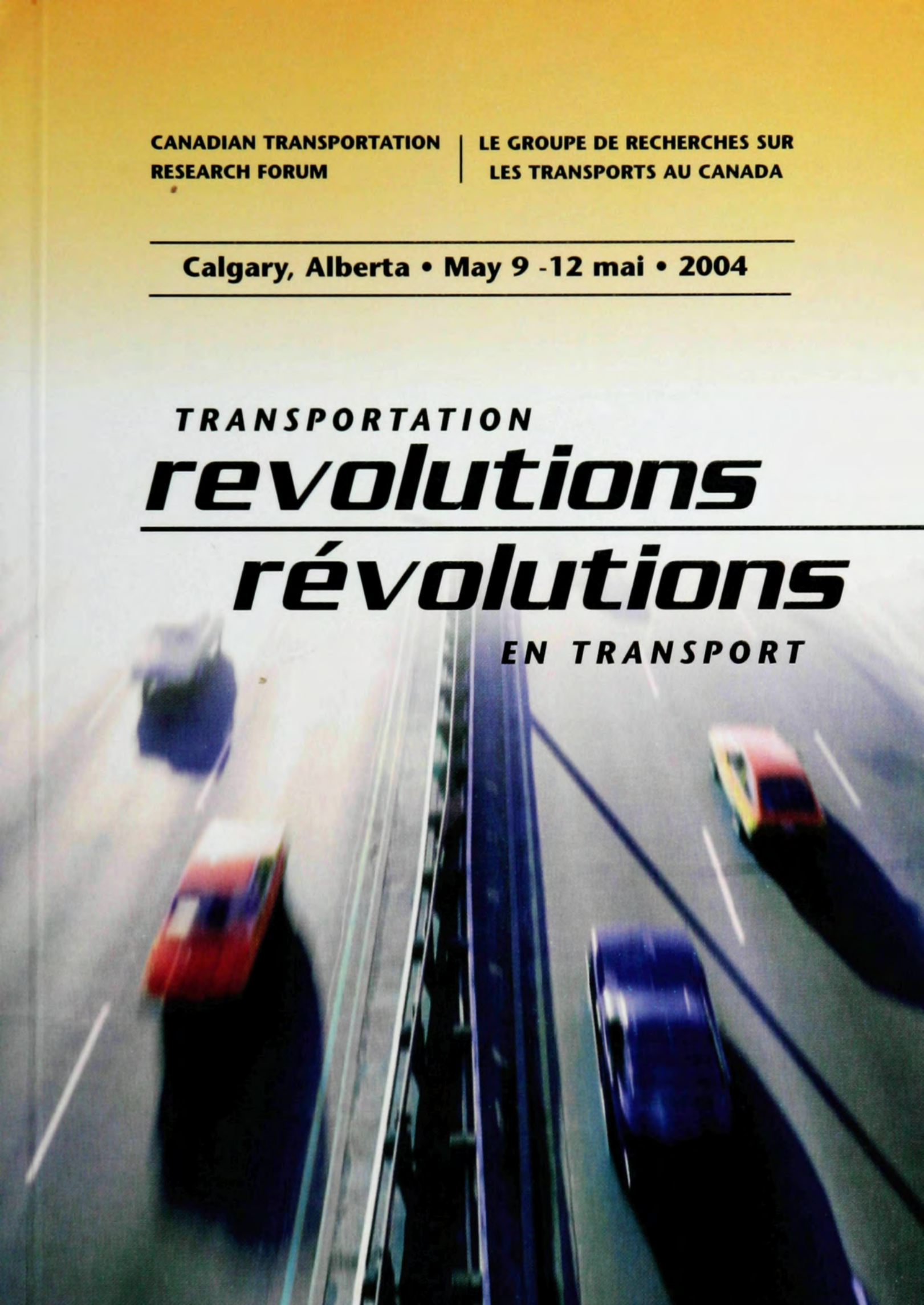
CANADIAN TRANSPORTATION RESEARCH FORUM | LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

Calgary, Alberta • May 9 -12 mai • 2004

TRANSPORTATION revolutions

révolutions EN TRANSPORT



CANADIAN TRANSPORTATION RESEARCH FORUM
LE GROUPE DE RECHERCHES SUR LES TRANSPORTS AU CANADA

PROCEEDINGS
of the 39th Annual Conference

ACTES
de la 39è Conférence annuelle

Transportation Revolutions
Révolutions en transport

Calgary, Alberta
May 9-12 mai
2004

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President's Message

I would like to personally welcome those of you attending the 39th Annual CTRF Conference in Calgary. The organizers have worked hard behind the scenes to bring this event to you and we hope that you get as much out of the event, as they've put in to making it a reality.

This proceedings contains the collective efforts of the participants and reflects not only the diversity of transportation research in Canada, but also the impressive research abilities of the contributors. Our theme this year, "Transportation Revolutions" is drawn from a reference to the major revolutions associated with rail and highway developments in the last century. But, in a more forward vein, posing the question, are we on the verge of yet another revolution in transportation? A number of papers in this volume reflect on that question and we hope you are intrigued and perhaps inspired.

An event like this comes about through the unselfish efforts of volunteer organizers and I would like to recognize their valued contribution on behalf of the CTRF community. Lloyd Ash took the lead as VP program, responsible for organizing the sessions, dealing with submissions, and many other aspects of the conference. Peter Wallis, as VP meetings oversaw the entire conference and received

valuable support from his colleagues Nancy Stirling and Sarah Bolton. Our local organizing committee, Keir Packer, Kevin Doyle, Kim Royal, Jan Bowland, and myself, also provided key local insights and assistance. Lastly, Gail Sparks at the CTRF head office provided invaluable guidance and help throughout the organizational process. Thanks to all of our organizers for their many hours of hard work.

I would also like to recognize the extensive list of sponsors, financial and otherwise who help to make this event a success. The firms and organizations that sponsor our conference provide an incredibly important service to the transportation community and I thank them for their commitment. Finally, I would like to thank you, the CTRF member for your continued support of the organization. Our membership is our strength and the source of what keeps this organization at the forefront of Canadian transportation research.

Enjoy the conference and these proceedings and make plans next year to attend our 40th annual conference. See you in Hamilton!

Je voudrais, à titre personnel, souhaiter la bienvenue à ceux d'entre vous qui assistent à la 39è conférence annuelle du GRTC à Calgary. Les organisateurs ont travaillé dur, derrière la scène, pour vous offrir cet évènement; nous espérons que vous en retirerez beaucoup d'autant plus qu'ils ont tout fait pour traduire ce projet en une réalité.

Les Actes contiennent les efforts collectifs des participants et reflètent non seulement la diversité de la recherche en transport au Canada, mais aussi les capacités impressionnantes de ceux qui y contribuent. Notre thème de cette année, *Révolutions dans les transports*, est tiré de références relatives aux révolutions majeures qui ont marqué le développement des modes ferroviaire et routier durant le siècle passé. Mais, en poussant la réflexion plus loin, posons-nous la question : sommes-nous à la veille d'une autre révolution en transport? Un certain nombre d'articles dans ce volume reflètent cette question et nous espérons que cela vous intrigue et peut-être vous inspire.

Un évènement comme celui-ci résulte des efforts considérables d'organisateurs volontaires et dévoués dont je voudrais souligner, au nom de la communauté du GRTC, l'inestimable contribution. Lloyd Ash en a assumé la direction en sa qualité de vice-président - Programme, responsable de l'organisation des séances, des soumissions d'articles et de beaucoup d'autres aspects de la conférence. Peter Wallis, en tant que vice-président – Conférences, s'est occupé de toute la conférence et a reçu un soutien de choix de la part de ses collègues Nancy Stirling et Sarah Bolton. Notre comité d'organisation local, Keir Packer, Kevin Doyle, Kim Royal, Jan Bowland et moi-même, a apporté les contributions locales et son appui. Enfin, Gail Sparks, au siège social du GRTC, a été une guide de grande valeur et a accordé son aide au processus d'organisation. Merci à tous nos organisateurs pour leurs nombreuses heures de dur labeur.

Je voudrais également mettre en lumière la liste des commanditaires financiers et autres qui ont contribué à faire de cet évènement un succès. Les entreprises et organisations qui commanditent notre conférence fournissent un service d'une importance capitale à la communauté des transports; je tiens à leur exprimer ma reconnaissance pour leur engagement. Finalement, je voudrais vous remercier, vous le membre du GRTC pour votre support constant à l'organisation. Notre membership est notre force et la source de ce qui maintient celle-ci à la pointe de la recherche en transport au Canada.

Appréciez donc la conférence et ces Actes, et prévoyez déjà votre présence à notre 40è conférence annuelle. Au plaisir de vous voir à Hamilton!



Clarence Woudsma, CTRF President

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Prediction of Freeway Crash Potential for Real-Time Crash Prevention
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Advanced Minibus Technology and its Potential Applications to Suburban Communities

Introduction

Suburban municipalities are often the fastest growing municipalities in Canada. Unfortunately, transit services in those regions are either non-existent, or ineffective. As a result, most of the residences in these suburban communities are highly dependent on automobiles. Major roads are clogged by single occupancy vehicles (SOVs). In affluent regions like the York Region in Ontario, about 70% of households have two or more vehicles. Ironically, buses are not helping either as they are often SOVs as well. This report attempts to address the issues of declining ridership and increasing automobile dependence in suburban communities by introducing demand responsive minibuses, which essentially bring people from their homes to rapid transit stations. We will use York Region as an example, and show that this kind of system is unparalleled in its accessibility and flexibility benefits to passengers and transit providers. Coupled with a hierarchical transit system, innovative intelligent transportation system (ITS) technologies, minibuses can provide a cost effective solution to the transportation challenges.

Background and Challenges

York Region is located north of Toronto, with 71.8% of the population concentrated in Vaughan, Markham and Richmond Hill, which are all adjacent to Toronto. On an average weekday in 2001, over 1.5 million trips were made to, and/or from York Region. According to the 1996 Transportation Tomorrow Survey, during the weekday morning peak period, a stunning 79% of the trips are made by automobiles, while only 8% of the trips are made by transit. The

survey also shows that York region residents are highly dependent on automobiles. In York, only 4% of households do not have a vehicle. 28% of households have 1 vehicle and an alarming 68% of households have 2 or more vehicles. During peak hours, virtually all major corridors are highly congested. York Region is served by two transit providers: York Region Transit (YRT) and GO Transit. Currently YRT provides only bus mode of travel, aimed mainly at serving local communities. GO Transit, on the other hand, provides mainly inter-municipal services. It provides three transit mode choices: commuter rail service, inter-municipal bus service and inter-city coach service. Although the service available is fairly extensive, still only 8% of trips are made by transit, and buses are often empty during non-peak hours.

Transit Network Design

Hierarchical Network Design Philosophy

Computer networks are often designed as a hierarchy, in which computers close together are served by relatively low-speed (often 100Mbit/s), inexpensive computer networks. Computer networks at different locations within a city are served by medium-high speed (~Gbit/s), more expensive fiber-optics network. Cities and continents are connected by very high speed, very expensive multi-fiber optical network (~Tbit/s) which serves billions of users each day.

Even our road transportation network is designed following loosely a hierarchical design. We have large, high-speed inter-city freeways like the highway 401. Then there are "major roads" in the form of a grid network that connects communities. Within communities, we have side streets that connect the houses.

The rationale behind hierarchical network design is its cost effectiveness. Hierarchical network design provides high capacity to pipes that are shared by many users at a higher cost, and smaller capacity to pipes that are shared by local users at a lower cost.

In order to achieve cost effectiveness, transit network design should be designed in a similar fashion. We need high capacity rapid transit system connecting the cities within the region, as well as connecting them to other Greater Toronto Areas (GTA). At the lower levels, we need express buses for medium distance travel and minibuses for short distance travel (<2 km). The following figure is a conceptual illustration of our transit network design.

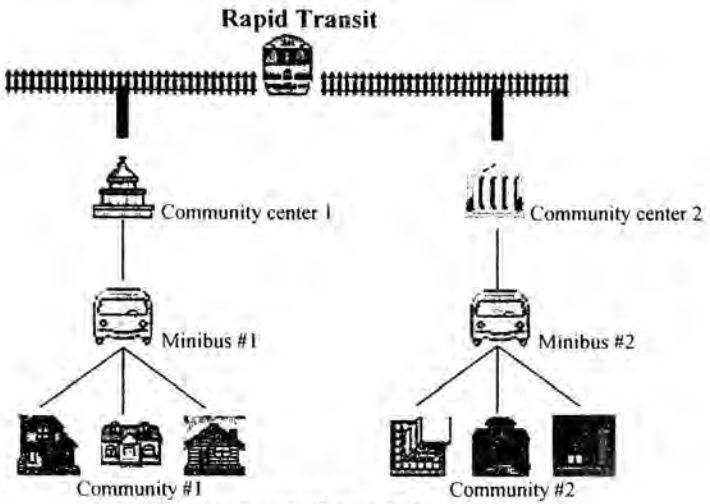


Figure 1 Conceptual Transit Network Design

Rapid Transit Network

Rapid transit (RT) network is at the highest hierarchical level of the transit system. It should have the following desirable properties:

1. High speed, capacity and reliability
   - This is required due to the number of people using the rapid transit network.
2. Long distances between stops
   - Short distances should be covered by minibuses.
   - Fewer stops means higher travel speeds and lower number of RT vehicles required.
3. Stops located at the highly populated / popular areas

- This is required to minimize the number of required connections to popular destinations such as malls, thus reducing the requirement on minibuses.

Using York Region as an example, we propose rapid transit on its two major corridors – Yonge St. and Highway 7 consistent with the York Master Plan. Figure 2 shows the RT network complete with existing GO train network.

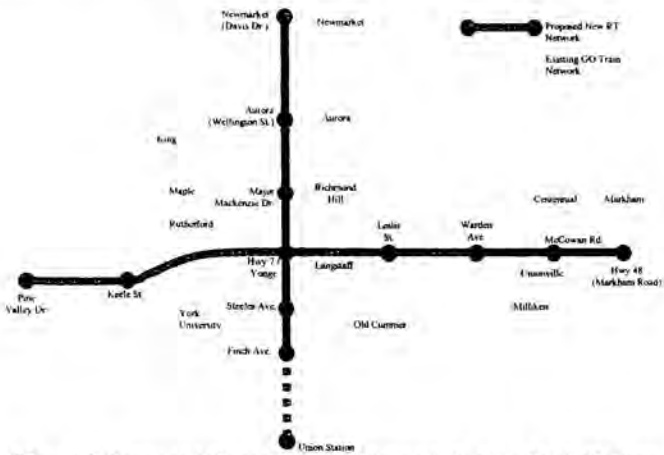


Figure 2 Proposed Rapid Transit Network for the York Region

Express Grid Bus Network

Express grid bus network serves as an intermediary between rapid transit and minibuses. It aims to serve locations that are far away from the rapid transit network and bring those residences to the rapid transit network. Because of their long distances from rapid transit and potentially large demands, these locations may not be served in a cost effective manner by minibuses. Also, the demand of these routes may not justify the cost of a rapid transit system on these routes. For details of express bus route, see proposed system map in Figure 3.

The buses are "express" due to the following features:

1. They run at medium – high frequency (every 10 minutes during rush hours, every 20 minutes during non-rush hours);
2. Their stops are only located at major transfer points at key locations, no other stops in between;
3. Various transit priority features are to be implemented on these routes, including HOV / bus lanes, transit priority signalling and queue jump lanes.

Minibus Network

Minibus is a low cost, low capacity, demand responsive transit mode that is suitable for serving low-medium density areas. Although its capacity is low, we can still achieve high passenger volume if the travel distance of minibus is small. I.e., each minibus should serve only a small area with low travel distance.

In order to define the service areas for minibuses, York Region is divided into 74 zones: 33 zones west of Yonge St. and 41 zones east of Yonge St. Each zone can be serviced by a different number of minibuses depending on demand. If the demand of two adjacent zones is low, these zones can be combined to be served by one minibus. Minibuses can also be moved around to serve sudden demand surge at specific zones. Should new residential area be developed, the new demand in the area can be served by creating a new zone and assign some minibuses to that zone. The flexibility of this minibus system is so powerful that no traditional transit arrangement can compete.

Each minibus zone belongs to one or two "major transfer points" or hubs. These major transfer points are rapid transit stations or major bus stops, which are strategically placed at shopping malls. The minibuses for each zone will always go back to the major transfer point they belong to. If a zone is assigned two transfer points, then there will be two groups of minibuses running on that zone, with each minibus group returning to its respective transfer point. It should be noted that due to the flexible nature of minibuses, the assignment of minibuses to zones and the assignment of zones to transfer points can be changed according to demand and the travel pattern of the users.

Another key feature of this minibus system is that all minibuses run in a generally clockwise direction. The rationale is that this will minimize the number of left turns required, which are more time consuming and dangerous. Sequence of pickup / drop-off will also be based on this clockwise direction. The operation of the minibus system will be described in the next section.

Figure 3 gives the overall design of the transit network for Vaughan, Richmond Hill and Markham.

Minibus Requirements and Operation

Minibuses operate on flexible routes and schedules. Its "timetable" is determined, in real time, by user demand. In order to determine the number of minibuses required at each zone, we need demand information during the peak periods. Couple this information with bus capacity, expected round trip time and expected number of stops, we can determine the minimum number of minibuses required for a zone. Once we establish an initial number, we can reallocate minibuses based on the demand data readily available from the transit vehicle request system, and optimize the whole minibus system based on different performance metrics such as average response time and average round trip time.

One way to establish this initial demand data is by way of a residence survey, which obtains the number of people who will likely use this minibus service and their desired times of travel. With this time-demand profile, we can derive the number of minibuses required to serve this travel demand for different time periods. Suppose zone X has a peak demand of 240 passengers per hour. Further assume that each minibus has a capacity of 15 passengers and an average round trip time of 15 minutes. Therefore, during that peak hours, 240/15 = 16 minibus round trips need to be made to serve the demand. With a round trip time of 1/4 hour, the number of minibuses required for zone X is 16/4 = 4 minibuses.

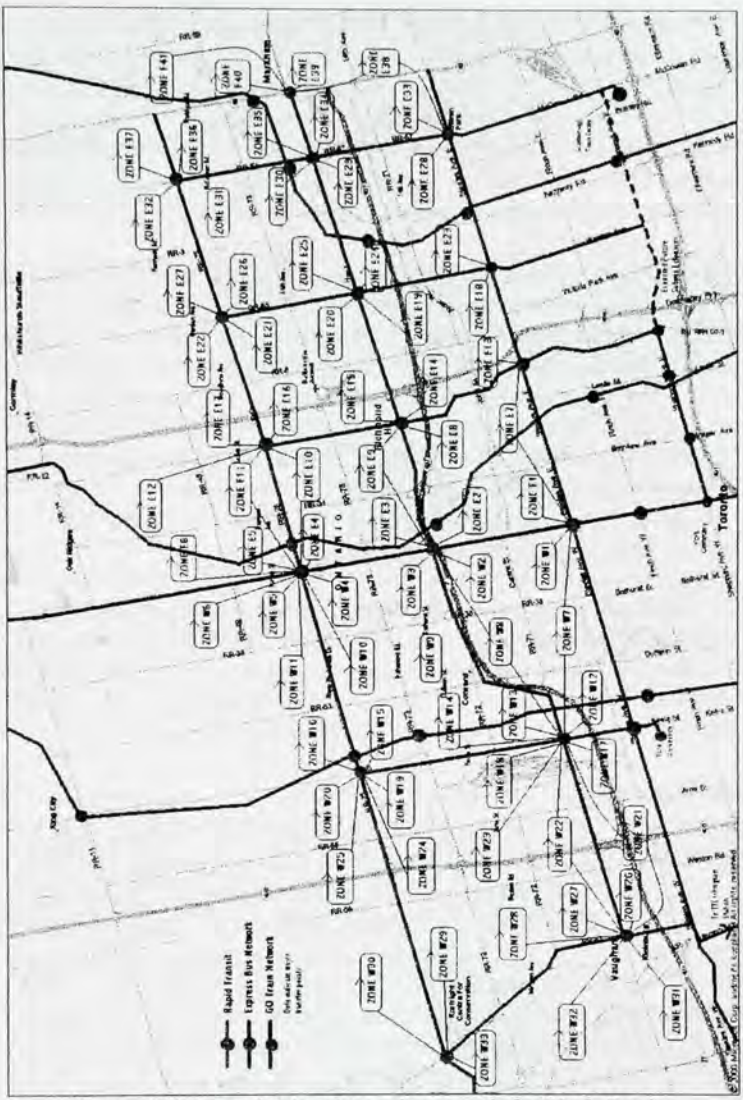


Figure 3 Proposed 3-level transit network for York Region

It is anticipated that zones with high population densities (such as those around city centers) will have a high demand for minibuses and may require up to 6-8 minibuses per zone. Low population density areas may require just one minibus, or even share a minibus with another zone. Based on the above analysis, an average of 4 minibuses per zone seems reasonable. To cover all 74 zones, we need a fleet of just under 300 minibuses during peak demand periods.

