mini-bus is near the pick-up point. Foo (2004) describes a system with pickup at the passenger’s home or office. All authors visualize a system of mini-buses that serve local precincts and offer a flexible, on-demand service to line-haul stations in contrast to the fixed-route/fixed-schedule of traditional transit bus services.

**Fixed-route and schedule Vs. Flexible-route and schedule buses**

The traditional transit can be compared with the re-engineered mini-bus systems approach in terms of opportunities for cost elimination and service improvement. Some guidance for re-engineering is found in the literature (Ballou, 2004; Womack and Jones, 1996). The principles are defined and illustrated with examples for improvement.

**Consolidation:** carrying as much as possible as far as possible can minimize costs. This is the basis for hub and spoke networks. Small vehicles collect passengers and move short distances to transfer stations where larger vehicles are used for the line haul. Consolidation minimizes the costs of the line haul and extends the level of service in terms of connectivity. Figure 1 presents a conceptual model of the hub and spoke network. A person at **x** could go via hub **A** to hub **B** or to another smaller destination at **y** or **z**. Efficiency from the passengers' perspective depends on the total time expended on the trip. If the line haul service to the hubs is frequent, then the extra time required to transfer may be minimal.




Foo (2004) describes the advantages of consolidation using mini-buses in detail. Passengers receive more frequent service; transit authorities enjoy higher load factors on buses and a simpler route system with fewer stops. The transfer stations would have to be more elaborate to handle the volume of traffic, but the need for commuter parking lots is eliminated.

**Mixed Strategy:** Hybrid systems generally have lower cost than pure systems. The typical objection to small buses is that operating costs are almost as much as for large buses. Morlok et al (1997) note three errors in this thinking. First, most passengers find the large bus service unattractive, which makes it hopelessly uneconomic. Second, the assumption on operating costs is that all drivers are paid the same.

This need not be the case; mini-bus operators could be entry positions, or privately operated. The responsibilities and skill required for a large bus warrants the higher salary than a mini-bus. Third, a more attractive at the door service could attract more riders and mini-buses could charge more because the quality is higher.

Using only one vehicle size to perform all functions means excess capacity is experienced some of the time. A combination of owned and hired services can reduce total costs because surges in demand can be more easily accommodated and total capital costs are lower.

**Postponement:** the longer a commitment to a service or product can be delayed, the greater the opportunity to lower costs. Information can replace inventory. "Pull" systems can schedule production commitments to fit actual demand.

Conceptually, when the transit authority places a standard bus on a fixed route it commits to 45 seat-kilometers times the length of the route. On-demand mini-buses commit only 12 seats and the service can be delayed until a call is received to begin a route. Route flexibility provides an opportunity to pick up passengers in any order, and if desired, passengers could be dropped prior to arrival at the assigned station of the mini-bus.

**Total Cost Concept:** it's total costs that matter, not just "out-of-pocket" costs. From the consumer's perspective, this is called generalized cost and includes the opportunity costs of time required to make the journey. The value of time cannot be ignored; some consumers would never take the fixed-route/fixed-schedule bus even if it were free because they cannot afford the time required.

Transit authorities recognize the value of riders' time in their efforts to create rapid bus and light rail systems. The blind spot seems to be the value of their customers' time getting to the rapid transit station, or waiting for the service to arrive. A bus pass is many times less expensive than the cost of operating a second car. The difference in cost provides a rough estimate of the value that consumers place on the time wasted on the transit bus and its other inconveniences. Mini-buses could greatly reduce travel time and thereby lower the generalized cost of using the transit system.

**Differentiated Distribution:** consumers have different needs; "one size does not fit all". Some consumers will pay a premium for quality service, while others have severe budget constraints. Some consumers have special needs. Some consumers are flexible in their travel needs, while others have a very narrow time window to complete their journey. The provision of a uniform product or service is unlikely to satisfy anyone.

Suburban residents must have higher incomes to afford the luxury of single occupancy houses. If the transit authorities were to consider the price of a bus ticket relative to income, they could more easily justify charging suburbanites more for a connecting service to the line haul bus. The lack of choice for suburban residents pushes them into a second car.

The majority of low-income people would be unaffected by a higher charge for the feeder system. They live closer to the CBD, or on the busier streets that form the line haul network.