At first, 300 minibuses may seem to be a lot of vehicles. It should be noted that this is peak period figure, and we will likely need only 100 minibuses running during non-peak hours. Moreover, each minibus running during the rush hour means up to 15 fewer private vehicles on the roads driving the full distance between origin and destinations (c.f. minibuses travel only within their zones). Overall, minibuses mean both fewer private vehicles and shorter vehicular trips, leading to reduced congestions and pollution.

Transit Vehicle Request System (VRS)

The transit vehicle request system plays a central role in our minibus system. The purpose of the proposed transit vehicle request system is to allow passengers to request minibuses in the comfort of their homes / offices. We will describe the operation of this system, in both passengers' and transit operator's point of views.

Passenger's point of view

Before the VRS can be used, the household / individual needs to be registered to use the service. This can be done conveniently by phone or on the web. The information required by the registration process may include name, address and phone number for billing purposes. The household may set up common destinations for the whole family, and person-specific destinations for each family member. The departure time can be set-up to be regular (e.g., every weekday morning at 7am) or by request. If a regular time is set, a minibus will arrive at the set regular time to pick up the passenger unless cancelled otherwise. For by-request departures, the user will have to request a

minibus either by phone or via the internet. Regular time pick up will likely have a higher level of service in terms of reliability than by-request departures because these trips can be planned ahead of time.

Once the required information is set-up, each family member will be issued a "smart card". The smart card will contain all the origin / destination information, as well as some account information.

Regularly scheduled trips will have service nature similar to that of school buses. A minibus will pick up passengers who requested regular pick-up ±5 min depending on traffic situations. For by-request trips, minibus can be requested by phone or via the internet.

Once a vehicle is requested, the request will be dispatched to a minibus. The passenger must board the minibus upon its arrival within 30 seconds or he will miss it. The minibus may then go pick up / drop off other passengers living near-by before arriving at the RT station.

For connecting trips from say the subway station to the office, passengers simply board the minibus and swipe the smart card. The desired destinations will show up on the driver's screen. Should the passenger wants to go to an alternative location, she can go to a smart card service station located at the RT station and change the destination before boarding the minibus.

At key locations, such as community centres, shopping malls and major intersections, machines similar to pay-parking machines are installed. Passengers can request a vehicle by swiping their smart card at those locations, and select from a list of destinations. A minibus will then arrive within 10 minutes to pick up the passengers.

Transit Operator's Point of View

There are two types of minibus services. One is regularly scheduled pick-up / drop-off service and one is variable, by-request or "demand responsive" service. Regularly scheduled trips are always at a higher priority and the service of those trips can be planned effectively ahead

of time. Once the requests are entered by passengers, the computer can arrange the trip order such that overall travel time of the minibus is minimized. Then it can generate map and direction for the entire trip. When there are many requests, the computer will have to assign the trips to different minibuses in order to keep the round trip time at a minimum, yet minimizes the total number of minibus required. Once these fixed trips are defined, by-request trips can be accommodated with minimal adjustment to these fixed trips.

Note that trip tables can change weekly or even daily, depending on passenger's requests. In the drivers' point of view, these are all done automatically and they do not have to worry about it. All drivers need to do is to follow the instructions on the navigation unit and pickup / drop-off passengers along the way at the requested locations.

Minibus in-vehicle Navigation Unit

In-vehicle navigation unit tells the driver where to pickup / drop off their passengers, or provide drivers the directions. Like the VRS is an interface to passengers, the navigation unit is an interface to drivers.

When a minibus is switched on, it registers itself with the central computer and downloads the trip table via a wireless communication link similar to the cell phone. The computer onboard will display the appropriate map and turn-by-turn information on the screen. The minibus is equipped with a GPS receiver so that its current location is known and provided to the central computer. Should there be a substantial delay due to congestion or incidents, the information can be fed back to the central computer. The navigation unit can pick an alternative route, and waiting passengers can be served by minibuses dispatched by the central computer from another zone.

Summary of Advantages and Disadvantages

This chapter will summarize the advantages and disadvantages of our proposed transit system with minibuses. The advantages will be grouped into categories: user related, operator related and others.

Benefits to Users

- Truly universal access to transit;
- Waiting at the comfort of home;
- Much improved safety;
- Reduced concern about the weather;
- Reduced transit vehicle wait time;
- Increased rapid transit vehicle speed;
- No more worries about schedule;
- Passengers can carry more;
- Eliminate the need of extra private vehicles.

Benefits to Transit Operators

- Achieve true rapid transit;
- Huge ridership benefit potential;
- Unmatched service flexibility and expandability;
- Data readily available for planning purposes;
- No need for large commuter parking lots;
- Better connection with GO transit;
- Improve reliability of RT schedule due to reduction of stops;
- Reduce impact on traffic due to the reduction of bus stops on main streets;
- Reduce number of empty buses;
- Potential for large increase in revenue base;
- Allows simple route structure for express buses;
- Much reduced requirements on regular buses.

Other Benefits

- Enhanced sense of community;
- Benefits to business owners located at transfer stations;
- Reduce community vehicle dependence;
- Potential for much innovation.

Some Potential Disadvantages

- Concerns about revealing personal travel patterns;
- Learning curve for users and operators;

- Potentially high capital and operating costs – this will be analyzed in the next section.

Cost and Revenue Analysis

Capital Costs

Capital costs are calculated based on the purchase of 300 10-year service life minibuses. Costs of supporting items are additional costs to the current system due to the introduction of minibuses. The following table give a summary of the capital cost of our proposed minibus system.

Item	Quantity	Unit price	Total
Items installed on all minibuses			
Minibuses (10 year service life)	300	$150,000	$45,000,000
In-vehicle navigation units	300	$5,000	$1,500,000
Software licenses	300	$500	$150,000
GPS Receivers	300	$500	$150,000
Smart card readers	300	$500	$150,000
Other infrastructure items (communication, maintenance, computer control system, etc.)			$11,000,000
Grand total capital cost			**$55,950,000**

The total capital cost is estimated to be just under $56 million, which is very moderate compared to the budget proposed by the York Transportation Master Plan (TMP) which is in the range of $1.9 to $3.7 billions over 30 years.

Operating Costs

The spreadsheet below gives the operating cost structure of our proposed minibus system.

As expected, at almost $23 million per year, driver's salary is the single biggest cost in the system. Vehicle maintenance costs totalling more than $4 million are the second biggest cost in the system. The third biggest cost is fuel, estimated to be $2 million.

Item	Hrs/year	$/hour	#people	$ /year
Driver salary				
peak (5hr*5day*52wk)	1300	$25	300	$9,750,000
off-peak (14hr*5day*52wk)	3640	$25	100	$9,100,000
Weekend (19hr*2day*52wk)	1976	$40	50	$3,952,000
total driver cost				**$22,802,000**
Maintenance cost	852800	$5		**$4,264,000**
Fuel Cost				
Avg. round trip length	2.5	miles		
number of trips per hour	3			
total mileage per year for all vehicles	6396000	miles		
Fuel per mile	6.33	Mpg		
Total fuel requirement	1010427	Gallon	$2/gal	**$2,020,853**
Other costs associated with minibus				
Insurance cost	852800	$1		**$852,800**
Minibus storage	$1,200	per year	300	**$360,000**
IVN map / software upgrades				**$100,000**
IVN IT-Support / Maintenance crew	2080	$40	4	**$332,800**
VRS Operating Costs				
VRS phone attendant salary				
peak (5hr*5day*52wk)	1300	$20	8	$208,000
off-peak (13hr*5day*52wk)	3380	$20	4	$270,400
Weekend (20hr*2day*52wk)	2080	$30	2	$124,800
total VRS attendant salary				**$603,200**
VRS IT-Support / Maintenance crew	2080	$40	4	**$332,800**
Billing Cost				**$100,000**
Administrative staffs	2080	$30	10	**$624,000**
Administrative costs				**$100,000**
Grand total operating cost per year				**$32,492,453**
Amortization / depreciation of capital equipment				$5,595,000
Net Cost including Amortization and Depreciation				**$38,087,453**

VRS attendants are the operators who register users and assist users should they have problem using the VRS. People (such as elderly) who wish to request a minibus from a live person may do so by pressing '0' at anytime in the VRS phone menu. VRS attendants can also answer billing questions, provide route information, etc.

Total operating cost is estimated to be $32.5 million. If we include amortization of the capital cost, net cost per year becomes just over $38 million, which is quite moderate compared to many transit systems.

Revenue

Revenue is the other side of the equation. Can this system be self sustaining? We attempt to answer this question with the table below:

	2001		2031	
	Weekday	**Weekend**	**Weekday**	**Weekend**
Total number of trips	1200000	120000	3000000	300000
Transit mode share	8%	4%	17%	6%
# trips by transit	96000	4800	510000	18000
avg # rides per trip	1	1	1	1
total # trips / day	96000	4800	510000	18000
Cost per minibus trip	$1	$1	$1	$1
# days / year	260	105	260	105
Total fare revenue fare	$24,960,000	$504,000	$132,600,000	$1,890,000
Grand total of revenue from fare (2001)		**$25,464,000**		(in 2001 $) **$134,490,000**
Advertising:				
# of buses	300		300	
# of ads / buses	4		4	
Yearly ad space rental	$100		$100	
total ad revenue / year	$120,000		$120,000	
Grand total of minibus revenue		**$25,584,000**		(in 2001 $) **$134,610,000**

The total number of weekday trips and the transit mode share percentage are obtained from the York Region TMP. We assume that during the weekend, there are only 1/10 of the trips compared to weekday, and mode share is only half, at 4%. Note that weekday transit mode share assumed is 8%, which is 2001 number before introducing any minibus. With the accessibility provided by minibuses, transit mode share should be much higher. Based on "a buck a trip" and every transit trip involves (on average) 1 minibus trip – a rather conservative estimate, the total revenue from minibus fare only is just over $25 million, resulting in the recovery of 78.37% of the operating cost. With the number of trips grows to 3 million per

weekday (or 3.5% per year), and transit mode share of 17% as targeted in the TMP, total revenue will exceed $130 million (in 2001$). Although the operating cost will also increase correspondingly, there is a clear chance of a financial break-even or even a profit.

One should take note that the above analysis does not account for ridership benefits to GO transit and other GTA transit operators such as the TTC. The revenue also does not include many intangible benefits described in the previous section.

Conclusions

In this report, we argue that because of generally low density of residence and employment, accessibility of RT and buses in suburban areas is very poor. If we increase the number of stops on RT and bus routes, the travel times, as well as number of transit vehicles required, will increase dramatically. As a cost effective solution, we propose an extensive hierarchical transit system, with demand responsive minibus at the lowest level. Because of its flexible nature, it is most suitable for low-medium population density areas such as the York Region. We use York Region as an example and design a transit network, which composes of two rapid transit lines, seven express bus routes and 74 minibus zones. Number of stops is kept to a minimum for RT and express bus lines, thus enhancing their operating speed and reliability. Detailed operations of the transit vehicle request system is described, both in user's point of view and operator's point of view. We look at a long list of advantages provided by this minibus system, as well as discuss some potential concerns about this system. The list of advantages clearly outweighs the list of disadvantages. A cost and revenue analysis is then provided and we show that, based on conservative 2001 numbers, the operating cost recovery is over 78%. We project that the fare revenue from minibuses can grow to over $130 million in 2031. With so much benefits provided by the minibus system, the proposed system deserves a much more detailed and in-depth study.

Comparing Mail-Out and Open-House Survey Methods for Gauging Public Attitudes To Transportation Plans

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INTRODUCTION

Background

Many public authorities seek to incorporate public participation in their decision-making processes, including those processes involving transportation policy and planning. This is done for a number of reasons. At its best, the public participation process is "designed to help assure that the people's will is done" (Innes and Booher, 2000, p6) – in an attempt to design things to meet the aspirations of its citizens. In some cases, transportation planners seek to involve the

community while the planning and decision-making is still readily influenced, and attempt to take the opinions and values of the community into account when developing the plan (Shepherd and Bowler, 1997).

Presumably, along with the desire to "do the people's will", there are two general assumptions that underlie the decision to include some public participation in decision-making (Mumpower, 2001):

- the decision-making process can be improved by the inclusion of knowledge and perspectives that would otherwise be absent; and
- if the public has better access to knowledge and is more able to influence the process, then it may develop a sense of project ownership and thus increase its support.

Common Methods of Consultation/Participation

Governments tend to use two basic methods for consulting the public. One is opinion polls, or surveys, in which the participants are randomly selected and asked to respond to some form of survey instrument. The other is open-houses, where there is an open invitation to the public to take part in some form of meeting and provide verbal or written comments or reactions to what is presented. This latter method is mandated by the Municipal Government Act (2000) for municipal planning activities in the Province of Alberta.

Open-house processes are felt to have a number of advantages, as follows:

- a general indication of attitudes is provided relatively quickly, sometimes without the need for much analysis;
- there is an opportunity to educate a fairly large number of members of the public to the point where they can appreciate the issues and make relevant and coherent contributions to the planning process; and
- working relationships can be fostered among the administration, community leaders and members of the public.

Despite these advantages, and the resulting popularity of this latter method, little is known about its validity as a representative indication of public attitudes. Most noticeably absent from our understanding is the extent to which the responses from such self-selected samples of the population are representative of the whole. As the shape of major, permanent projects may rest on the responses of these open-house participants, it is important to know the extent to which the participants are members of what might be called a "vocal minority".

METHOD

The Edmonton Opportunity

In 1997, the City of Edmonton sought public opinions using both of these aforementioned methods as part of a larger survey. With both methods, participants were asked to complete the same questionnaire. The collection of data from these two groups of individuals using the same instrument provided an opportunity for comparing the two methods - in order to gauge the similarities and differences between these two samples and their corresponding populations.

The intent of the research reported here was to identify and examine any differences in the indications provided by the resulting two samples – and, more formally, to establish if there is a significant bias in the self-selected sample obtained in the open-house process in particular.

Key Choices Survey

The Edmonton Key Choices Survey was conducted between 25 April and 24 May 1997 as part of the development of the Edmonton Transportation Master Plan.

The Transportation Master Plan was to becomes the general outline according to which the city would develop its transportation infrastructure and related transportation policy. As such, the

Transportation Master Plan had the potential to influence significantly the future of the city and its citizens – impacting everything from the mobility of goods and people to the nature of the urban form and the resulting quality of life provided.

The Key Choices Survey questionnaires were distributed in two ways. The City conducted a series of open-house meetings concerning the Transportation Master Plan, and all attendees were asked to complete the questionnaire as part of the meeting. Questionnaires were also mailed-out to a randomly-selected set of households in the City of Edmonton, together with materials describing the Transportation Master Plan process. These households were also subsequently contacted by telephone and encouraged to respond.

The Questionnaire

The questionnaire included a series of eleven 'worksheets' designed to elicit the respondent's attitudes to elements of policy relevant to the Transportation Master Plan, along with some standard questions seeking personal information about the respondent. In each of these worksheets, the respondent was asked to allocate a set of 12 points among 2 or 3 different possible planning objectives in order to indicate the relative degrees of emphasis the respondent felt was appropriate among the objectives. For example, with two competing objectives, A and B, if the respondent felt A was all important relative to B, then A would get 12 points and B would get 0 points; whereas if the respondent felt A and B were equally important then both A and B would get 6 points.

The first six worksheets asked the respondent to allocate 12 points among two alternatives each time, as follows:

1: improving mobility versus saving money;
2: improving accessibility for the mobility disadvantaged versus saving money;
3: improving mobility for commerce versus preserving and enhancing neighbourhood integrity;

4: improving personal mobility by automobile versus preserving and enhancing neighbourhood integrity;
5: improving personal mobility by automobile versus protecting the city's environment; and
6: personal mobility by automobile versus the protecting the global environment.

The last five worksheets asked the respondent to allocate 12 points among three alternatives each time, as follows:
7: improving personal mobility versus protecting the environment versus saving money
8: improving personal mobility by automobile versus improving personal mobility by transit versus improving personal mobility by bicycle;
9: improving accessibility for the mobility disadvantaged, versus improving alternatives to auto use versus saving money;
10: protecting the global environment versus protecting the city's environment versus preserving and enhancing neighbourhood integrity; and
11: using debt to finance transportation expenditure versus using user charges to finance transportation expenditure versus using municipal taxes to finance to transportation expenditure

In total, 472 completed questionnaires were obtained at the eight public open-houses hosted by the City; and 868 completed questionnaires were returned by the mail-out sample group (representing a response rate of 29%).

The observations in the mail-out sample were then weighted so that the joint distribution for the sample matched that for the population (according to Statistics Canada tables) in terms of age, gender, household size and dwelling type. All of the results for the mail-out sample presented here use this weighted version of the sample.

RESULTS

Distributions of Points

Figure 1 compares the distributions of points obtained for worksheet 1 for the two samples. Similar sorts of 2-dimensional and 3-dimensional distributions were obtained for the other two-alternative and three-alternative worksheets, and these are presented elsewhere (Mackay, 2004).

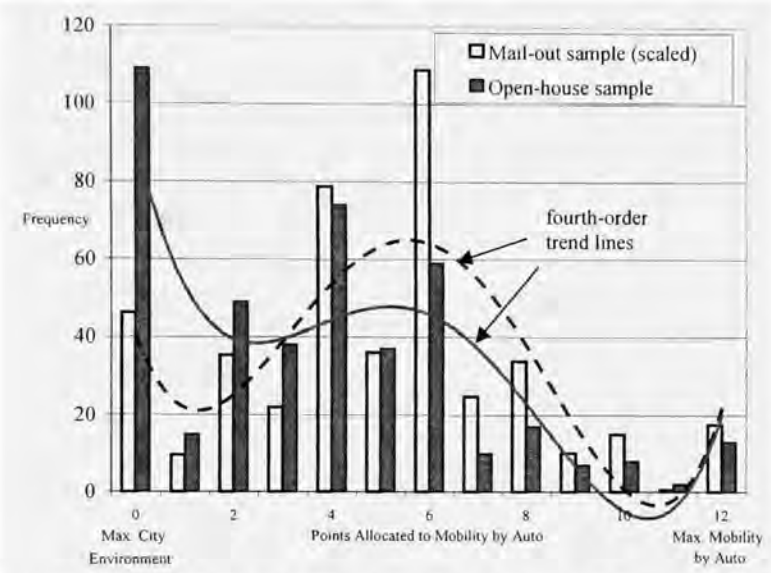


Figure 1: Distributions of points allocated in worksheet 1

Sample Comparison

The relationships between the two samples and their corresponding populations are illustrated in Figure 2. In the analysis that is done, each sample is taken to be representative of its corresponding population. The random sample is representative of the general

population (Link A) because it is a random sample, at least within the practical constraints of the comparatively modest budget available for this work, that has been subsequently weighted to match known population distributions. The open-house sample is similarly representative of the open-house population (Link B), again, at least within the practical constraints that are acting. It is the open-house population's 'representativeness' of the general population (Link C) that is of issue here. This 'representativeness' is examined by comparing the two samples, to see if they are significantly different.

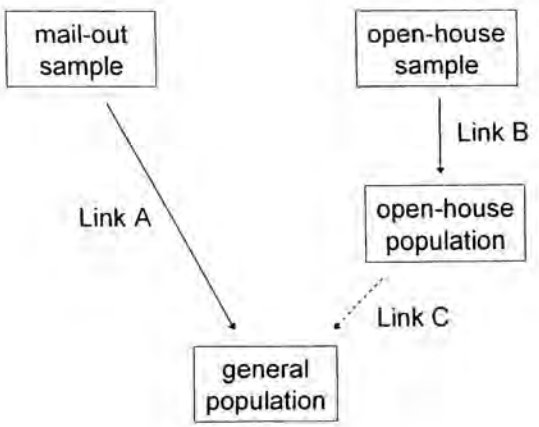


Figure 2: Connections between the samples and the populations

The significance of the difference between the two samples was tested in two ways, using Mann-Whitney U-tests and Chi-squared goodness-of-fit tests.

The Mann-Whitney U-test (Conover, 1980) is a rank-sum method for determining if two samples come from populations with the same

mean. It does not require that the data follow any specific distribution. The null-hypothesis is that the two samples come from populations with the same means. The test was performed on the results from each of the two-alternative worksheets.

The Chi-Squared goodness-of-fit test (Ang and Tang, 1975) compares the frequency distribution of a sample against expected values. The null hypothesis is that the sample follows the expected distribution. The test was performed on the results from each of the two- and the three-alternative worksheets, with the expected values derived from the mail-out sample and the observed values derived from the open-house sample.

The results of the Mann-Whitney U-tests and the Chi-squared goodness-of-fit tests for the six two-variable worksheets are shown in Table 1. The results of the Chi-squared goodness-of-fit tests for the three-variable worksheets are shown in Table 2.

Table 1: Results of comparisons for worksheets 1-6

Worksheet	*Mann-Whitney U-Test*		*Chi-squared Goodness-of-fit*	
	Z-score	*P-value*	χ^2	*P-value*
1	18.580	0.000	1,050.70	0.000
2	11.551	0.000	365.50	0.000
3	5.066	0.000	97.92	0.000
4	9.813	0.000	251.38	0.000
5	9.210	0.000	167.90	0.000
6	6.814	0.000	175.25	0.000

Table 2: Results of comparisons for worksheets 7-11

	Worksheet	χ^2	*P-value*
7	Mobility	36.58	0.000
	Environment	153.44	0.000
	Money	465.98	0.000
8	Personal Mobility by Auto	353.99	0.000
	Personal Mobility by Transit	144.75	0.000
	Personal Mobility by Bicycle	111.60	0.000
9	Accessibility for Mob. Disadvantaged	41.76	0.000
	Alternative to Auto	206.51	0.000
	Money	298.63	0.000
10	Global Environment	71.39	0.000
	City Environment	36.28	0.000
	Neighbourhood Integrity	45.89	0.000
11	Debt	60.53	0.000
	User Charges	82.11	0.000
	Municipal Taxes	56.67	0.000

In all cases the null hypothesis is rejected with a very small P-value, indicating that there is a strong, statistically significant difference between the two samples in all respects considered. This provides a strong indication that the open-house sample is NOT representative of the general population. The strength of this indication is felt to be sufficient to overcome much of the uncertainty arising because of the assumptions about representativeness inherent in the sample

comparison process (regarding Links A and B in Figure 2 as discussed above).

Indications Regarding Attitudes

Further inspection of the responses to the individual worksheets provide the following more general indications of differences between the two samples:

- Those who attended the open-houses tended to place a lower value on saving money than the general population. In all questions where saving money was an option, the open-house group tended to favour the other option or options. While the mail-out sample also tended to place a lower value on saving money than other options, this tendency was far weaker than in the open-house group.
- There was a tendency to place a lower value on improving mobility for the automobile in both samples. The mail-out sample tended to show a slight preference for any other option when compared to improving mobility for the automobile (mean of 4.33 for automobile on worksheet 8). This tendency was much stronger in the open-house group (mean of 3.29 for automobile on worksheet 8).
- Those attending the open-houses displayed a fairly strong and clear preference for the city's environment, followed by neighbourhood integrity over the global environment. Those in the mail-out sample were more ambiguous, indicating a weaker preference for the city environment and a somewhat weaker concern for environmental matters relative to others generally.
- Both the mail-out sample and the open-house sample displayed little enthusiasm for improving personal mobility by bicycle - as an alternative to the auto and transit modes. This lack of enthusiasm was slightly greater for the mail-out sample (mean of 3.01 and a mode of 2 for bicycle on worksheet 8) than it was for the open-house sample (mean of 3.17 for bicycle on worksheet 8).

- The two samples displayed fairly similar, strongly negative attitudes regarding debt as a method of financing transportation expenditures. The mode value for the distribution was 0 for debt on worksheet 11 in both cases.

Organizations in the Open-House Sample

Of the 392 open-house respondents who gave valid responses on all six of the two-alternative worksheets, thirty-one indicated they were part of an organisation or interest-group concerned about the Transportation Master Plan (which was asked in the questionnaire). The responses for this group of thirty-one respondents from organizations were analyzed to see if there was evidence of any sort of coordinated action.

Table 3 shows some characteristics of the distributions of responses from these respondents from organizations. Only one of the modes is at an extreme point. Further, if this group was attempting to act in some coordinate fashion, then the standard deviations should tend towards zero. The standard deviations are sufficiently large to suggest that this group did not assign their points *en bloc*.

Table 3: Characteristics of distributions of points assigned the first alternative in worksheets 1-6 by the responses from organizations

Worksheet	*1*	*2*	*3*	*4*	*5*	*6*
Mean	7.77	8.68	4.29	4.10	4.10	4.84
Standard Deviation	2.51	2.74	3.02	2.24	2.52	2.91
Mode	10	12	4	6	6	6

A Mann-Whitney U-test was used to investigate whether this group of respondents from organizations provided significantly different responses from the rest of the respondents at the open-houses. The null hypothesis of the test that the two samples had the same mean could NOT be rejected with a P-value of 0.073. Thus, it cannot be said with much confidence that those respondents from organizations

provided indications different from the rest of those attending the open-houses on an individual basis. But the P-value is still not too large. So, those from organizations do not appear to have been very much different from the rest at the open-houses.

Extent of Extreme Responses

The cumulative deviation from the mid-point score was calculated for each respondent over the set of six two-alternative worksheets. A comparison of the distributions of these cumulative deviations from the mid-points for the two samples indicates that the open-house participants tended to be more severe in the way they divided their points between the two options when compared to the randomly selected sample.

The bulk of the respondents in the mail-out sample deviated between four and thirteen points from the mid-point over the first six worksheets. The mean deviation for this group is 12.78, which equates to an average deviation of 2.13 points from the mid-point per worksheet. The respondents in the open-house sample had a mean deviation from the mid-point of 17.76 points over the six worksheets, equating to an average of 2.96 points per worksheet. At the extremes: a total of 20 of the respondents in the open-house sample (5.1% of the total) scored at the extreme 36-point value, having assigned points on an all-or-nothing basis for all six of the two-variable worksheets; whereas only 15 (1.7% of the total) of the mail-out sample were scored at the extreme. This difference is even more pronounced when considering the proportions deviating thirty or more points from the mid-point: 15.6% of the open-house sample versus only 3.7% of the mail-out sample.

This suggests there is some greater degree of extreme, or 'stronger' attitudes within the open-house sample - which is perhaps not too surprising given that such attitudes may be the reasons these people decided to make the effort to attend the open houses.

CONCLUSIONS

The most significant finding of this research is that the attitudes displayed by those self-selected people attending open-house events in Edmonton are not representative of the attitudes of the general population in Edmonton. While this finding is for Edmonton specifically, it may also be the case elsewhere.

It was also seen that the views expressed at the open-houses tended to be more extreme than those expressed by a more representative group. However, in many cases, especially those having only two alternatives, the responses from the two groups, though different, did tend to favour the same option. The difference would appear to be in degree, rather than in direction. Thus, it may be possible to take the results of an open-house process as indicative of the direction of attitudes and preferences for the general public, at least between two planning objectives, with some degree of over-stating the strength of conviction regarding these attitudes and preferences.

It is important to acknowledge that this work had limitations. The mail-out sample is unlikely to be exactly representative of the general population. It was weighted to match various population characteristics, but it got only a 29% response rate. Still, the open-house sample was so significantly different from the weighted mail-out sample that it is felt the uncertainties arising from this limitation are largely overcome.

Some other findings regarding specific issues were:

- The desire for improved mobility by automobile is comparatively weak within the set of objectives considered. In all cases where a question involved mobility by automobile, this option was the least preferred in both sample groups. There was no other option that elicited such a consistent and obvious willingness to trade against.
- There is a strong aversion to the use of debt to finance transportation spending. Both groups of respondents overwhelmingly favoured user fees and increased taxes in

order to finance actions required under the Transportation Master Plan. This finding is of interest given the political climate at the time of the survey. The governments in Alberta had been stressing deficit elimination and debt reduction for some time prior to the Key Choices Survey. This raises the question: Were these government actions a reflection of this aversion to debt in the electorate, or did the aversion stem from the actions of the government?

- Neighbourhood integrity was not a big concern, despite it apparently being a contentious issue at the time of the Survey. In both samples, it consistently rated above enhancing mobility but not above the city's environment.

The findings of this research put into question the representative nature of attitude and opinion data obtained in an open-house setting. While the self-selected respondents attending open-houses did favour many of the same options as the mail-out sample, they did so with greater conviction. This suggests a strategy regarding the decision to use an open-house process to measure public opinions. If the aim of a consultative process is merely to see which of several options is preferred by the general population, then a self-selected sample from open-houses may indeed provide valid indications. On the other hand, if the intention is to gauge accurately the level of public support both for and against a given option, the use of open-houses may not be appropriate. In addition, the results of an open-house process need to be interpreted with great care: when the options are more complex, as in the three-variable questions, the views obtained in open-houses become less indicative of the views held more generally.

ACKNOWLEDGEMENTS

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All of the analysis done and all of the opinions expressed or implied here are solely the responsibility of the authors. No government position can be inferred from the discussions contained here.

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Operational and Tactical Planning in the Beverage Industry

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1. Introduction

This report presents the results of a study conducted for a Canadian beverage manufacturer and distributor. For reasons of confidentiality, we refer to the company as CanBev, and we present the analysis in such a way as to avoid using actual data.

In 1999, CanBev's new product, H1, was introduced to the New England region of the US. The response was extremely positive: within six weeks, a year's worth of forecasted sales had been met. Based on that success, management decided to invest heavily in the US market. A US division was soon established and the brand was rolled out to all states by summer of 2000. Impact Magazine, an influential publication on branding success, rated H1 as one of the top 10 new brands of alcoholic beverages in the US for the year 2000. Sales of H1 in the US continue to grow through 2002. In the summer of 2002, two new flavors, H2 and H3, were added to the portfolio alongside the original H1 flavor.

The flows of products and information in the US logistics system for the H products are shown in Figure 1 below. Production is carried out at plants called co-packers; these are not owned by CanBev. CanBev buys production hours from the co-packers and provides a production plan on or around the tenth of each month, determining the volume of each stock keeping unit (SKU) produced in the next month. CanBev pays the co-packers based on actual production volume. After the beverages are produced, they are shipped to Distribution Centers (DCs) in full truckloads. The distributors of the products place orders

to CanBev sales personnel, and CanBev sends the orders to distributors by trucks from DCs. Meanwhile, CanBev sales personnel keep in close touch with distributors, exchanging information about products and promotions, and acquiring the estimated order quantity and mix of SKUs for the next 12 months. This forecast information is collected by CanBev planners, who determine the production, transportation and inventory schedules based on the forecasts and the cost structure.

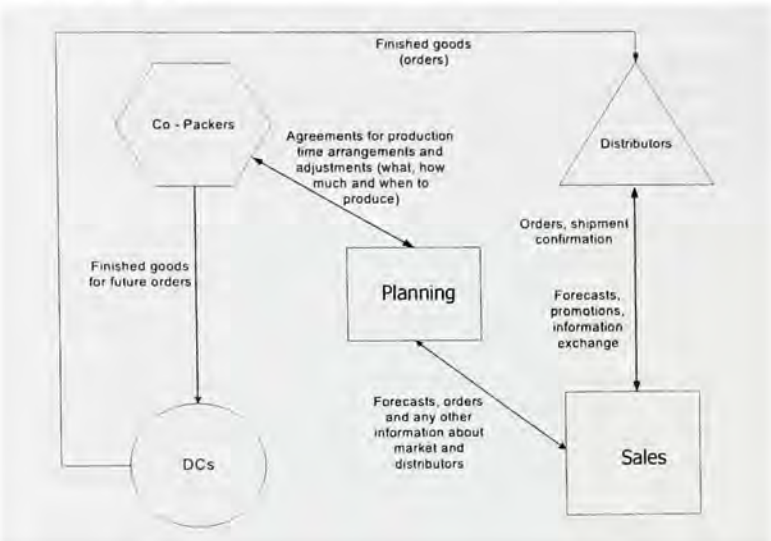


Figure 1: Flows of products and information in the logistics system for the H products

The success of the H products in the US market resulted in a series of business issues during the summer of 2001. Co-packers failed to meet production plans, DCs did not have the right mix of SKU volume to fulfill orders, retailers complained about stock-outs, and high transportation costs occurred due to frequent transshipments among DCs. In a highly competitive beverage market, these issues could

erode the confidence of retailers and negatively affect CanBev's expansion plan. In light of these issues, CanBev needed a planning tool to improve its US logistics system from production and transportation to inventory, by ensuring that the right amounts of the right SKUs would be at the right place at the right time. To meet this need we worked with the company to develop a customized stand-alone computer based planning tool, referred to as the Aggregate Logistic Optimization Tool (ALOT), to assist in planning the production and distribution of H products in the US market. The tool was designed to enhance the performance of CanBev's U.S. inventory and distribution system for H products, using a computer based optimization model. The tool was designed to determine co-packer production levels, allocations to DCs, transshipment between DCs, and DC inventory levels that minimized total costs subject to satisfying business constraints.

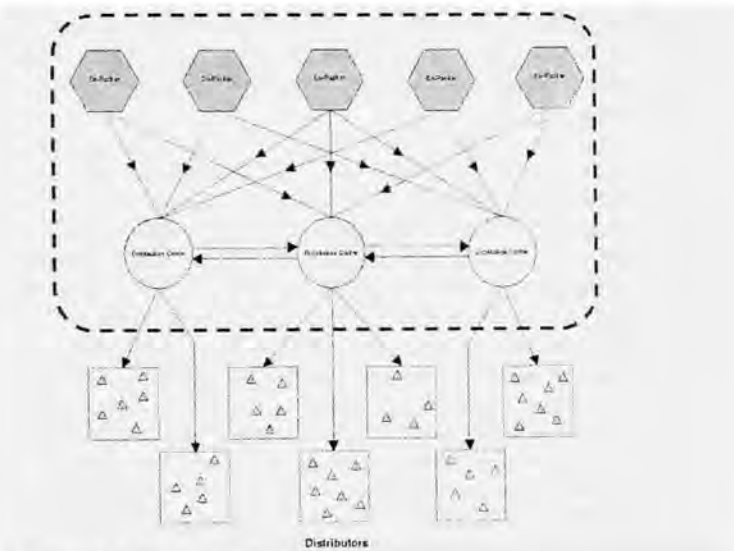


Figure 2. Logistics Network

This study was carried out in two phases. In Phase I, the project team reviewed CanBev's operation systems in the US market, studying physical and information flows, forecasting and production timelines, and the constraints involved in the operation. The team aggregated and simplified the problem into one that is solvable and useful for CanBev planners. This simplified model included the production, distribution and inventory systems of 10 co-packers, 4 DCs, and 12 typical products, with 4 package types for each of three flavors (H1, H2 and H3). This initial model was used to prove the concept and convince CanBev of the model's capabilities.

In the second phase, the model was expanded to describe the actual logistics structure in the US market. The new model included 10 co-packers, all 5 DCs, and all 40 SKUs currently supplied to the US market. It also allows inter-DC transshipment, which had not been implemented in the Phase I model. After the new model was validated, a stand-alone planning tool, ALOT, was developed. The teams from both CanBev and the COE worked closely throughout the project. Collaboration between two teams was a key factor in the success of this project.

ALOT models a multi-period, multi-commodity production and inventory planning problem, in which differentiated products use common facilities and materials and must therefore be considered jointly instead of independently. There is considerable research in the area of multi-product production and inventory planning. Johnson and Montgomery [1974, Chapter 4.6] describe multi-product linear programming models, including resource constrained production planning, process selection decision-making, product mix decision-making, production smoothing problems, and production and work force planning. Most of the models consider backlogging, which was not required in this study. Phillips and Garcia-Diaz [1981, Chapter 5.III] also introduce multi-commodity network flows. They discuss linear programming formulations of models of this type, but their emphasis is on the algorithms for solving for optimal integer solutions. Evans (1977) also focuses on obtaining approximate integer solutions to dynamic, deterministic, multi-product, and

multistage production-inventory planning problems. Bazaraa and Jarvis [1977, Chapter 11.3-4] examine the application of the decomposition algorithm to the minimal cost multi-commodity flow problem, and specifically analyze characterization of basis while applying the simplex method. Ahuja et al (1995) list several applications of multi-commodity flow problems, including communication networks, railroad transportation networks, racial balancing of schools, and multi-vehicle tanker scheduling.

Brown et al. (2001) describe the Kellogg Planning System (KPS) used by the Kellogg Company, the world's largest cereal producer. We found that ALOT resembles KPS in many ways. KPS is a large-scale multi-period linear program, guiding production and distribution decisions for its cereal and convenience foods businesses. An operational version of KPS helps determine where products are produced and how finished products and in-process products are shipped between plants and DCs. Also, there is a tactical version of KPS, which helps to establish plant budgets and make capacity-expansion and consolidation decisions. Operations by KPS reduced production, inventory, and distribution costs by an estimated $4.5 million in 1995. The KPS tactical version was used to guide a consolidation of production capacity with a projected savings of $35 to $40 million per year. The major difference between KPS and ALOT is that the cereal and convenient food production process is more complex than beverage bottling. Therefore the KPS linear program models a multi-stage production system, while ALOT, though multi-period, models a single stage system.

2. Model and Implementation

The problem studied here is a multi-period, multi-product network flow problem formulated as a linear program (LP).

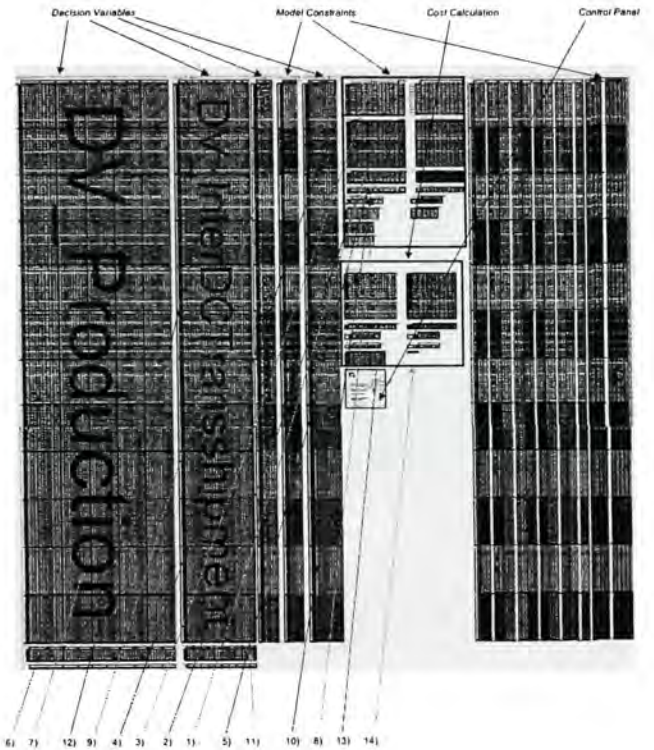
The objective of this LP model is to minimize the total logistics cost, which consists of production, transportation, transshipment and inventory costs and find the corresponding number of cases of each

SKU produced at each co-packer for each DC for each period while maintaining all the constraints of the system.

Data were provided for ALOT from CanBev's information system. Availability of data was a key factor contributing to the success of this project. In this model, we assume all data are deterministic.

The model was implemented in MS Excel. CanBev uses Excel extensively in their planning work. Getting the required data into the model and exporting the solution from the model was easy and convenient. Setting up the model in Excel made the model easily understandable for CanBev planners. Putting 48,000 decision variables and 16,000 linear equations into one Excel spreadsheet and locating them appropriately, however, requires quite a bit of work. Out of the 256 columns available in an Excel spreadsheet, the model uses 218 columns. Various techniques in Excel and VBA (Visual Basic for Applications) were applied to create the model. Figure 3 shows a screenshot of the main ALOT model spreadsheet in Excel.

While the model spreadsheet is the heart of the ALOT model, data input and output spreadsheets are also very important components of the tool. ALOT includes a graphic user interface which allows users to quickly locate particular spreadsheets, and switch between them conveniently and easily. Using checkboxes in the main menu, ALOT users can choose the constraints to be held in each solution. Figure 4 is a screenshot of ALOT main menu. The coding component of ALOT, including form and button design, input data validation, LP solver integration, and feasibility checking, was done with VBA in Excel.



Function of Tables

Please note that all of these tables are accessible from the control panel.

Production Plan
1) Monthly production total of all SKUs
2) Annual production for each SKU
3) Monthly production for each production line
4) Monthly production for each SKU at each co-packers

Co-packer to DC Transportation Plan
5) Annual transportation total of all SKUs
6) Monthly transportation total of all SKUs
7) Monthly transportation for each SKU

Inventory Plan
8) Annual/monthly inventory total of all SKUs
9) Monthly inventory for each SKU

Inter-DC Transshipment Plan
10) Annual/monthly transshipment total of all SKUs
11) Monthly transshipment total of all SKUs
12) Monthly transshipment for each SKU

Total Costs
13) Monthly Cost
14) Total Overall Cost

Figure 3. ALOT Model in MS Excel Spreadsheet

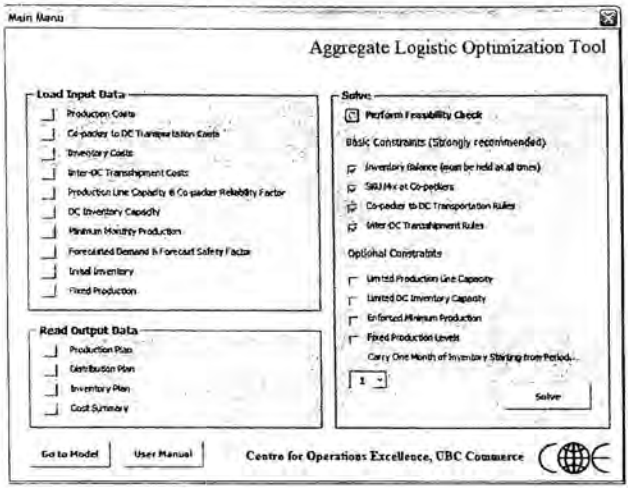


Figure 4. ALOT Main Menu

3 Use of ALOT as an Operational and Tactical Tool

ALOT is a planning tool with a user-friendly interface. Users can load input data, read output data, choose model constraints and solve the model very conveniently. All data tables can be accessed from buttons on the main menu. Checkboxes on the main menu enable the users to test different combinations of constraints, and to examine various operational scenarios. A user manual was integrated into ALOT, explaining how to use the tool, cautions to be taken at each step, and the logic behind the tool. Customized printing options are available for all output data tables.