**Sub-optimization Trap:** Minimizing any single cost is unlikely to minimize total production costs. Spreading labour costs thinly can reduce capital equipment utilization. Spreading capital costs thinly can increase unit labour costs and reduce productivity. Slow uptake of information technologies minimizes current costs, but foregoing productivity improvement leads to sub-optimal long-term outcomes.

Sub-optimization is chronic because the transit systems have tapped out the subsidies available in municipal budgets. They are forced to provide service to an ever-expanding urban footprint, with a fixed budget (revenue increases from fares barely keep up with inflation). The result is increased head times between buses, reduced service on the weekends and a failure to adopt intelligent transportation technologies. If the transit authorities considered the opportunity costs of poor customer service, they would recognize that the cost of the fixed-route/fixed schedule model is far from optimal.

**Muda Elimination:** A "lean thinking" approach to the elimination of waste reduces cost and improves process efficiency. Waste can be any process, step or event that does not add value. Continuous improvement is possible in any system, but the big gains require more radical changes in design.

Many forms of waste in the fixed-route/fixed schedule model can be identified. A separate handi-transit system that duplicates the line haul bus is one example. Handi-transit could be virtually replaced by mini-buses and low floor line haul buses. Most disabled passengers do not have to travel in peak hours. Mini-buses could focus on this market segment in the off-peak. If disabled persons needed to travel during the peak, the mini-bus could have a policy of boarding them first, then picking up regular passengers.

**Summary of old and re-engineered systems**

The transit systems in many North American cities are modeled on the operations management of the mid 20th century. They follow the same route maps, with extension due to population growth, and most continue to use fare box technology typical of the 1950s.

The idea behind re-engineering transit is to use electronics to create intelligent, demand-based pick up and delivery of passengers (GPS, barcode readers, smart cards, wireless communications and computers). The feeder network would be re-regulated to permit minibus operators (public or private) to serve normal and handi-transit demand without subsidies.

The subsidy savings from the feeder routes could be directed to the construction of comfortable transfer stations. These facilities could be open to private concessions (coffee shops) and professional offices (e.g. medical). The transfer stations could create opportunities for public-private partnerships to reduce the public investment required.

The publicly owned 40-foot buses would be re-directed to provide a rapid, frequent corridor service. Suburban residents would pay more, but the corridor service could continue to operate at current fares.

Fixed-route/fixed-schedule transit and demand-based mini-bus feeder systems are compared in terms of the re-engineering principles:

<u>Consolidation</u>

Fixed-route/fixed-schedule Transit

- Network of radial routes connected to a central core, with some heated shelters, but little effort to consolidate passenger numbers on larger vehicles

Demand-based Mini-bus feeder service

- System designed around locations with temperature-controlled, comfortable transfer stations that connect mini-bus feeder shuttles and line-haul buses

<u>Mixed Strategy</u>

Fixed-route/fixed-schedule Transit

- Publicly owned and operated monopoly mainline and feeder system, with transit operated bus shelters
- Fixed stops, fixed routes, fixed schedule and separately contracted handi-transit service

Demand-based Mini-bus feeder service

- Publicly owned rapid transit mainline service
- Public-private transfer stations and mini-bus feeder services integrated with handi-transit; operated with public oversight

<u>Postponement</u>

Fixed-route/fixed-schedule Transit

- Commitment of fixed number of seats to suburban routes on scheduled time-windows and streets, irrespective of demand

Demand-based Mini-bus feeder service

- Delivery of seats in suburban areas, determined by on decentralized, demand-based decision-making at the home or precinct level

<u>Total Cost Concept</u>

Fixed-route/fixed-schedule Transit

- Considers only the direct cost of operating buses

Demand-based Mini-bus feeder service

- Considers the generalized costs of riders that includes the value of time as well as out of pocket costs for fares

Differentiated Distribution

Fixed-route/fixed-schedule Transit

- A pure system with respect to operations and equipment that supplies a uniform service on all routes

Demand-based Mini-bus feeder service

- A mixed system that sizes supply to demand, with reservations and on-call service features

Sub-optimization Trap

Fixed-route/fixed-schedule Transit

- Attempts to minimize costs of unionized labour force, with minimal concern for customer service