ALOT also allows for future expansions of CanBev business in the US market. For instance, besides all of the H SKUs, "dummy" SKUs are included in the model, which can be turned into new SKUs in the future if necessary. Finally, ALOT provides the options to close and open co-packers and DCs, and change transportation rules.

ALOT was developed as an operational tool, supporting CanBev's regular business decision-making process in production, transportation and inventory. ALOT solves the multi-period model by using a rolling horizon approach. The model is solved at one point in each month, for a planning horizon of the next 12 months. As one period elapses and better data and forecasts become available, the model is advanced by one period. The month t = 2 becomes t = 1, etc., and the whole process is repeated.

Although ALOT was intended primarily for operational planning, its first application was for tactical planning. During the development of ALOT, one of the co-packers ran into financial difficulty and was shut down with short notice. The co-packer was one of the production facilities with all three types of production lines, and its closure had a significant impact on CanBev's summer marketing plan. CanBev was faced with an option either to support this co-packer by investing in it, or to let it go and shift the production orders to other co-packers. The project team used the prototype of the tool and analyzed the two options. The analysis showed that the optimal logistic plan with or without this co-packer makes negligible difference in the total cost in coming 12 months. Finally, CanBev decided not to invest in this plant, based on analyses including those done by ALOT. Another example was the cost quantification for carrying one month extra inventory. This enabled the company to have a good estimate for the cost of having extra stock to prevent the stock-outs. Other tactical analysis possibilities include measuring the impact of varying forecast accuracy, closing and opening plants and DCs.. ALOT supports CanBev in decision making for internal operations, as well as for external business activities such as negotiations.

4. Conclusion

In this report, we present an overview of a linear programming model and a computer based planning tool, ALOT, to optimize CanBev's logistics system for its H line of products in the US market. ALOT can be used both as an operational planning tool and a tactical planning tool. It assists the CanBev planners in making business decisions, such as capacity planning and investment, by running

"what if" scenarios. CanBev began using ALOT in their daily operations in September 2002. According to CanBev's vice president of process integration, ALOT has changed the way CanBev does its business planning. With the quantitative support of ALOT, the production plan of 2003 is expected to differ significantly from that of 2002; expectations are that the 2003 plan will be more rational and cost efficient. There remain possibilities to expand ALOT. Considerations for future research include improving the quality of forecasts, modeling with stochastic programming instead of deterministic, and including optimization of DC to region transportation are in consideration in the future.

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THE DEMISE OF THE JOURNEYMAN MEAT CUTTER AT CANADA SAFEWAY LTD.

The intent and purpose of this paper is to demonstrate how and why Canada Safeway Limited, Western Canada's largest grocery retailer, changed its meat department operations by eliminating the journeyman meat cutter. The writer will attempt to walk the reader through a history of developments, both technological and social, that led Canada Safeway Ltd. to make this landmark decision, and outline how it affected customer service as a whole at Safeway. Readers will hopefully see why they have stopped being able to buy meat directly from the experienced meat cutter over the counter and are now subject to environment that is devoid of personalized service, where the customer chooses the product from the meat case. In this new environment, Safeway management hopes the customer finds what he or she came for. And in many cases, customers may not have really noticed the changes as they have been gradual and introduced or sold to the public with great fanfare at each new store openings over the years. The changes at Safeway will be looked at through a series of chronological events, the examination of the logistical processes and other forces in the market place. Also traced will be the make up of the retail grocery industry and the meat packing plants that supplied the stores, from the early stages to present day. This research work will be done by interviewing Safeway Store and Meat Managers, Meat/Buyer Merchandiser, backstage non-union employees, Packaging Company Representatives, texts, library research articles, trade publications and the author's own personal experience in the retail grocery industry.

What is your experience when you walked into a present day Safeway Store and went to the meat department? Can you find a journeyman meat cutter or struggle to find the hidden buzzer? Did any staff appear or did everyone already leave for the day? Did you find what you were looking for in the self-service counter or did you just leave?

Who is Canada Safeway Ltd.

Safeway is one of the lone survivors in the American retail grocery industry. It was a global company with stores in Germany, Scotland, England, Australia and Canada. It was taken private by the KKR group (Kolberg, Kravitz and Roberts) in the mid 1980's and presently it is a publicly traded company listed on the New York Stock Exchange under the symbol SWY-N. Total store sales in 2001 totaled $34 Billion. In the U.S., Safeway has 1,577 stores scattered in different regions. In Canada, known as Canada Safeway, it has 215 stores operating mostly in Western Canada with Winnipeg Division controlling 56 stores in Manitoba, Saskatchewan and Northern Ontario.

Some Early History

Early Retail Chains and Meat Suppliers

In the 1960's Winnipeg's retail grocery industry was comprised of three large chains, Safeway, Dominion and Loblaws. Each were unionized and represented by the United Food and Confectionery Workers. There were smaller players like Atlantic & Pacific, Codville, and Co-op. The major meat suppliers to these chains were Canada Packers and Swifts. Some of the smaller independent suppliers were O.K. Packers, East-West and Burns. The Amalgamated Meat Cutters Union represented the workers in all the union plants.

Immigration, Community Colleges, Demographics and Expanding City Boundaries

To immigrate to Canada in the 1950 & 60's, immigrants had to meet certain skill requirements. The journeyman meat cutters entered Canada from Europe this way. They had apprenticed anywhere from two and half years up to five years in their profession in Europe. Safeway hired these immigrants from Scotland, Ireland, England, Holland, Germany, Switzerland and Italy.

Canada did not have formal training schools until the advent of the Community Colleges in the middle 1960's. The meat cutting courses in Winnipeg's Red River Community College were five months in duration and featured theory and limited practice in cutting. This course was similar to the one at George Brown College in Toronto. Once the students in the meat course got through the theory of the course, they sold their practice meat cuttings every Friday to other college students and staff at cost. The college recovered the cost of

the meat and the students gained over the counter experience as well as cutting. However, the individual grocery store or chain now had to have the newly hired apprentice meat cutter work under the guidance of the store's skilled journeyman cutters. This apprenticeship usually took five years for a meat cutter to get to the top rate and be recognized as a journeyman by his fellow workers.

To meet the demand of Canada's growing population in the 1960's through immigration, industrial growth and baby boomers, the advent of the planned communities outside of the city proper was started to meet the housing needs. In West Kildonan, it was Garden City; in St. Boniface, it was Windsor & Niakwa Park; in Fort Garry, it was Fort Richmond and Richmond West; in St. James-Assiniboia, it was Westwood, Pinewood Place, Crestview and Silver Heights; in East Kildonan, it was North Kildonan; in Transcona, it was Heritage Park; in Charleswood, it was River Park West; St. Vital, it was Southdale and in Winnipeg proper, it was River Heights and Tuxedo. Each grocery chain had real estate and construction departments that followed the changing demographics of the cities and planned five years in advance for potential sites for stores in these new suburbs.

Shopping Centers and Store Designs

Free standing stores were still a popular idea, but the shopping center store was the best public draw. Long range planning went into store design as it was difficult and costly to expand a store within a given shopping center after it was built. Stores expanded from the old 10,000-16,000 square feet up to 28,000-32,000 square feet. With the seasonal weather, customers could spend more time in the stores and the shopping center offered more than just a trip to the store for groceries.

The majority of the Safeway stores in the 1950 and early 1960's were carry-overs from the past several decades, free standing stores usually around 10,000 square feet in size. There were three or four checkouts at the front, a produce and dairy counter, three to four aisles and the meat counter at the back of the store. The meat section could have an open self service counter or a small glassed case showcase eight to 12 feet in length. The meat cutting area usually behind the case, open to serve the public and at store temperature. There would be several cutting blocks and the customer dealt with the meat manager or cutter. The customer would ask the meat personnel for their recommendations or perhaps they saw something advertised on the

front store window or preferred a special type of cut. The customer would see the person select or bring out a piece of meat from the cooler, cut it, trim it, show the cut for approval, weigh and price it in front of the customer, wrap it up in brown waxed paper and tie or tape the package. The customer and meat manager established a relationship as this type of transaction occurred once or twice a week. Not only did the meat manager or cutter have to be good at their trade, they had to have excellent interpersonal skills. They had to sell their product. For the customer, this was a folksy, warm atmosphere to shop in. All the key store staff knew your name and if you shopped with your children, they inquired and talked with them also. The customer was catered to.

These open air meat cutting/processing areas and over the counter service might have been the practice for many decades, but due to the following changes in the grocery and meat retailing business, changes were immanent.

What led to the Demise of the Journeyman Meat Cutter?

Advances in Refrigeration Methods

Better refrigeration methods in the industry meant new designs for meat cases such as longer and then double decked in specific areas and refrigerated meat cutting rooms. Gone were the days of meat preparation in the store's open room temperature. As former meat merchandiser, Klaus Schwertzel, explained, "It was a wonder that we didn't kill a lot of people with this meat cutting method!" Klaus was referring to bacteria growth as it expands at a geometric progression, the warmer the temperatures, the faster the growth. The meat grinder was used first thing in the morning for fresh ground beef, then again later in the day for the supper hour rush. Loose bits of ground beef would be left in the grinder throughout the day, warming up and starting the bacteria growth. The second batch would have a head start in bacteria growth and could probably be somewhat safer if used that evening. If the ground beef was left to the next night's supper, then, there could be problems. Stores at first had sliding glass windows behind the meat counter so that the customer could see and ask the meat cutter for advice or special cuts. This was the first step in phasing out the individual, personalized over the counter service. Whereas previously the customer came face to face with the meat cutter, the meat cutter now had their backs to the customer.

The Role of Governments (federal, provincial and city) in Regards to Store Hours, Consumer Health Protection, Consumer/Corporate Affairs and Competition Bureau.

The advent of bigger stores also created more problems for Safeway with government enforcement agencies. As ads were created for the newer, larger stores in the suburbs who could carry many more new products, the ads had to feature disclaimers that stated "products not available" in the smaller store locations in the city core. Failure to disclaim a product could lead to false advertising charges by Corporate & Consumer Affairs.

There were clear cut boundaries where the city and provincial health department officials had jurisdiction. However, the federal government officials overlapped the city and provincial jurisdictions. Ottawa tried to phase out these federal inspectors in late 1970's but the inspectors went out and proved that they were needed to protect the public. Hence, the newspapers had front page feature articles on the meat departments such as Pork in Ground Beef or Unsanitary Meat Departments. Safeway was involved with one of the "pork in ground beef" charges, but health departments usually charged the smaller independents. Safeway took the lead in changing the method of operations to avoid cross-contamination and health departments used Safeway as an example to the rest of the industry. For example, if you cut some pork chops on a block and then trimmed hundreds of pounds of beef for ground beef on the same block, then, an extremely small trace amount of pork will be evident in the ground beef.

The health department inspectors banned the big wooden meat processing blocks from the departments as this method was tied to cross-contamination. These chopping blocks had deep cuts from the heavy blows of the meat cleaver. These cuts in the wood could not be cleaned out with daily washings as the meat particles were lodged deep in the wood. These areas were perfect for bacteria growth and would pass bacteria on to the fresh cuts of meat being processed and posing health threats to the customer. The nylon/ plastic cutting tables were introduced. In the following months several local kitchen furniture stores featured re-conditioned hard maple meat cutting blocks with wheels for easy mobility in the kitchen.

Stores used to spread sawdust in the meat cutting room for safer footing due to pieces of fat getting underfoot and to absorb blood. It was also at this time that the health department looked closer at the

meat cooler operations where the hanging beef was aging or stored. At Safeway, the meat room was swept every Saturday afternoon and new sawdust used to absorb the dripping blood was put down. However, if this schedule was not followed, mould could eventually grow in the sawdust. The City of Winnipeg Health Departments found this in several smaller independent stores and banned sawdust in all meat operations. Without sawdust, crushed cardboard boxes and then cardboard on rolls were used. It wasn't pretty but it worked.

Another problem area in the meat departments the health protection officials checked for was the percentage of fat in the various types of ground beef. Regular ground beef could have no more than 30% fat, lean ground beef 20% and extra lean 12% fat. Safeway always went under these percentages to escape prosecution; their regular mince was 25%, lean 15% and extra lean 7 to 8% fat. With hanging beef, the processed trim went into tubes under the counter. The meat cutter used an unreliable method of determining the amount of fat in the trim tube by eye balling it. If the meat cutter thought there were too much fat, he added frozen meat trim. The Safeway Meat Merchandisers on their store visits always tested a number of ground beef packages for fat content. If one of the Health Inspection Agencies caught a store with higher than allowed fat, the store was charged in court. The chain would be liable to a fine, adverse publicity and lost customers.

As well, meat department could not have two compartment sinks as the City of Winnipeg Health Department declared three compartment sinks to be the only legal method to properly clean and sanitize meat trays and cutting items in the meat department. This decision resulted in a $12,000 cost to all stores.

Changes in Transportation Modes: Rail and Trucking

The packing plants relied on cattle coming to market by rail car as the rail branch lines ran into all the regions were grain and cattle was grown. The plants also shipped live and processed meat to U.S. markets. The plants liked shipping processed meat as it was value-added product. With the rail abandonment, trucks became the main transportation method of moving cattle to markets. The report on Transportation-Related Opportunities and Barriers to Diversification of Value-Added Agricultural Exports from Western Canada by Dr. Barry Prentice, September 1991 showed in Table 2.1, page 5 the decrease in shipping by rail of live cattle, hogs and meats over a 20

year period, 1965-1985. Trucking picked up the business (P. 8 A). Figure 4.3 on page 44 of the report shows the states where Manitoba exported the meat.

Meat packaging plants had to maintain fleets of trucks to deliver the meat to the stores. The meat trucks were parked at the plants at the end of the day's deliveries (around 4:00 P.M.) and loaded after midnight for the daily runs. The trucks would leave and start making deliveries from 7:00 A.M. on until late afternoon. These were insulated trucks. The cool beef would cool the truck initial, but then with the door open to unload and the day's warmth, it would get warm. In one instance, a store refused a delivery of beef late one afternoon as the beef was warm, wet and slimy. Spoilage had set in.

Globalization

The market shift towards globalization had been happening at Canada Safeway for some time. Safeway stores always had frozen lamb from New Zealand. Australia started sending frozen beef to Canada in the 1980's. Argentina and Brazil beef also made inroads as special features with Safeway's competition as a competitive advantage in advertising lower cost steaks.

Changing Technology, Packaging and Scaling

The biggest changes in technology and packaging came at the same time of changing government legislation affecting the store meat operations. One type of packaging introduced was the O2, the oxygen scavenger packaging which was developed in Japan. In the U.S. it was film packaging such as Cryovac, a division of Sealed Air which was the most noted trade name due to the advertising and the pouch packaging in the meat industry. These market innovations paved the way for block ready beef and the elimination of hanging beef in the chains. It also meant a better leak proof package. The meat would carry a longer red bloom for sales appeal. There would be less re-processing of the packages saving labor costs.

The meat cutters had a number of injuries due to lifting and struggling to bring the hanging beef into the store from the delivery trucks. The fronts weighted in around 175 pounds and hinds at 120 pounds. Not only was the product heavy but it was slippery to hold and carry. As inventories had to be taken every four week, all the hanging beef had to pushed outside the meat room to the scales in

order to be weighted. Block ready beef did away with a lot of the injuries as beef was received on flats and wheeled to the meat rooms. The changes were really noticed in the weekly counter set-up. As business slackened off on the later Saturday afternoon, the meat counter was allowed to run down. From two layers to one layer and then the packages spread out more as the whole counter had to be taken down that evening. Stores that stayed open until 9:00 P.M. had more opportunity to run the counter down than those that closed at 6:00 P.M. All the chain grocery stores were closed on Sunday. Meat staff started at 5:00 A.M. to begin cutting for the wrappers. Some even started a Sunday midnight shift. All the effort of the meat department on Monday was to try and set up the counter from scratch for the coming week. The meat department did not want to be waiting on the customer that particular day. They were just too busy getting the counter set up. If payday was on Monday, it was next to impossible to keep the counter up and the department was behind all week. The stores usually had the counter set up fully by early Tuesday afternoon.

When dealing with a perishable product, the store could not cut too much meat and stock the counter too full. The shelf life of cut meat was two days. Packages had to re-processed, re-opened, trimmed where necessary, then re-packaged and weighed. This was very labor intensive. Monday's cuts had to be processed on Wednesday, Tuesday on Thursday and so on throughout the week.

With the stores being opened every evening to cater to the customer's changing work environment, this trend impacted greatly on the corner store by taking away their core business. Previously, with the stores being closed at 6:00 P.M., the corner store picked up a lot of their business in the evenings, especially the high profit sandwich and fast fry evening meal types. The worst time for the consumer to go grocery shopping is on the way home as impulse buying is very high. But Safeway benefited greatly with the longer store hours.

New Trends in Meat Supply Operations and Impact on Counter Set-Up

The coming of block ready beef or primal cut addressed many issues. Sawdust was no longer needed in the meat storage room as the beef came in tough plastic packages that rarely leaked. The amount of Workers Compensation Board claims due to strenuous lifting and

knife cuts from processing endless amounts of meat on the blocks were reduced. Another issue impacted on the firm's bottom line, a dramatic increase in sales per manhour due to reduction of labour and increased sales. The impact of block ready beef was really evident on Monday as the meat counter could now be set up on Monday and if payday occurred on this day, lost sales due to not having no product out was a thing of the past.

Pork can be processed from the packer and can be cut the next day with no aging as it is tender. Aging pork will result with a rancid taste in the fat. However, beef has to be aged for it to be tender. Fronts need at least five days and hinds at least seven days. Beef was better if aged 10 days. Loins, the steak region of the beef, need from 7-10 days. The store lost money as meat ages due to shrink and trimming away of dried flesh. The store also had hanging beef and money tied up in inventory due to the aging. If the store cut into this beef before the beef was properly aged, the customer would get tough beef and probably come back for a full refund.

Block ready meant the meat was cut and put into Cryovac, heavy plastic pouches, to age. There was no shrinkage as aging happened in the package. When the package was cut open, there was some loss of juice but this that happens when beef is hung for any period of time.

As block ready beef was already in use in the United States, it was not hard for Swift's to add a production line for Safeway. In Brandon, the local plant also added a block ready line to supply stores in that region. Beef now came to the store several ways, from the packing plant in cardboard boxes or from the Safeway's Distribution Center on nightly deliveries with other produce or grocery orders. Instead of the top rate meat cutter receiving the beef during the day, the lower rate part time food clerk placed the boxes or pallets of meat in the meat cooler.

Safeway opened the Lucerne Meat Processing Plant in Alberta and stores started receiving the tube ground beef, regular and lean commonly seen today in the case. The fat percentages were now controlled at one plant under constant monitoring, no more hit or miss or eye balling the fat contents. All these changes meant better quality control in the meat product, a safer product for the customer, and an extended product shelf life. Customers could buy meat to eat that day, or perhaps the next day for supper. You would hope the product

the customer buys would have a couple of days at home and not go bad the next day.

The meat department could switch very fast if there was a rush on a certain type of cut or if the customer wanted a special cut. All it took was a few minutes, to open a box, cut a pouch, cut, trim, weigh and price it. Before with hanging beef, it was roll out the beef handing on the rail, lift it off the rail, cut it on the saw into the proper portion, cut it further on the block, trim it, then weigh and wrap it. Then, roll the beef on the rail back into the cooler. Process the other left over meat, put in on trays, cover it and put it in the cooler. As clean up started at a certain time each day, the power saw would be taken apart and no cuts could be done after that. There were certain amount of lost sales. Block ready changed this, as you did not need the power saw if it was taken down for cleaning.

However, block ready beef was the first setback for the journeyman meat cutter. Due to the increased efficiency, higher sales per man hour were set and departments started cutting back hours and positions in their department.

Changing Consumer Demands and Habits

As families moved to suburbs, the lifestyles were changing also. The stay at home wife was now working part-time or full time. Newer married couples worked for several years to save up enough for down payments on houses. The only problem was that the majority of the stores closed at 6:00 P.M. on Mondays, Tuesdays, Wednesdays and Saturdays. The only evenings Safeway was open were Thursdays and Fridays. Working people had problems shopping at Safeway due to the stores closing at 6:00 P.M. There were only a few free standing stores on major routes that stayed open Monday through Saturday until 9:00 P.M if people wanted to shop after hours. These stores that offered the public a place to shop after the normal 6:00 P.M. closing time will play a role latter on in the scheme of things.

The Introduction of Delicatessen Style Products

Safeway stores had a separate meat case for packaged luncheon meat, a very high profit product, that was stocked by the meat manager or other meat cutters. Then, a small fresh deli counter was put into the stores, staffed by a combination of meat cutters and service clerks. As the sales increased, so did the size of the deli counter and it was taken out of the meat operation into a separate reporting department. The meat department not only lost sales but a high profit operation that

supplemented their labor and high cost operation. Lower paid service clerks were now doing the work. Over all the stores reported the same sales and profits, but each department was judged on the ROI or return on investment strategy.

Again, with fresh fish counters sales were taken away from the meat department, separate reporting department introduced and staffed with lower priced service clerks.

Smoke house operations that relied on the experience of European trained journeyman meat cutters were tried for several years but were not that successful. Fresh sausage making managed to stay around for a lot longer time but that did not require a skilled journeyman.

If one looked at the changing make up of products in the meat counter and more particularly, the frozen meat products, the percentage of fresh meat sales was declining. The total dollar sales would be down somewhat, but the price of fresh meat over the past decade has steadily increased. For families, the weekly roast is a thing of the past; it is out of their budget range-$50.00 plus dollars.

Healthier Living

Another change occurred in life styles-eating healthier. Perhaps it took too much time spent preparing a good meal with so many other activities the kids are in today. There might be trade-off for speed and selection in place of time to drive/attend practices or other social activities. Fresh chicken started appearing in special CO2 packages with a shelf life of a week or more. Previously thawed chicken had one or two rows in the meat counter. Today, chicken commands anywhere from 10 linear feet of counter to a whole triple deck refrigerated unit or 30 linear feet.

Another new section in the meat counter was the fresh pasta section that only requires a service clerk to put boxes to on the shelf. This section took space away from the red meat. The customer could now make a choice to go with either pasta or red meat by looking up and down the counter.

Restaurants are abundant in Winnipeg and radio talk shows mentioned that Winnipeg has more restaurants per capita than other cities. There is bonus coupon offer, buy one entree and get another one free at getting the customers to trade-off of preparing the fresh meat dinner at home versus a dinner out. This has affected meat department sales as well.

Introduction of the Micro Wave Oven

The micro-wave oven also changed the eating habits of the family and the need for a journeyman meat cutter. Just stick it in, hit the minute button several times and dinner is ready. The frozen meat section has expanded greatly, several types of frozen wings, frozen beef and chicken burgers, ribs, breaded products, tempura, lesagna, etc. More and more new products are coming out all the time. Previously stores had one frozen food section, now there are two sections. All of these new products impacted on the meat department and the management decision makers at head office. Fresh meat sales are declining. You do not need a skilled journeyman meat cutter to put out boxes of assorted varieties of frozen meat products where a service clerk could suffice.

Unions

In the summer 1978, Safeway went through a two month labour dispute in which a lot of the stores were closed. Safeway initially opened a few and then more each week. However, it was not a full service Safeway store. Due to previous contracts, new meat managers had to join the union and the ranks of non-union meat managers were small. The meat cutters were a skilled and organized trade. There were not enough managers to run the meat markets in the stores. During the strike, the non-union managers stocked luncheon meats and other limited frozen meat products. But the counters were empty. Block ready beef was just around the corner and not yet set up for the Winnipeg Division Stores. Currently, the profitable stores in Thunder Bay, Ontario have been locked out for a number of months. The two unions, one for the packing plants and other one for the stores merged in the 1980's under the United Food and Commercial Workers Union.

Competition for Market Share, Price Wars

Wages have been steadily increasing for the skilled cutters as well as benefits. As the cutters had been at Safeway for some time, most were at the top end of the scale. The Westfair Group opened a new chain, Super Store came into Winnipeg with large stores in key locations. They had one meat department manager in a store and one assistant manager and the rest were newly hired cutters at the bottom of the scale. Economies of scale were several years later. Cutting was done at one store and product was sent to the other stores. These satellite Super Stores resulted in very low labour costs. Also, one large store was doing the business of three to five Safeway stores.

Safeway was losing out as it was too top heavy with declining quarterly sales. Initially, Safeway during the early stages of the price war had 58% of the retail grocery market. The war drove a lot of the small players from the market, such as a number of Family Fare and later Food Fare Stores to a few. Dominion left Manitoba and Western Canada, but still exists in some locations in Ontario. The competition started bringing in frozen beef from off-shore to gain market share. Other players such as Costco came into the picture. I.G.A. did a complete make-over by going to large corporate stores and moving away from the small independent owned store. Loblaws stores were closed or now known as Extra Foods. If there was a big enough parking lot and the right location, it became a Super Store such as the store at St. Anne's and #1 Highway.

The meat manager was respected and each cutter had at one time or another hope of being one. The price wars of the 1980's and intense competition with no bonuses made a lot of meat managers change heart about being a manager and some stepped down to cutter position. By stepping down, they earned more per hour as they become union and worked 37 hours a week with less stress. Non-union managers easily worked 40-50 hours weekly. The pressure of working with less and less help and trying to shoulder the slack became a problem. As each non-union meat manager position was filled according to the union contract with union meat managers, these new union managers began stepping down. Management had a hard time coping with this new phenomenon where employees did not want to advance into management.

The price wars also lead to more global source of products mainly to gain a competitive advantage over the competition. Buyers went beyond the Canadian border to bring in products that the competition could not match in the newspaper ads.

Suppliers

In this same time period, the packing plants changed considerably. Swifts was the first to go, followed by smaller packers. Then Canada Packers with the patented Maple Leaf Brand of products closed. Both of these plants were high multi-story plants. Burns was a late comer into Winnipeg, but they had the most efficient plant with one floor and they survived. Hillside Farms, a non-union hog operation in Neepawa, was a key factor in some plant closings. Schneider Meats from Kitchner/Waterloo opened a plant in Winnipeg.

McCain's set up meat operations under Maple Leaf in Brandon and Winnipeg in the former Burns plant. The newest player in town is Can West who has the Safeway contract to supply their 56 stores.

Closing of RRCC Meat Program

The future of the meat cutter took a definite turn for the worse when Red River Community College looked at the long range industry view for the meat cutter in the late 1980's. The college dropped the meat cutting program. The major meat cutter trainer and supplier in the province to the retail grocery industry was shut down. It was only a matter of time before the real effects would be felt throughout the grocery industry. There would be the smaller rural locker/freezer plants doing their own training. The meat supply industry would train a person for a particular area of the production line.

New Developments, Central Cutting, Wrapping and Pricing.

No doubt Safeway looked at the ages of the cutters and tried to reduce meat cutter wages by offering buy outs in the mid 1990's when portion cut pork was sent to stores. Safeway started hiring part-time meat cutters or trainees who would get in-store training. Relief Meat Manager, Peter Twerdun, pointed out he had many trainees over the years, but only one stayed as he had the skills. With no training school for the basics of at least four solid months, classroom and practical, Safeway did not want to spend or invest a lot of money on training on a part time person. Part time staff are very migrant as they are looking for a permanent full time position, a career, and do not have long term ties to a company.

Given the proper conditions, Safeway had thought of their own supply plant supplying all the stores in a geographic area. It happened with block ready in Alberta with the Lucerne Meat Plant, opened in early 1980's. Lucerne Meats shipped block ready to the Winnipeg stores.

The U.S. had similar operations in place years earlier. However, the envisioned portion cut, a counter package shipped to stores on trays, did not happen after all these years. Now, Can West has come along to offer three plants to supply all Safeway stores in Western Canada. It would appear that Can West has done their homework as they have won the Canada Safeway contract to supply all their stores. This technology had been around for some time in Europe and the United States.

According to article the author received from Winpak, Total Packaging Solutions, the article Principles of Food Packaging on Red Meats, page 127, lines 9-17 states: The principal factor involved in a centralized prepackaging operation is proper shelf-life. If the conventional 2 to 4 day shelf-life is retained, the area over which the product can be shipped is severely limited. By increasing the final shelf-life to 7 days or more, centralized meat cutting and packaging becomes practical. Close temperature control, excellent sanitation and color maintenance through oxygen control increase the shelf-life of fresh red meat to 7 or more days with advantages for the supermarket in better distribution, more uniform cutting methods, quantity discounts and reduced overhead.

There has probably been several models presented to Safeway management showing all the plus and minus benefits with this new method of counter ready meat besides the figures for customer retention. Safeway will have key meat personnel at the plant to ensure standards are met and followed. Tuxedo Store Manager, Ken Ryman, mentioned that the stores and the customer will get a very sanitary product. As Safeway is an American company, there has been lawsuits with stores selling unsanitary products, especially ground beef and e-coli. This new method of meat coming into the stores, there will no handling of raw products by store staff. The stores will receive the meat counter packages priced, ready to put out by service clerks. There may be larger packages called "mother packages" that contain many packages over wrapped. Safeway is fully committed to it. Will there be any going back to the old days? No, all the cutters will be gone or retired.

An interview with the Tuxedo Safeway Meat Manager revealed that once he was transferred due to the new meat program, the deli manager, who is in a service clerk category, will be running the meat operation in the store. Inventories will be taken each day to determine the future orders. Dollar off coupons will be used to move the items in the counter after two days. There would be no re-processing the meat. For those taking the buy out, management believe there will be an attendance problems in the last weeks for these employees. If you do not get anything for saved/banked sick days, use them up. With less and less cutters, for those stores that are not on the system to date, they will have some problems getting proper help and management expects a lot of juggling here. The store

managers are hoping things will progress alone smoothly, but they know they and only they will have to deal with many problems in the interim.

As one manager explained, he was alone in the department. As his shift would be ending, the afternoon/evening person would be starting. Previously meat rooms had a lot of activity, overlap and interchange. Management has cut down the hours mainly to the trade-offs over the years in the meat department. Now, the meat cutter is alone in the job and not for long in the job. Within weeks, the service clerk will be putting out the packaged meat into the counter, taking inventory each day and sending the results in for future orders. Action will be taken on meat packages as the time limit in the counter is 48 hours and this will be through reduction stickers. The cutter will be one store ahead of the phase in for that store with the final phase is only several months away. What happens in this period or after this period is up? For some cutters that have enough years and old enough, then, it is early retirement. For some others, it may be part-time until they reach this stage or they have taken a package. For others, they will try and ply their trade in other markets or set up shop that caters to their trade and old time customer service values.

If the customer would like a special cut, then, it would be pre-ordered several days in advance. Would the customer(s) do this all the time? Management hopes so, whereas the meat cutters in the stores think opposite. One meat manager pointed out a customer who shops several times a week and spends hundreds of dollars on special orders. He informed me that he had ten customers like this. One customer pays his wages for the week. For those that have the money, they will probably do the walking to find that old quaint, friendly over the counter service.

Just in Time (JIT) Deliveries

Previously with hanging beef, stores had to build up inventories for the proper aging of the beef. Block ready beef did reduce the amount of inventory, but stores still needed inventory as they received only two deliveries a week. The new program Canada Safeway is going on resembles the Just in Time delivery method. The clerk takes inventory each day, down loads the information to the plant. The store receives a shipment for the next day's sales and the same pattern continues for the next day. Also, with JIT, the company forges a

partnership with a small number of suppliers or perhaps only one. They both work toward a common goal in partnership. Instead of Safeway trying to get the best prices by dealing with many meat suppliers, large and small, they are going with only one for their fresh red meat.

Concluding Remarks

Did one factor or did a series of inter-related market forces impact on the decision-makers to come to the conclusion of eliminating the position of journeyman meat cutter only to be replaced by a service clerk position merely to price the packages and put them into the counter? Over the course of several decades, different events happened that eventually lead to the elimination of the journeyman meat cutter at Canada Safeway. At times it was like a roller coaster ride, but there is always an end to the ride

The retail grocery meat industry has changed dramatically when it is examined over a time span of 50 years. The preparation areas, customer service, meat cases, new products, packaging have all changed over this time period as well as how the ways meals are prepared at home. When one looks at the numbers and duties of the journeyman meat cutter at the start of the paper until now, one notices the dramatic changes that have occurred over this time period. The journeyman cutter went from handling/processing the raw meat product all day to pricing a package and now due to UPC label, putting a package out. Their work schedule went from primarily a day job in the beginning, then to several evenings a week, higher wages and benefits until the present situations of uncertainty and early retirement packages.

Safeway has now got a JIT (Just In Time) meat program. Time will only tell whether this program was "Just in Time" to survive the fierce grocery market competition in Western Canada. However, if the front running business employs sound logistical processes, it will only be a matter of time before the rest of competition copies or gets on board with a similar type processes.

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Solving the City of Calgary High School Location Problem for the Year 2033

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1. Introduction

This paper provides a methodology for finding new school locations. Consideration is given to efficiency (measured by total travel time), equity (measured by maximum travel time), the number of new schools required and to scales of economy.

The paper has four sections following the introduction: the second section describes the study area, data resources and predicts the growth in high school student populations over the next 30 years based on transportation zones (TZ); the third section describes the location-allocation modelling methodology used in the paper; the fourth part describes the results of the analysis; this is followed by a discussion of the research findings and suggestions for future research.

The primary objective of the paper is to implement a methodology that will determine the following: the size and number of schools required in Calgary over the next 30 years; the locations of any new schools that are required; and the influence of efficiency, equity and economies of scale on these decisions. The research makes use of state-of-the-art GIS software, ArcInfo and TransCAD, provided by ESRI (Redlands, CA) and Caliper Corporation (Newton, MA), respectively.

2. The Study Area, Data Resources and Projected High School Student Population

This paper used data supplied by the transportation modeling group at the City of Calgary. This data included:
1) 2001 enrollment of senior high school students by each school;
2) 2001 high school student numbers by transportation zone (TZ);
3) 2008 to 2033 projected student enrollment every 5 years (2008, 2013, 2018, 2023, 2028, and 2033 year);
4) 2001 Road Network (Arc/Info coverage file) 80695 arcs, 55857 nodes;
5) Transportation zone (an ESRI shape file with 1161 zones);
6) Transit time, automobile time each transportation zone pair;
6) Location and current attendance data for each high school.

Calgary is one of North America's most rapidly growing cities. This rapid pace of growth is expected to continue until 2028 and is then predicted to decline gradually. Here, expected student enrollment patterns will be examined at the macro level (city wide), by TZ and within four regions of the City.

Table 1 shows that high school enrollment will increase rapidly between 2013 and 2023. This rate of increase will slow during the next five years and then between 2028 and 2033 there will be an absolute decline in enrollment numbers.

Year	2001	2008	2013	2018	2023	2028	2033
Enrollment	37117	38800	36739	40804	45964	47079	45058

Table 1 High School Student Enrollment Change in Calgary

Figures 1 and 2 show the spatial distribution of the new high school population by TZ. During the first of these two periods (Figure

1) there is a small increase in the student population but, in addition, a number of students are moving to new communities and occupying new TZ. The boundary of the City does not change very much but there is a movement of students away from the downtown area and a raid increase in the TZs that are on the edge of the City.

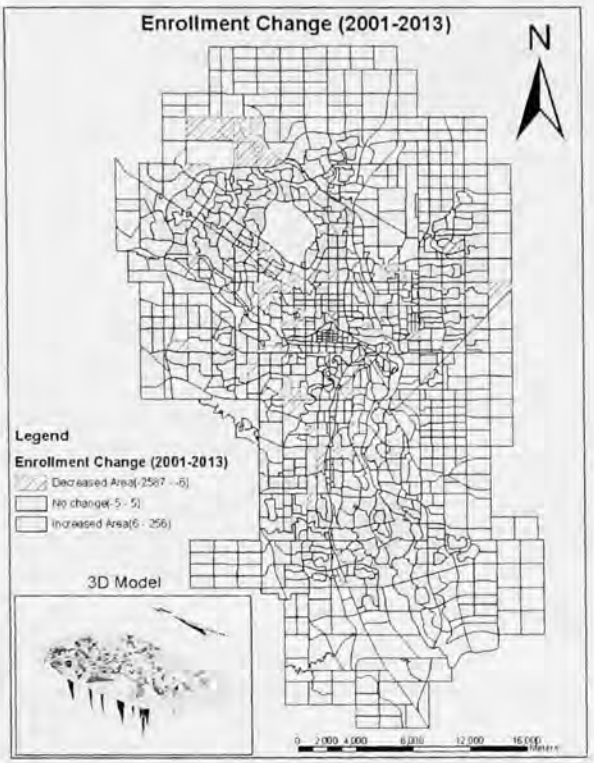


Figure 1: Enrollment Change: 2001-2013

In the period from 2013 to 2023 there is a rapid increase in the population together with an expansion of the urban area as shown in Figure 2.

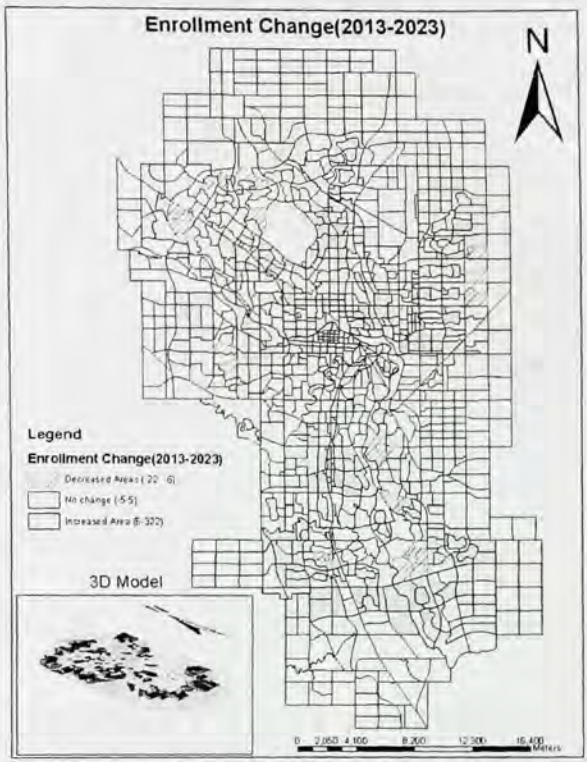


Figure 2: Enrollment Change: 2013-2023

In the final period (from 2023 to 2033) there is less rapid growth in the first five years and then a decline in population during the second half of the period. Throughout the thirty years the growth in high school enrollment shows a "ripple effect" (Clarke et al., 1980) as

student enrollment moves toward the city periphery from the inner urban areas (Figure 3). In Calgary this change in student numbers and location is asymmetrical and occurs mainly in the north and south directions.

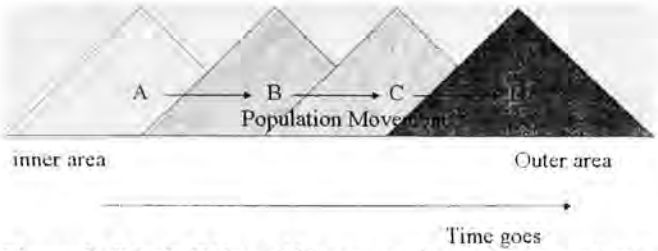


Figure 3: Ripple Effect of Movement in Student Populations

In order to make the location-allocation model operational it is necessary to model the students' travel time. To do this transit travel times are used since most high school students will use public transportation. However, in order to divide the City into regions for modeling the location of new schools "network" travel times were used. These travel times were calculated by dividing the road lengths by the posted speed limits. There was a 0.732 coefficient of determination between these network travel times and the transit times. This analysis allowed the identification of four districts in the City. Their population change is detailed in Table 2.

NW	13504	15186	14822	16684	19238	19759	18838
NE	4967	8396	7642	8410	9005	9049	8525
South	8583	11843	10880	12165	13900	14474	14240
Center	10063	3375	3395	3545	3821	3797	3455

Table 2 Enrollment Change by District (2001 to 2033)

The Central District shows a drastic decline and here the concern will not be the opening of new schools but rather the closing of the existing facilities. The Northwest shows the largest growth and will have to accommodate over 6,200 new students. The South and the Northeast will grow less rapidly but these districts will also have to cater to over 5,800 and 4,000 additional students, respectively.

3. Methodology

The first step in the analysis involves determining the number of schools. The literature suggests that there is a trade-off between economies of scale (e.g. cheaper construction, a larger number of programs offered, etc.) and a greater personal involvement of the student in his or her education. Malczewski and Jackson (2000) suggest that school size should be between 1200 and 1500 students. Public schools in Calgary currently range from 1200 to 2500 students. According to these numbers Calgary would need between 7 and 11 schools as shown in Table 3.