Demand-based Mini-bus feeder service

- Balances the supply and demand with intelligent transportation technologies and flexible service to optimize customer service

Muda elimination

Fixed-route/fixed-schedule Transit

- Low floor city buses are used on some routes, but a duplicate handi-transit service is used for most persons with disabilities

Demand-based Mini-bus feeder service

- The system can be designed to be barrier free, and require shuttles to carry people with disabilities

**Implementation of Mass Transit Re-engineering**

Organizations resist change because both management and workers worry that the new state of affairs could be worse than the current situation. Womack and Jones (1996) spend half their monograph describing the barriers to change and the process of implementing a leaner model. Ironically, only firms faced with the prospect of business failure, like the newspaper publishers described earlier, are able to make the kinds of radical re-engineering changes that are required to achieve dramatic productivity gains. Risk aversion on the part of managers and workers dominates their thinking.

None of the technology required to re-engineer transit is new, or unproven. Intelligent transportation technologies could be implemented off the shelf, and minibuses exist in many different configurations that could serve the market. Technological change has been retarded by the public utility ownership monopoly.

> "The limited application [of minibuses] is largely a consequence of transit agencies having a monopoly on common carrier rights in virtually all service areas of this country: If the single public agency does not attempt such a service, it can not be tried, for a private innovator or entrepreneur can not legally compete with the agency. The monopoly status provides a barrier as the new entrant will either have to seek the cooperation of the agency, or else initially provide service extra-legally, as Miami and New York minority entrepreneurs did. Moreover, lack of cooperation means that a new entrant can not count on joint fares, scheduled connections, or other features that would make the service more attractive and reduce the risk of starting a new service." Morlok et al. (p. 10, 1997)

In short, the problem lies with the governance structure of urban transit. As long as the municipalities are determined to retain monopoly ownership, and are content to subsidize urban transit services, implementation of a re-engineered system can only come from within the existing management. None of the city governments are happy with the current situation because transit subsidies are draining tax revenues that could be used more appropriately. All that is required is for one city council to prove that the new model works, and others will quickly follow.

**Conclusions**

A "carrot and stick" approach has been used to encourage or coerce people to change their life-styles to utilize the existing fixed-route/fixed schedule transit bus service. Literally nothing has worked. Car owners have not been bribed by subsidized fares or tax deductions, any more than they have given up their cars because of high parking rates, or "guilt trips" to save the environment by riding the bus. Consumers have made choices based on personal preferences of where to live and work that simply no longer fit the model of the fixed-route/fixed-schedule transit system.

The re-engineering approach involves the use of mini-buses to provide a level of customer service that meets the travel demands of consumers. Some tenets of a re-engineered public transit system are worth consideration:

- Recognize as given that the land settlement pattern is set, such that most suburban neighbourhoods are unreceptive to 40-foot bus, fixed route systems.
- Private automobiles have desirable qualities and convenience that the fixed-route/fixed schedule system of traditional mass transit cannot match.
- Technology exists to create a flexible transit service that could be competitive with the cost/convenience of owning a "second' car.

If "one-car" families could enjoy the same life-style using transit that is available currently to only "two-car" families, the cross-elasticity between cars and transit should increase significantly. Transit does not require huge subsidies to compete with the car, it only needs a new approach that gives consumers a desirable alternative.

Technological advances can be necessary to re-engineer a process, but often employees and management resist change because of the fear of the unknown. Past experience with re-engineering suggests that if a better model can be developed consumers will embrace it willingly, and job quality can be improved. Ultimately the fixed-route/fixed schedule system of traditional mass transit must change because it is too expensive and ineffective to persist indefinitely. The technology exists to create a more flexible mini-bus system and awaits only one committed civic champion to begin the long overdue process of re-engineering urban transportation.

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[i] For the period October 2006 to October 2007, the combined ridership of 10 large urban transit systems in Canada was 4.7% higher.
http://www.statcan.ca/Daily/English/071218/d071218g.htm

[ii] Source: Statistics Canada, CANSIM, table 326-0009 and Catalogue no. 62-001-X.

[iii] http://www.caa.ca/pdf/2007-04-27%20DrivingCostsBrochure2007.pdf The CAA bases this on the car ownership and operating costs available as of December 2006.