Area\Pop	Enrollment Change	*Most Needed (School size>= 1200)*	*Least Needed (School Size <=2500)*
Northwest	+6246	5	3
Northeast	+4097	3	2
South	+4000	3	2
Center	-6242	0	0
Sum	+9982	11	7

Table 3: Number of Schools Required in Calgary by 2033

The population change for each TZ between 2001 and 2013 was calculated and each TZ having an enrollment increase of more than 150 students was considered as a candidate location for a new school (see Figure 4). The centroids of these zones were then exported to the TransCAD GIS package for location-allocation modeling.



Figure 4: Candidate Zones for Locating New High Schools

Rush hour transit times were provided by the City of Calgary for 890 TZs. Travel times had to be estimated for an additional 271 TZs and this was achieved by developing a regression models that estimated the relationship between travel time and Euclidean distance. The model provided an explanation of over 66% and was deemed to be sufficiently accurate for use in subsequent location-allocation analysis. The 1161 travel times were now entered into a dbf file for use in the TransCAD GIS package. This represented a huge travel time, cost matrix of 1,347,921 (an 1161 by 1161 matrix).

Two location-allocation models were investigated: the p-median model which is the most efficient solution and minimizes the total travel time for students attending the various schools in the district and the p-centre model which minimizes the maximum travel time and represent a more equitable solution (Longley and Batty, 1996; 2003). This maximum travel time was set as the maximum between any TZ and a candidate location. Both models were run to determine the locations for the maximum and minimum number of schools in each district (5 and 3 in the North West; 3 and 2 in both the North East and South districts).

Frequently, it will not be possible to locate a school at the optimum location because of other concerns such as land availability and cost. Thus most attempts at location-allocation modeling will include a sensitivity analysis to determine how much the objective function will increase if the school is moved a small distance from its ideal location. The accessibilities of each TZ were calculated and then contoured to provide a map showing how much the objective function would increase as the school was moved from its ideal location.

4. Results

The analysis provided a large number of results. The initial computer runs for the North West district showed solutions for 5, 4 and 3 school for both the p-median and p-centre solutions. Here only the three-school solution for the North West is reported. This solution for both algorithms is shown in Figure 5. Table 4 shows various

statistics for the different solution based on the two algorithms. The p-median solution is generally preferable as it provides a much lower aggregate travel time while generally increasing the maximum travel time by only a small amount (and in one case actually providing an improvement in this statistic).

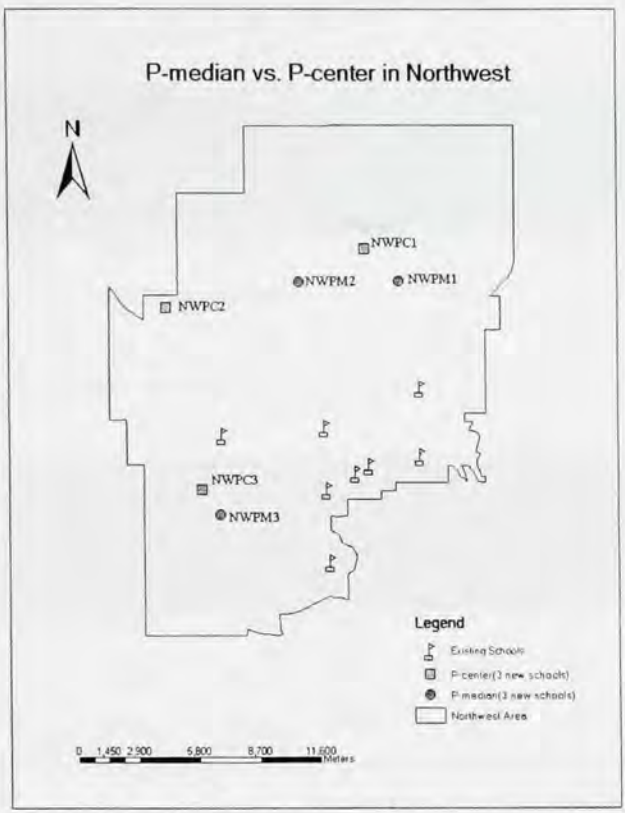


Figure 5: Three New School Locations in the North West

Similar results were obtained for the North East and for the South districts as shown in Figures 6 and 7 for their minimum number of schools solutions. It may be noted that in general the p-median solutions tend to push the schools closer to the center of the City where the TZs with the higher student numbers tend to be located.

SCHOOL	Tz	Allocated Population	Average of Travel Time	Sum of Travel Time	Maximum Travel Time	Stdv of Travel Time
NW_PM1	3203	3668	7.15	564.53	20.40	6.34
NW_PM2	2917	5650	9.11	701.50	20.07	5.50
NW_PM3	626	4698	7.75	511.71	18.29	4.43

SCHOOL	Tz	Allocated Population	Average of Travel Time	Sum of Travel Time	Maximum Travel Time	Stdv of Travel Time
NW_PC1	3313	5912	9.85	994.42	20.46	4.95
NW_PC2	2901	1957	7.61	205.42	17.47	5.83
NW_PC3	631	4624	8.77	552.69	17.68	4.65

Table 4: Selected Statistics for the 3 School NW District Solutions

Sensitivity analysis was carried out for all solutions and was portrayed in the form of contour maps and slope maps. The latter demonstrating how quickly the objective function increased as the

school was moved from its ideal location. In Figure 8 the smaller circles indicate a much lower sensitivity to moving the school from its ideal location.

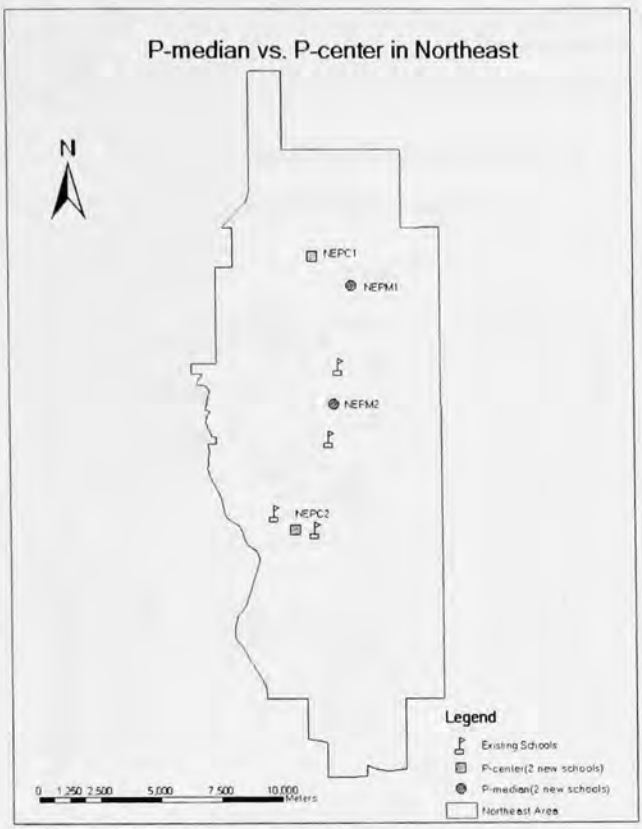


Figure 6: Two New School Locations in the North East

5. Discussion

This analysis provides only a general guide to the number and location of new schools in Calgary over the next 30 years. In the analysis there are many sources of data uncertainty. These sources include; the estimation of travel time between TZ centroids; the projection of travel times into the future for the year 2023; the use of



Figure 7: Two New School Locations in the South

travel time predictions based on the regression model between Euclidean distance and transit time; the use of the City of Calgary's population projection estimates; no account was taken of the possible synergy between school location and the location of other facilities such as parks and recreation centers; no consideration was given to the process of gentrification and the in-filling of older housing (although this is likely to affect the City center more than the periphery).

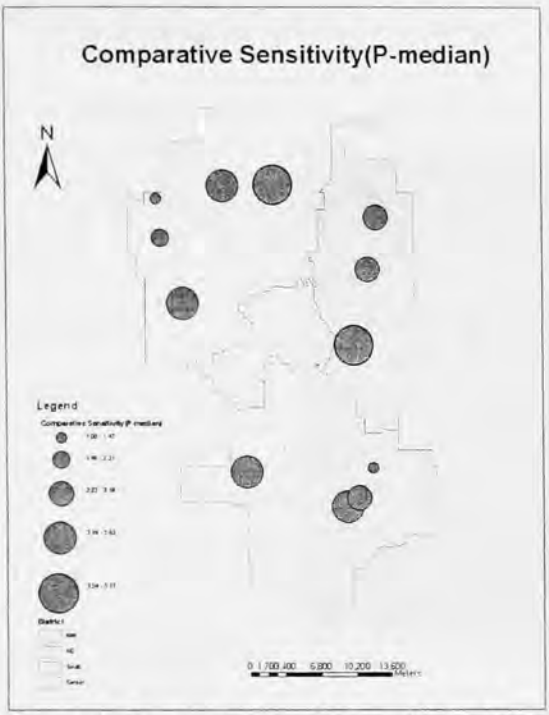


Figure 8: Sensitivity for All New School Locations

Future research should concentrate on developing multi-criteria decision location models that can take into consideration variables other than travel time.

6. Conclusion

Location-allocation modeling has a long and distinguished history in providing solutions for facility location problems. In recent years location-allocation algorithms have become integrated with GIS



Figure 9: Accessibility Slope Map (the higher the slope, the more sensitive the location)

GIS packages. This has enabled researchers to make formidable use of the powerful data analysis tools that exist within the GIS software. Travel time matrices and population projection models can be combined with p-median algorithms to determine optimal locations for facilities such as schools. Accessibility contour maps can demonstrate the sensitivity of proposed solutions.

While such models are affected by the quality of their data inputs they provide an excellent starting point for planning the future locations of schools in a City such as Calgary.

Acknowledgements

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QUO VADIS DEREGULATION?

Lessons from the marine sector

by

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Introduction

Since the passage of the first National Transportation Act in Canada in 1967, and the Staggers Act in the United States in 1980, there has been a steady trend in the transport sector towards deregulation and privatisation and an increasing reliance on market forces to set prices and allocate resources. This trend, it is widely argued, has brought benefits for both shippers and carriers, in the form of higher productivity, greater efficiency, and more flexibility to react to market conditions.

The marine sector, however, has not participated in these deregulatory trends in quite the same way as other modes, primarily because of its different historical development. Not playing quite the same role in nation-building and regional development that (say) the railways have, the sector was not highly regulated to begin with, and has had a different relationship with government. Marine transport, being international in nature, and operating outside the jurisdiction of any one state, has never, in fact, been particularly susceptible to regulatory control.

While the overall trend towards deregulation has been widely accepted as beneficial, it is arguable that some level of regulatory

control – whether exercised from outside the industry by governments, or from inside in the form of self-regulation – is nonetheless necessary. While we can acknowledge that a regulatory regime may be harmful if oppressive enough to stifle innovation, it can also provide the machinery and framework for setting and enforcing adequate security and safety standards.

Since the events of September 11, 2001, these issues have grown in importance. Air transport particularly has been subject to increasingly tight control, but delays to trucks crossing the Canada-U.S. border also attest to the effect of heightened security precautions.

The marine sector is not immune to the danger of terrorist threat, and indeed, there has been speculation that the use of a marine vessel as a floating bomb, in much the same way as aircraft were used on September 11, poses a threat to major ports in the U.S. and elsewhere. (Langewiesche).

The question posed in this paper, therefore is this. Does the marine sector, with its freedom from regulatory control, suffer from "too much of a good thing?" That is to say, by staying free from regulatory control, has the industry failed to develop the kind of framework and machinery employed by other modes of transport to enforce adequate safety and security measures in the face of modern terrorist threats?

To address this question, the paper begins at a philosophical level, addressing the very broad issue of the role of the state in free enterprise economies. It then moves to a discussion of the salient history of marine transport and the historic role of governments in protecting trade routes, and closes by identifying some broad general lessons that can be taken from this examination of the marine sector, and that can be applied to all modes and to the issue of deregulation in general.

The Economy and the State

To begin at the most basic level, it is apparent that the appropriate division of authority and responsibility between the private and public sectors has never been – and likely will never be – definitively established. It is, in fact, a never-ending topic of public discourse – in the western world certainly, but arguably in other societies as well. In a compact and insightful series of lectures in 1992, economist Robert Heilbroner points out that this relationship has engaged economists and social thinkers since the dawn of the industrial revolution. Moreover, he says "the immediate central issue in capitalism, the issue that takes on an often obsessive prominence in every capitalist nation ... is the relationship between business and government, or from a somewhat more distant perspective, between the economy and the state." (Heilbroner, 1992, p. 50)

Heilbroner traces the shape of public dialogue on this issue, beginning with Adam Smith's classic definition of the minimum duties of the state, *viz.*: internal and external security, and the provision of "certain public works and public institutions" which cannot be profitably provided by private enterprises. (Ibid., p. 53) Few have quarrelled with the generality of Smith's definition, but the debate about the details has been long and vigorous. Political parties and other organisations on the left tend towards a broad inclusiveness; those on the right seek to narrow the interpretation and restrict the role and power of the public sector.

Despite the tenor and persistence of this debate, it must be acknowledged that the absorption into the market place of the widest possible range of economic activity has been the signal quality of laissez faire systems. At the same time, in most societies, this process, referred to by Heilbroner as "commodification," (Heilbroner, 1986, p. 60) is subject to certain moral limits. There is, for example, a fairly widespread revulsion against trade in human transplant organs, which finds its roots in moral concerns about whether such things belong in the marketplace at all. Some thinkers go further. Karl Polanyi was an academic whose interdisciplinary work covered

the fields of economics, sociology and anthropology. He took the position that some goods, of which land and labour were two, were not commodities in the same way as boots and shoes, and therefore should be banned from trade. The core of his argument was that commodities are, by definition, things produced for purchase and sale, whereas, for example, labour "is another name for a human activity that goes with life itself," and "land is only another name for nature." Hence, he argued:

> To allow the market mechanism to be the sole director of the fate of human beings and their natural environment ... would result in the destruction of society. ... Robbed of the protective covering of cultural institutions, human beings would perish from the effects of social exposure. Nature would be reduced to its elements, neighbourhoods and landscapes defiled, rivers polluted, military safety jeopardized, the power to produce food and raw materials destroyed. (Polanyi, p. 32)

Polanyi wrote these words in 1944 but his words seem to be prescient. His reference to "rivers polluted" adumbrates today's environmental damage, while, as will be discussed later, his talk of "military safety jeopardized" finds ominous echoes in the potential effects of terrorism. Of course, we are quite used to having land and labour embedded in our market economy, but arguably modern labour laws, and increasingly stringent environmental regulations, are providing the kind of "protective covering of cultural institutions" which Polanyi thought necessary to ameliorate the harsher impacts of the market.

Transport and the State

The division between the relative responsibilities of the private and the public sector, and the debate as to what does, and does not, belong in the marketplace, has been particularly contentious and difficult in the transport sector. The reasons differ somewhat between modes.

Railways, for example, have historically been seen as instruments of public policy. The role of railways in national development of both the United States and Canada, and the role of government in encouraging railway construction, is well understood. European settlers felt the need to exert sovereignty over what, from their point of view, was newly acquired territory, through both a military presence and immigration, and neither of these could be supported without an effective means of transporting goods, people and military might. In the 1800s, the only effective means of doing so was the railway. At the same time, railways would not be commercially viable until sovereignty was established and immigration provided the population base for economic activity.

Highways have presented a different challenge to the proponents of deregulation insofar as it has proven almost impossible to effect widespread privatisation of the infrastructure. User fees, except in a few exceptional circumstances like Toronto's Highway 407, have proven difficult to levy, while at the same time, roads are seen as "public goods," freely available to all who can afford the hire or purchase of a vehicle to travel on them. Of course, the trucking sector is virtually free of economic regulation, and, indeed, the success of the relatively unconstrained trucking industry to capture profitable traffic from the highly regulated railways was one of the major impetuses behind deregulation. (MacPherson Royal Commission, 1961)

Air transport has shared some of rail's qualities as a tool of public policy. Initially, many nations established "flagship carriers" that were as much an expression of national pride as they were commercial enterprises, and were shielded from competition in the marketplace. Today, however, the national carriers have been thrown to the competitive wolves and told to survive. Similarly, air traffic control facilities, again once provided by the state, are increasingly being privatized, and replaced with organizations like NavCanada.

Despite the moves toward deregulation and privatisation, it must also be acknowledged that transportation does have aspects that require it

to be treated as a public service. In some instances – northern communities in Canada being one – the integration of remote or sparsely populated areas into the social fabric of a nation sometimes requires that less than fully profitable transport service be provided. Farms require roads, regardless of the ability of the users to pay for them.

There are economic as well as social arguments for the public provision of transport services. Again in the case of rural roads that service farming areas, it is arguably better for society as a whole to have land in agricultural production rather than lying idle. Apart from the difficulty of privatising road infrastructure, there exists what are called "network externalities," which means that it is better for all users of the road network to extend it into remote areas because the economic activity thus generated makes the whole network more valuable for all users. (PROLOG, p. 58)

State intervention in transport also arises because of the need to control market power. The railways were historically monopolies, and as monopolies can and do exploit their customers on both price and service, regulatory controls have been imposed. Captive shippers will attest that this aspect of state control is still well justified.

Establishment and enforcement of safety regulation has also been deemed to lie within the purview of the public sector. While it is true that private enterprise has a deep interest in safety, and is constrained by insurance and employee safety considerations, it is also true that the economic incentives in some cases can induce private enterprises to take greater risks with both property and human lives than society as a whole deems appropriate.

The Special Case of Marine Transport

International marine transportation possesses three unique characteristics that differentiate it from the other modes. First of all, marine transportation takes place in international waters that are not

under the jurisdiction of any one nation. By whose regulatory regime, therefore, might a carrier be bound?

Secondly, there is the sheer size of the world's oceans. Even if – especially in the aftermath of "9/11" – a regimen of security provisions is held to be necessary, what measures of enforcement are possible when vessels can lose themselves in the vastness of the seas?

Thirdly, it must be recognized that marine transport is almost as old as human civilisation, and its historical development has not necessitated some of the practices and protocols that developed for other modes. Air transport, for example, unlike marine, requires a world wide system of air traffic control that tracks virtually every aircraft aloft. Moreover, an airline's international operating rights are subject to agreements between countries which provide for reciprocal arrangements for each nation's carriers. These treaties are normally dependent on satisfying the host country that the guest airline will operate safely and responsibly. Marine transport has not needed the same level of technological sophistication to prevent vessels from colliding with each other, while the international protocols which give one nation's vessels access to other countries' ports are less restrictive, reflecting the needs and concerns of an earlier age.

In various ways, therefore, the relationship between the public and private sector has been different for marine transport than it has for land and air transport.

However, while different, an historical perspective shows that marine transport has had its own unique place in the relationship between commerce and the state – a place that is different from that of land and air transport, but is no less intimate or important.

Marine Transport, Prosperity and Trade

In a nutshell, what has underlain the relationship between governments and the marine industry has been the fact that nations have relied on trade for prosperity and trade has relied on ocean going

ships for transport, while at the same time, merchant mariners have relied on government to secure trade routes so the international commerce could take place. A few examples, from disparate, if unusual, sources, illustrate this strong relationship.

The fundamental and long-standing dependence of governments on trade is well described by Albert Hourani in his book, *A History of the Arab People*. Writing about the development of the Middle Eastern world, he describes the relationships which grew up among a chain of cities which stretched from Spain to Northern India ca. 1000 to 1200. He points out that governors "needed the wealth that was to be derived from trade and industry," and so "a conqueror would move up a chain of cities lying on a trade route."

"Within limits," he continues, "a powerful ruler could divert trade routes and attract them to his capital." Thus, "between the two poles of the city, the palace and the market, relations were close but complex" with the ruler needing "the economic activities of the city to provide him with arms and equipment for his army and ships, furnishings and adornments for his person, entourage and family" and "merchants [to provide] his financial reserves." Merchants in the urban community, meanwhile, "needed the power of the ruler in order to ... guard the trade routes and conduct relations with other rulers in order to smooth the paths of trade." (Hourani, pp. 130 – 134)

The historic importance of marine transport in international trade is well illustrated by the trading system which developed in the Indian Ocean during the Ottoman Empire. It stretched from the Middle East, down along the east coast of Africa, and eastward to the Indian subcontinent. Ocean transport sustained it, and ocean power virtually destroyed it when Portuguese mariners sailed around the Cape of Good Hope in the 15th century in search of gold and slaves. Created and destroyed by naval power, this trading system was later partially restored by the same means in the mid-19th century by Seyyid Said, a ruler of Oman, who established a navy and "asserted his claim, first to tribute and later to customs, upon the trading communities of the coastal towns [of Africa]. He chose Zanzibar as his base for East

African operations [which] soon became the commercial entrepot for the whole of the East African coast, the rendezvous for all foreign shipping, the export market for the slaves and ivory of the mainland, and the import market for cloth and beads, guns, ammunition, and hardware from India, Europe, and America," (Oliver and Fage, p. 171; see Hourani, pp., 215 and 225, and Oliver and Fage, *passim* regarding the Portuguese invasion of the Indian Ocean area.)

The importance of naval commerce and naval power to the expansion of the British Empire is, of course, legendary. What is probably less widely appreciated is that the United States actually rejected the importance of naval power and ocean transport until the late 19th century when a naval officer by the name of Captain Alfred Thayer Mahan argued that both were essential to national development, trade and prosperity. Historian Barbara Tuchman documents the influence of his widely read book, *The Influence of Sea Power on History*, where he argued that "command of the seas was the chief element in the power and prosperity of nations." (Tuchman, p. 150) Mahan's book is a delightful historical document in which, in the flowery prose of its time, he points out that: "Foreign necessities or luxuries must be brought to [a country's] ports, either in its own or in foreign ships, which return, bearing in exchange the products of the country, whether it be the fruits of the earth or the product of men's hands; ... The ships that thus sail to and fro must have secure ports to which to return, and must, as far as possible, be followed by the protection of their country throughout the voyage." (Mahan, p. 26) Mahan's comment is insightful, and, as this paper discusses later, his last thought is one that has lately been largely ignored.

The Recent Evolution of Marine Transport

However deep the mutual dependence of the public and private sectors on maritime transport, it has not, until recently, resulted in a willingness of the industry to submit itself to any governmental restrictions. The chief means of avoiding such restraints, the practice of using "flags of convenience," is devastatingly described in a recent article by William Langewiesche in *The Atlantic Monthly* magazine.

> No one pretends that a ship comes from the home port painted on its stern, or that it has even been anywhere near. Panama is the largest maritime nation on earth, and is followed by bloody Liberia, which hardly exists. No coastline is required either. There are ships that hail from La Paz, in landlocked Bolivia. There are ships that hail from the Mongolian desert.

More disturbing than the obvious charade of ships coming from the likes of such countries is the fact that, according to the article, the alleged locations of these registries are as fictitious as the maritime qualities of the nations themselves.

> The registries themselves are rarely located in the countries whose names they carry. "Liberia" is run by a company in Virginia, "Cambodia" by another in South Korea, and the proud "Bahamas" by a group in the City of London. The system, generally known as "flags of convenience," began around World War II, but its big expansion occurred only in the 1990s – and in direct reaction to an international attempt to impose controls. (Langewiesche, p. 50-51)

Langewiesche calls this "free enterprise at its freest," and acknowledges that one of the major effects of escaping from regulatory constraints has been a massive and continuing increase in the efficiency of ocean transport – precisely, in short, the benefits that proponents of deregulation – including the author of this paper – have long argued for.

The question, then, is this: have these efficiencies – which we tend to attribute to deregulation – come at a cost? It is here that doubts about the conventional view of deregulation arise. Langewiesche suggests that the answer is yes, and presents as evidence detailed descriptions of the fate of two vessels where safety and security standards were lacking. In one, the *Kristal*, he suggests that poor labour and safety standards led to the loss of the vessel and much of its crew. In the

second, the *Alondra Rainbow*, he shows how lack of adequate international security resulted in the vessel being high-jacked by pirates, its cargo stolen and its crew set adrift.

Much of Langewieshe's argument is supported by Carlos Salinas, Chairman of the Federation of ASEAN Shipowners' Associations. In 2002, he summarised the current concerns about marine security, referring to the case of the *Alondra Rainbow*, and the newly emerging fear that sometime, somewhere, a vessel loaded with explosives will sail into a major world harbour and blow the city sky-high. The situation, says Salinas, has caused the marine industry to re-think its position. "In the aftermath of the attack on the World Trade Center [on] September 11, 2001, the nations of the world have been galvanized against the threat posed by modern day terrorism. This has led to a flurry of activities aimed at reviewing security issues in a new light. ... Regional organizations like ASEAN, the European Community, and APEC have urgently tabled discussions on the crafting of [security measures]." Individual states, he says, have acted likewise. (Salinas, p. 5)

What is most relevant to this present paper is Salinas's repeated references to the role and responsibilities of governments and public bodies in these new initiatives. It is a theme woven throughout his paper, and is reiterated several times. He points out that: "Years of experience have taught us repeatedly that the capacity to implement must first be ensured before rules and regulations can be enforced." This capacity, he goes on, cannot be the sole responsibility of the industry. "It would not be amiss to emphasize the overriding need for cooperation between [the?] private sector and government, and among all governments in the [Pacific] region." And again, "the inter-locking and simultaneous maritime threats that exist in the region require an equally inter-locking and simultaneous response from the public and private sectors of all countries." (Ibid. pp. 14, 15) This is a very different kind of message than the one the industry has been relaying for years by its practice of registering its vessels in countries like Panama and Liberia, where registration dollars have

been traded for an assurance that no regulatory hand would intrude into the ship owners' affairs.

In passing, it is worth pointing out that, while providing security on the seas is said to be impossible due to the "ungovernable" nature of the world's oceans – their size and extra-territorial nature – the same could be said of security in international air transportation. It too operates internationally, and the skies are no smaller than the oceans. What is different, of course, is the technical systems and institutional regimes within which air transport operates. As noted earlier, these are partly dictated by the characteristics of the mode and the political climate in which it has developed. Sophisticated tracking of aircraft is necessary to preserve any kind of safety, while at the same time, developed countries were not prepared to have foreign planes enter their airspace without formal agreements governing their operations. It is significant that, in some recent work on marine security, instructions were issued to take into account the activities of the International Civil Aviation Organization in developing standards for airline safety and security. (Ibid., p. 10)

Conclusions

The purpose of this paper is not address the details of marine security, nor to criticise the work of those involved for failing to be sufficiently aggressive in implementing security measures. The author of this paper is not sufficiently knowledgeable about ocean transportation to do either of these things.

Rather, it seeks to draw together a number of eclectic and disparate threads of scholarship, experience, reflection and speculation, and to consider the conclusions which might be drawn when the regulatory regime (or lack thereof) of the marine sector are regarded, to use Salinas's phrase, "in a new light?" And for those of us who have struggled first hand with the stultifying effects of over-regulation, and who have extolled the benefits of market forces, to consider what relevance this perspective might have for the broader issues of deregulation and privatisation in transport generally.

The evidence examined here suggests that the marine industry has actively pursued a policy of escaping from any and all forms of government intervention in its affairs. Its practice of "flags of convenience" – a practice permitted by the international nature of the industry and the historic ungovernability of its vast realm of operations – has allowed it to circumvent any regulatory or legal constraint on its operations.

But its very success in this endeavour has enhanced its vulnerability to the new threat of international terrorism, and put it at increasing risk from piracy. In other words, its current vulnerability has arisen, at least in part, from its own practices. Suddenly, however, it is finding that it cannot exist without strengthening its ties with governments and other international authorities which are capable of implementing and enforcing international security measures.

It seems to the author of this paper that two lessons emerge from this examination. The first is that a balanced view of things is always necessary. Yes, deregulation can bring benefits, but deregulation pushed to its outer limits brings new problems.

The second lesson is that we should learn what history teaches. What the marine industry seems to be finding is this: that what was true in the Middle East at the turn of the second millennium is also true on the world's oceans at the turn of the third. Albert Hourani sums it up well. Nations and their governments – or what Hourani in historic context calls "the ruler" – need commerce to create industry, trade and prosperity. But traders also need "the power of the ruler ... to maintain order and the fabric of law, without which life in a complex and civilized community could not be carried on." (Hourani p. 134)

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The Effects of Two Road Safety Advertisements on Viewers' Perceptions and Driving Intentions

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Introduction

Road safety public education campaigns, especially public service announcement and paid television advertising, have been widely used in many countries to raise awareness of the safety issues, influence public attitude and change driver behaviors (Beach 1966; Hutchinson et al 1969; Johnston et al 1973; Kohn 1982; Fry 1996; Ben-Ari et al 2000; Tay 2002, in press). Many of these advertisements appear to be based on the premise that threatening messages that are likely to arouse a high level of fear, for example, by showing a gruesome car crash, are effective in producing attitudinal and behavioral changes (Beach 1966; Johnston et al 1973; Ben-Ari et al 2000; Tay, 1999; Tay & Watson 2002).

The conceptual and theoretical framework underlying the appeal to the emotion of fear has been well discussed in the literature (Leventhal 1970; Maddax & Rogers 1983; Witte 1992; Witte & Allen 2000). In its simplest form, the process consists of three steps (Latour and Zahra, 1988). The first step involves the creation of a fearful situation designed to activate a person's sense of risk and vulnerability. In the road safety arena, such situations arise from drinking-driving behavior and speeding.

In the second stage of employing the fear appeal, the danger is depicted to be serious enough to warrant attention. In road safety, this danger is often depicted by a bloody crash scene. For example, in one of the advertisements used in Australia and New Zealand, several teenagers were drinking and driving when their car skidded off the

road and down an incline. The driver managed to get out of the car in time to witness his friends being burned to death while trapped in the overturned car.

In the third phase, a solution is provided as a means of fear reduction. In most of the drink-driving advertisements used in Australia and New Zealand, this fear reduction is achieved by urging drivers not to drink and drive. In these advertisements, the negative consequences of not accepting the warnings issued are highlighted to stimulate the desired response from the audience. Thus, the most common punch-line used in the advertisements is "if you drink and drive, you are a bloody idiot."

However, after more than 50 years of research and practice, there is still no consensus regarding the effectiveness of these highly threatening advertisements in improving road safety but governments in Australia and around the world continue to believe in and invest heavily in them (Tay 1999, 2001). It is therefore important that research in this area continues to progress and provide more insights into other factors that may moderate the success of these highly threatening messages.

The purpose of this paper is to examine the effectiveness of highly threatening road safety messages in changing the intentions of drivers to participate in risky and illegal behaviors. In particular, it will examine the influence of important message characteristics like the level of fear aroused, the response efficacy (strategies to cope with the threat shown) and self efficacy (ability of viewers to undertake the coping strategies) on drivers' intention to speed and drive while impaired by alcohol.

Method

The study involved 139 volunteers, with the majority of participants recruited from a university but about a third of the sample were recruited from non-university sources, so that the participants' gender, age and education characteristics were more representative of the general driving population. About 56% of the participants were females and the age distribution was as follows: under 20 years old (20.1%), 20-29 (25.9%), 30-40 (21.6%) and above 40 years old

(32.4%). Even though there is a fairly even spread in the respondents' age and gender, the sample is nevertheless a convenient sample and further research should be conducted using a more comprehensive sample.

Participants watched two 90-second road safety advertisements, with one focusing on drink driving and the other on speeding. These advertisements were produced in another state and thus participants were unlikely to have been previously exposed to them. The advertisements were shown one at a time and immediately after viewing each advertisement, subjects completed the relevant section of the survey on their perceptions about that particular advertisement and their driving intentions. About half the participants were shown one advertisement first and the remaining half was shown the other advertisement first.

The items used to measure the respondents' perceptions and intentions were drawn from previous studies that had found them to have good validity and reliability (Witte 1994; Tay and Watson 2002) and were measured using standard 5-point Likert scales. The main items used in the survey are shown in Table 1. As discussed above, the main impetus of many road safety advertising campaigns is the appeal to the emotion of fear as a driving or motivating force and three items were used to measure this construct. However, since these items were highly correlated (Cronbach $\alpha = 0.88$ for speeding ads & 0.84 for drink driving ads), they were combined and their mean values used as a composite measure in further correlation analyses.

Two other important characteristics that have been found in recent studies (Witte 1994 & Tay & Watson 2002) to have a significant influence in changing drivers' attitudes and intentions were also included. Response efficacy refers to the provision of coping strategies in the message while self efficacy refers to the ability of the viewers to carry out the recommended strategies. Similar to the level of threat experienced or fear aroused, these measures are also highly perceptual and subjective. Therefore, self-reported values using the Likert scale are the most cost effective means of collecting these data.

Table 1: Items Used in Survey

Fear Arousal:
I felt frightened and/or tense while/after watching the advertisement.
I felt anxious and/or worried while/after watching the advertisement.
I felt nauseous and/or uncomfortable while/after watching the advert.

Response Efficacy:
The ad provided an effective strategy(s) to avoid drink driving.

Self Efficacy:
I feel confident in carrying out the strategy(s) shown.

Drink Driving Intention:
The ad increased my intention:
- to use various strategies to avoid drink driving
- monitor my drinking when I have to drive
- not to drive when I have too much to drink
- not to ride with a driver who has been drinking

Speeding Intention:
The ad increased my intention:
- to use various strategies to avoid speeding
- monitor my speed when I am driving
- not to drive with excessive speed
- to obey the speed limits

Defensive Avoidance:
I would prefer to switch channels if this ad appears on TV
I prefer to forget about such ads because they are horrible

More importantly, the survey also gathered information on the effect of the road safety advertisements on the intentions of drivers to speed and drive under the influence of alcohol. In another study on the effect of road safety advertising focusing on fatigue, Tay & Watson (2002) found that driver intention at the time of watching the

advertisements was a good predictor of self reported behavior one to two weeks after. Again, since the items used to measure these intentions were highly correlated (Cronbach α = 0.87 for speeding ads & 0.89 for drink driving ads), they were combined and their mean values used as a composite measure in further correlation analyses.

In most studies, the participants were shown the advertisement(s), followed by a survey of their perceptions and intentions. In these "laboratory" studies, respondents were not given an opportunity to avoid seeing the advertisements. This (lack of) self selection bias may have serious implications to both theory and practice. In particular, increasing the level of fear arousal in the message may be positively related to both positive driving intentions and defensive avoidance, resulting in an ambiguous outcome. Two items were therefore used to gauge any defensive avoidance behaviors and again, since the items were highly correlated (Cronbach α = 0.69 for speeding ads & 0.78 for drink driving ads), they were combined and their mean values used as a composite measure in further correlation analyses.

Discussion of Results

The means and standard deviations for the measures used are reported in Table 2. The mean response for fear arousal was moderately high, indicating that, on average, the respondents did feel the threat associated with speeding and drink driving advertisements. This result is expected since these advertisements were designed to appeal to the viewers' fear. Surprisingly, the respondents also reported a moderately high level of response efficacy although there was little or no coping strategies provided explicitly in these advertisements. As expected, the mean of the self efficacy reported was lower than the response efficacy and only slightly above the neutral level (equivalent to 3.00).

More importantly, the mean score for the composite measure used to evaluate the positive influence of these advertisements was fairly high, indicating that these advertisements were effective in changing the intentions of the respondents to participate in speeding and drink driving. On the other hand, the composite mean score for

defensive avoidance was moderately low, indicating that, on average, the respondents did not prefer to avoid the road safety messages.

Table 2
Descriptive Statistics of Measures Used

	Drink Driving Ads		Speeding Ads	
Measures	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Fear Arousal	3.38	0.91	3.44	0.96
Response Efficacy	3.45	1.22	3.52	1.22
Self Efficacy	3.18	1.05	3.27	1.01
Positive Intention	3.50	0.85	3.57	0.87
Defensive Avoidance	2.74	0.95	2.81	0.97
Note: Computed using "strongly agree"=5 to "strongly disagree"=1.				

Besides determining the effectiveness of the advertisements in changing driver intentions, this study also aims to examine the importance of several message and viewer characteristics in changing these intentions. Therefore, simple correlations between the self reported changes in driving intentions and the viewer perceptions of these advertisements were estimated and reported in Table 3.

Table 3
Correlations between Positive Driving Intention and Perceptions

	Drink Driving Ads		Speeding Ads	
Perceptions	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Fear Arousal	0.27	<0.01	0.29	<0.01
Response Efficacy	0.49	<0.01	0.46	<0.01
Self Efficacy	0.39	<0.01	0.42	<0.01
Note: Computed using "strongly agree"=5 to "strongly disagree"=1.				

Of the three characteristics perceived by the viewers, response efficacy is the most highly correlated with the intentions of drivers to

drive more safely and fear arousal the least correlated. These results imply that the main emphasis of road safety advertising should be to provide the viewers with coping strategies to deal with threats or dangers associated with risky driving activities such as speeding and drink driving. The prevailing notion of relying on "shock and gore" to drive attitudinal and behavioral changes may not be the most effective method to get the message across.

This result is consistent not only across both types of risky driving behaviors (speeding and drink driving) examined in this study but also consistent with earlier findings of Tay & Watson (2002) on the effect of advertising on another risky driving behavior: driving while fatigued. The robustness of these results suggests that these relationships may be salient and invariant across most risky driving behaviors.

Besides examining the effect of viewers' perceptions on positive driving intentions, this study also aims to examine their effect on defensive avoidance. Therefore, simple correlations between the self reported potential defensive avoidance behaviors and the viewer perceptions of these advertisements were estimated and reported in Table 4.

Table 4
Correlations between Defensive Avoidance and Perceptions

	Drink Driving Ads		Speeding Ads	
Perceptions	**Coefficient**	**p-value**	**Coefficient**	**p-value**
Fear Arousal	0.36	<0.01	0.33	<0.01
Response Efficacy	-0.12	0.17	-0.18	0.03
Self Efficacy	-0.10	0.24	-0.19	0.03
Note: Computed using "strongly agree"=5 to "strongly disagree"=1.				

As expected, the higher the level of fear arousal, the more likely it is that the viewers will engage in defensive avoidance behaviors. This result appears to be contrary to the popular notion, and our findings reported above that the more threatening messages are, the more effective the they are in inducing positive changes. There are

two reasons for these contrasting results. First, fear tends to polarise viewers' response (Tay & Watson 2002). Second and more importantly, as discussed earlier, due to the design of the experiment, the possibility of invoking defensive avoidance behaviors were not available to the viewers but had to be measured after the viewers had been exposed to the entire advertisement. Some viewers in the study would have preferred not to view the advertisements, and would probably not have done so in real life, but after viewing the advertisement, they reported that it had a positive effect on their driving intentions.

As expected, the higher the response efficacy and self efficacy, the less likely it is that the viewer will engage in defensive avoidance behaviors. These effects, however, were only statistically significant for the speeding advertisements but not for drink driving advertisements.

Again, these results, particularly for the effect of fear arousal on defensive avoidance, were consistent across both speeding and drink driving behaviors. They were also consistent with earlier findings of Tay & Watson (2002) on the effect of advertising on driving while fatigued. The robustness of these results again suggests that these relationships may be salient and invariant across most risky driving behaviors.

Concluding Remarks

Despite more than 50 years of research in fear appeals, an unequivocal answer to its effectiveness is still not possible. However, many governments in Australia and around the world continue to believe in and invest heavily in highly threatening road safety advertising. In the Australian State of Victoria, for example, the Transport Accident Commission invested A$70 million on a variety of road safety campaigns between 1990 and 1995 (Healy and Forsyth, 1996) and many of these advertisements had relied primarily on the appeal to the emotion of fear as the main driving or motivating force.

This study found that although the level of fear arousal is positively correlated with positive driver intentions, its impact was smaller than other characteristics such as response efficacy and self

efficacy. Moreover, the higher the level of fear arousal, the more likely it is that the viewer will invoke defensive avoidance behavior, resulting in a reduction in the share of viewers. Therefore, it is strongly recommended that policy makers and advertisers focus more on providing the viewers with ample strategies to cope with the threat rather than increasing the level of threats or fear arousal in the advertisements.

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Air Cargo Co-Mingling in Anchorage: Phase II

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Introduction

This paper outlines the implications for Ted Stevens Anchorage International Airport (hereafter ANC) resulting from the $60 billion, four year Federal Aviation Administration (FAA) reauthorization bill known as *Vision 100- The Century of Aviation Act*. While the bill increases the FAA funding formula from 3% to 3.5% (giving ANC an expectation of $13 million in 2004 as opposed to $10 million the year before) the most

significant gain is in the enhancement of the air cargo co-mingling options allowed at ANC. A foreign carrier transferring cargo at ANC is not considered by the FAA to be breaking the international journey. The co-mingling language was a rider added to the bill by Senator Ted Stevens (R-AK), chairman of the Senate Appropriations Committee.

Ted Stevens Anchorage International Airport: An Overview

ANC is strategically placed within 9 hours flying time to 95% of the industrialized world. Servicing 580 air freighters per week it is the world's busiest airport in terms of "landed" cargo volume; and volume-wise is the no. 2 (3) airport for FedEx (UPS). Ramp capacity allows for up to 49 air freighters to be refueled simultaneously. The typical refueling layover allows a freighter to carry an extra 100 tons of cargo thus trading off flight time for cargo revenue.

Annual air cargo growth by volume at ANC has averaged about 6% from 1998-2003. ANC has had a history of trying to preserve its advantage in the face of potential over-flying by carriers and polar routing by taking the lead on liberalization of air cargo operations in the United States. Indeed, Fairbanks International Airport (FAI) lost all of its Air France cargo flights in 2003 due to the carrier's acquisition of new Boeing 747-400 Extended Range aircraft. With the cancellation of these layovers

between Paris and Japan, FAI's weekly cargo flights have dropped from 33 to 23. Happily for ANC, UPS' six flight per week frequency rights into China are conditioned by the US Department of Transportation (USDOT) to require a layover at ANC.

ANC faces competition from other airports along the great circle routes between North America and Asia that wish to attract foreign carriers. Some of these airports are in Vancouver, Khabarovsk in Russian Far East, and Tashkent. Having just completed a $26 million (US) reconstruction of its north-south runway, ANC is in a better position to handle the super-jumbo Airbus A380.[1]

Air Cargo Co-Mingling: Previous Practice

Since 1996, USDOT has allowed co-mingling of cargo on an intra-fleet basis for foreign carriers and an inter-fleet basis provided one of the carriers is a U.S. domestic. Only when the second carrier proceeded directly to a non-U.S. destination would air cargo co-mingling between two foreign carriers be permissible.

The first iteration of co-mingling discussion centered, in part, around the preservation of U.S. jobs.[2] Labor unions such as the AFL-CIO and the Airline Pilots Association (ALPA) have been vocal against the second (phase II) iteration because the ability of a foreign carrier to leverage a different foreign carrier's lower 48 routing network would come at the expense of those of domestic

carriers.[3] In this way, U.S. jobs in the form of domestic carrier flight crews face competition from the foreign carriers. The unions see it as a transfer of U.S. jobs to foreigners--- but this is only to the extent that pre-existing domestic interlining contracts are allowed to expire and the business transferred to a foreign carrier. The next section discussion phase II of the liberalization.

Air Cargo Co-Mingling: New Options

Under the new options domestic and foreign carriers are afforded more flexibility and the outbound-U.S. operations through ANC have been liberalized. There are four new options as described below.

U.S. Entry Operations

(1) A U.S. carrier enters the U.S. at ANC and transfers cargo to a non-U.S. carrier which will deliver it to a point in the lower 48 or depart ANC for a third country.

(2) The same operation as in (1) only the transfer is between two *different* non-U.S. carriers. The proviso is that the receiving non-U.S. carrier has a pre-existing code-share/revenue/capacity contract with a domestic carrier which serves ANC.[4]

U.S. Exit Operations

(3) A non-U.S. carrier picks up cargo in the lower 48 and drops it off at ANC for transfer to a different plane in its fleet which is also exiting the U.S. This is an outbound co-mingling operation akin to inter-lining within the carrier's fleet. This is a mirror-image of inbound co-mingling (i.e., point (1) above).

(4) The same operation as in (3) only now the receiving airplane in ANC is of a *different* non-U.S. carrier. This form of inter-lining allows the two carriers to truly leverage each others' operational network. The impetus might be that the inbound ANC carrier is a gatherer for the outbound ANC carrier; or the inbound ANC carrier wishes to leverage the outbound ANC carrier's destinations.

Point (1) and (2) show that a carrier's interlining and leveraging off another's U.S. and non-U.S. network is allowed with the distinction of domestic and international carrier being immaterial to the co-mingling option. Under the old rules inter-fleet co-mingling among different non-U.S. carriers required the second plane to proceed directly to a non-U.S. destination.

If the cargo, in effect, proceeds through three or more countries then, depending on the point of origin and destination, the move described in points (1) through (4)

would be *de facto* 5th Freedom if the origin-destination of the run (in which the lower 48 and ANC are in-between) is in the carrier's domicile. If it is not, the move would be *de facto* 7th Freedom. Point (1) also shows that while the cargo has increased routing flexibility, the carrier's airplanes are doing nothing beyond the bilateral air agreement between agreed to by the governments of its domicile and the United States. Point (2), on the other hand, shows that the cargo routing is more flexible and the cargo may, in effect, travel to points allowed within the bilateral air agreement applicable to the other non-U.S. carrier. This is especially useful when the bilaterals in question have sufficient differences.[5]

Air Cargo Co-Mingling: Next Steps

Co-mingling operations, as an impetus for more international flights through ANC cannot be ignored. "[O]ne new overseas flight per day creates approximately 90 more jobs in Alaska and a payroll of $13 million."[6] Certainly, co-mingling deregulaton, as a form of inter-lining, gives cargo flexibility on ANC-lower 48 runs without the need to re-negotiate any applicable bilateral air agreements. Of course, there are further deregulatory steps one can envision in-between co-terminalization moves and cabotage transportation.

Value added-manufacturing through a foreign trade zone (FTZ) requires a layover of in-coming cargo as opposed to direct transfer from airplane to airplane. The

FTZ at ANC may be part of the solution to a problem that has vexed Alaska businesses and politicians for many years: how to attract manufacturers to the state as opposed to just resource extractors and service sector businesses.

Items entering a U.S. FTZ from anywhere in the world, do so duty-free. As well, items transferred among FTZs do so duty-free. Manufacturing within a FTZ makes sense when the duty on the imported components is higher than the duty on the finished product itself.[7] If the layover involves value-added at ANC's FTZ, previous to loading the final good on an airplane departing the U.S., there would be no duty applicable on either the input(s) or the final good. Since neither the input(s) nor the final good entered the U.S. on a commercial basis, no duty is assessed.

Value-added manufacturing takes place at several air cargo hubs in the U.S.--- notably in Memphis, TN and Louisville, KY because of the respective presence of the FedEx and UPS corporate headquarters. Just-in-time manufacturers at these locales naturally find it convenient to leverage of the availability of cargo lift to destinations throughout the world. In terms of have a manufacturing presence at our near ANC, a benefit in the form of time-savings may be had; especially if the markets for inputs and/or final goods are in Asia. All U.S. inbound/outbound Asia-domiciled carriers lay-over at ANC.

Conclusions

With its continued drive to remain a relevant and strategic air cargo hub ANC is pushing the envelope of air cargo deregulation in North America. It also represents a unique example of unilateral trade liberalization on the part of the United States government. What is also instructive is that such concessions can made outside the purview of the contentiousness of bilateral air agreements.

Endnotes

[1] FedEx expects to take delivery of three A380s in 2008 and 2009.

[2] For a complete overview of the original co-mingling operations and how they were formed at ANC see **Prokop (2002)**.

[3] AFL-CIO Trade Representative, Sonny Hall, was quoted as saying the language in the FAA bill, "threatened the already ailing airline industry and its workers by recklessly permitting foreign air cargo carriers such as China Airlines to prey on the U.S. marketplace." **(Keane 2003; p.17)**. However, it should be noted that some Anchorage based unions have been supportive. Notably, the Aircraft Mechanics Fraternal Association and the Carpenters' Union.

[4] For example, suppose China Airlines wishes to transfer cargo at ANC to a Japan Airlines plane traveling to the lower 48. Japan Airlines has to have a *pre-existing* code share agreement with a U.S. domestic carrier (likely Northwest Airlines) for its flight to the lower 48; and a revenue sharing agreement of some kind must also pre-exist. China Airlines will be required to note this code-share on its air waybill and Northwest Airlines will receive a portion of the revenue payable to Japan Airlines.

[5] It is also worth noting that point (2) is in the "spirit" of how the U.S. Bureau of Customs and Border

Protection views the treatment of international cargo in the trucking industry (see **Prokop 1999**). As far as the bureau is concerned a point-to-point move of U.S. cargo is not considered cabotage so long as the final U.S. destination (based on the bill of lading) has not been reached. Of course, in the air cargo industry the bilateral agreement trumps any liberties any border control officials would grant. And on the other side of the coin, co-mingling options were unilaterally granted and, as such, trump the view of the Immigration and Naturalization Service (INS) which, indeed, still considers point-to-point haulage of any kind to be cabotage.

[6] Jim Friedel, President of Northwest Airlines' cargo division, quoted in **King (2003)**.

[7] For example, an input (dutiable at 5%) used in a final good (dutiable at 1%) is now dutiable at 1% if and when the final product leaves the FTZ for the U.S. marketplace. This represents a 3.8% (i.e., [1.01-1.05]/1.05) savings on input cost.

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ALTERNATIVE FORMS OF ECONOMIC REGULATION OF AIRPORTS: MODELING AND EMPIRICAL EVALUATION

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ABSTRACT

This paper investigates the effects of different forms of price regulation on airport efficiency. Our results shows that while ROR regulation may lead to over-investment in capacity, price-cap regulation is prone to under-investment. The extent of the under-investment is found to be less under the dual-till price cap than under the single-till price cap. Our empirical investigation of capital input productivity and total factor productivity confirm the analytical findings. In particular, the total factor productivity is greater under the dual-till price cap than under either the single-till price cap or single-till ROR. This, together with our analytical result that the dual-till ROR may give airports an incentive to improve efficiency, support the argument made by several economists that the dual-till regulation would be better than the single-till regulation in terms of economic efficiency, especially for large, busy airports.

1 INTRODUCTION

Airports have traditionally been owned by governments, national or local governments. Until the late 1980s, the only examples of private ownership were of small, usually dedicated purpose, airports. This is changing, however. Starting with the 1987 U.K.'s privatization of the three London area airports (Heathrow, Gatwick and Stansted) and four other airports in the country to BAA plc., many airports around the world have already been or are in the process of being privatized.

The majority stakes of Copenhagen Kastrup International Airport, Vienna International Airport, Rome's Leonardo Da Vinci Airport and 49% of Schiphol Airport have been sold to private sector owners. Many other European airports are in the process of being privatized. Auckland International and Wellington International Airports in New Zealand and a large number of major Australian airports have been privatized as well. South Africa, Argentina, Mexico and many Asian countries are also in the process of privatizing their airports.[1] Canada is currently reviewing its policy of using not-for-profit corporations for management of its major airports.

The privatized airports would pursue profit maximization. Out of the concern that the airports are local monopolies, having a captive market, many airports in the world are under price regulation in order to prevent them from abusing their market power. The form of price regulation varies from country to country, with most being cost-based in principle so that the airport is expected to achieve financial break-even, including a fair return on the capital invested in the airport. Some forms of price regulation such as the rate-of-return (ROR) regulation may have undesirable implications on the firm's behavior, leading to inefficient capital investment and a general lack of managerial drive to reduce costs and improve efficiency. Other forms such as the price-cap regulation are designed to allow the airport to benefit from cost reduction by retaining the incentive (and pressure) on the airport to improve efficiency. The U.K., Australia and Demark adopted the price-cap regulation, which has been widely adopted by other countries and by different public utility industries such as telecommunications, electric utilities, railroads, etc.[2] Many other countries implicitly put their airports under some form of the ROR regulation.

Recently, economists have been rethinking the price regulation of airport. Studies on country-specific options and experiences include Forsyth (1997, 2002a, b), Beesley (1999), Kunz and Niemeier (2000), Starkie and Yarrow (2000), Starkie (2001), Tretheway (2001), and Gillen and Morrison (2001). Beesley (1999) argued that the price-cap

[1] See Hooper (2001) for the list of Asian airports being considered for privatization.

[2] Some useful details on various issues for implementing price-cap regulations for U.K. airports are available in Civil Aviation Authority (March, 2001).

regulation was inappropriate in the case of Heathrow. Tretheway (2001) pointed out that the ROR regulation tends to be complex, unresponsive and expensive to administer. Kunz and Niemeier (2000) have argued that the cost-based ROR regulation used in Germany is inefficient and results in the misallocation of resources. Starkie (2001) further concluded that *ex-ante* regulation for airports might be unnecessary because the airports are unlikely to abuse their monopoly power due to the existence of a complementarity between the demand for aviation (aircraft and passenger movements) services and the demand for concession (retailing) services.

In this paper, we investigate the impacts of different forms of regulation on capital and productive efficiencies. We find that a price-cap regulation on airport charges may introduce a distortion in airport capacity decisions. Specifically, whilst airports under the ROR regulation may result in over-invest in capacity, owing to Averch-Johnson effect, airports under the price-cap regulation are prone to under-invest in airport capacity. Of the two price-cap regulations, the dual till has less severe distortional effects on capacity investment than the single till.[3] Also, the presence of concession profits would give airports a strong incentive to improve economic efficiency. Using major airports around the world, our empirical results suggest that the capital input productivity is highest under the single-till price cap, followed by the dual-till price cap and then by the ROR. On the other hand, the total factor productivity (TFP) is greater under the dual-till price cap than under either the single-till price cap or single-till ROR. These empirical results are consistent with our analytical results. The TFP result further supports the argument made by, among others, Starkie and Yarrow (2000), Starkie (2001) and Forsyth (2002a) that the dual-till price cap would

[3] Helm and Thompson (1991) examined the likely investment behavior of transport utilities transferred to private ownership, and compared this with the corresponding behavior under public ownership. They pointed out that the investment incentives under privatized ownership induce under-investment, and further showed that the extent of under-investment depends upon the price elasticity of demand in the final product market. In our analysis, we consider the likely investment behavior of privatized airports under different forms of price regulation.

be better than the single-till price cap or single-till ROR in terms of economic efficiency, especially for large, busy airports.

2 THE BASIC MODEL

An airport supplies aviation services to airlines and passengers. These services include runway facilities for aircraft landing and takeoff, terminal buildings for passenger traffic, technical services to the aircraft such as fueling and maintenance, and navigational services, etc. The airport incurs both operating costs and capital costs for providing these services, and charges the users in order to recover its costs and to make an excessive return on capital (or, profits) if price regulation is not in place. In an airport, congestion would build up as the traffic volume increases over time, resulting in increased flight delays. The costs of the delay are part of the total (generalized) travel costs of the passengers and also constitute part of the operating costs of airlines due to increased flight time either in the air or on the ground. Consequently, passengers will view their total costs (the full price) of taking a flight as the sum of ticket price and costs of delay. Let

$Q(\rho)$ = demand (number of flights) for airport facilities (landing and passenger terminal services) which depends on the perceived full price, ρ,

ρ = P + D, the "full price" perceived by the passengers which is reflected in the carriers' demand for airport facilities,

P = airport charges for a flight, including both landing fees and passenger fees,

D = flight delay costs experienced by each aircraft, which depends on total traffic level and airport capacity, D = D(Q,K),

K = capacity of the airport,

C(Q) = operating costs of the airport, and

r = cost of capital.

For simplicity, in this paper we assume that the capacity of the airport, K, can be adjusted continuously.

Consider a publicly-owned airport whose objective is assumed to be social welfare maximization. Social welfare is defined, as is common

in the literature, as the sum of consumer surplus and producer surplus:

$$SW = \int_{\rho}^{\infty} Q(\rho)d\rho + PQ - C(Q) - Kr + Q[\int_{p}^{\infty} X(p)dp + pX - c(X)]$$

where X(p) is the per-flight demand and p is the price of concession services (or goods) provided at the airport, and c(X) is the cost of providing the concessions.[4] Suppose that the public airport is subject to a budget constraint so that the airport does not impose any financial burden on the public. Then the airport is faced with the following problem:

$$\max_{P,\,p,K} \int_{\rho}^{\infty} Q(\rho)d\rho + PQ - C(Q) - Kr + Q[\int_{p}^{\infty} X(p)dp + pX - c(X)]$$

$$s.t. \quad PQ - C(Q) - Kr + Q[pX - c(X)] = 0 \tag{1}$$

Consider first the price decisions. The first-order conditions lead to:

$$P_W = C' + Q\frac{\partial D}{\partial Q} + \frac{\lambda}{1+\lambda}(\frac{\rho}{\varepsilon}) - \frac{V + \lambda R}{1+\lambda} \tag{2}$$

and

$$p_W = c' + \frac{\lambda}{1+\lambda}(\frac{X}{-X'}) \tag{3}$$

where λ is the Lagrangean multiplier. In (2), subscript W denotes that the pricing principle is derived from the welfare-maximization

[4] Note that in this formulation, concession welfare (i.e., the sum of concession surplus and concession profits) is treated as linear in the number of flights. One may argue that concession profits will probably increase disproportionately with traffic volume. Notice that for given a flight, our model does allow the relationship to be non-linear. Extending the model to allow for possible non-linear relationships at the level of flights would complicate the mathematical derivations considerably, but would not affect the basic results of the paper.

objective, $\varepsilon = -(dQ/Q)/(d\rho/\rho)$ is the (positive) elasticity of demand for air travel with respect to full price,

$$V = \int_{\rho}^{\infty} X(p)dp + pX(p) - c(X(p)) \tag{4}$$

is the (per flight) consumer surplus from concession purchases plus concession profits, and

$$R = pX(p) - c(X(p)) \tag{5}$$

represents the (per flight) concession profits.

The first two terms on the right-hand side of (2) represent the marginal operating cost and the marginal congestion cost to other flights, respectively, so together they represent the "social marginal cost" of one flight. The multiplier λ depends on the nature of the budget constraint. It can be shown that λ will be positive if unconstrained welfare-maximization would result in a financial deficit to the airport. We are only concerned with the case where λ is positive or zero,[5] because when λ is negative, it would imply that unconstrained welfare-maximization would lead to financial surplus and so there would be no compelling reason to impose the budget constraint on the airport in the first place. Condition (2) then reveals that the optimal aviation charge P consists of the social marginal cost, a markup term which is inversely related to demand elasticity, and a markdown term which is a weighted average of concession welfare V and concession profits R. Condition (3) provides the socially optimal price for concession services which implies zero profit.

Now we examine the airport's capacity decision. Differentiating the Lagrangean with respect to K gives:

$$\begin{aligned} &-Q\frac{\partial \rho}{\partial K} + P\frac{\partial Q}{\partial K} - C'\frac{\partial Q}{\partial K} - r + \frac{\partial Q}{\partial K}V \\ &\quad + \lambda[P\frac{\partial Q}{\partial K} - C'\frac{\partial Q}{\partial K} - r + \frac{\partial Q}{\partial K}R] = 0 \end{aligned} \tag{6}$$

Since $\partial Q/\partial K = Q'(\partial \rho/\partial K)$ and $\rho = P + D(Q,K)$,

[5] That λ is zero represents the case of unconstrained welfare maximization.

$$\frac{\partial \rho}{\partial K} = \frac{\partial D}{\partial Q} Q' \frac{\partial \rho}{\partial K} + \frac{\partial D}{\partial K} = \frac{\partial D / \partial K}{1 - Q'(\partial D / \partial Q)} \tag{7}$$

Substituting (7) into (6), using (2) and simplifying the resulting expression, we obtain:

$$-Q \frac{\partial D}{\partial K} = r \tag{8}$$

Clearly, the socially optimal level of capacity is such that the marginal benefit of capacity in terms of reduction in congestion costs equates the marginal cost of capacity.

3 EFFECTS OF ALTERNATIVE FORMS OF PRICE REGULATION

Now we consider the effect of alternative forms of price regulation on a privatized airport. Given the space limitation, we shall in this section report what we have done with respect to our theoretical analysis and what the main results are. The derivations of these analytical results are available upon request from the authors.

We have analyzed the impacts of different forms of price regulation on capital and productive efficiencies. We found that the single-till ROR regulation tends to induce over-investment in airport capacity whereas the price-cap regulation is likely to lead to under-investment. Furthermore, of the two price-cap regulations, the dual till has less severe distortional effects on capacity investment than the single till. Our analytical results imply that

(1) the capital input productivity would be highest under the single-till price cap, followed by the dual-till price cap and the single-till ROR;[6] and

(2) the total factor productivity (TFP) would be greater under the dual-till price cap than under either the single-till price cap or the single-till ROR.

[6] In our analysis, we also found that under the dual-till ROR regulation, if the cost of capacity is known, the regulated airport would strive for maximum productive efficiency with the socially optimal capacity investment. Since our database does not have any airports that were under the dual-till ROR regulation, we are unable test this analytical result.

4 AN EMPIRICAL STUDY

Since we have made some simplifying assumptions to obtain our analytical results, it is useful to see if our findings hold in reality. In order to do the empirical validation of our analytical results, it is necessary for us to compute and compare the capital input productivity and TFP. For empirical analysis, we borrowed the capital and total factor productivities computed for *The First Annual ATRS Airport Benchmarking Report: Global Standards for Airport Excellence* by the Air Transport Research Society (ATRS, 2002).[7] Its survey of literature and extensive statistical analysis on airport productivities indicate that the following variables also influence the airport productivities:

- Size of the airport represented by volume of passenger traffic per year (PAX)
- Percentage of airside services revenue in the total airport revenue (RATIO_AV)
- Degree of non-weather related congestion delays at the airport (CONGSTON)
- Whether or not the airport is used by one or more major carriers as a hub (HUB)[8]
- Ownership types – public, private, or public-private mixed ownership
- Input price differentials in different continents and different countries. For this we simply use dummy variables indicating each continent (Asia, Europe and North America).

In addition to these variables, the present paper has found that the form of price regulation may influence airport productivities.

We have estimated several specifications of regression equations including these variables (see Table 1) and the following dummy

[7] The methodologies for computing the capital input and total factor productivities for the ATRS global airports benchmarking report are well documented in Adler, *et al.* (2002).

[8] The definition of a hub is borrowed from FAA/OST (1999, Appendix A).

variables indicating the form of price regulation each airport is subjected to:

- Single-till price-cap regulation
- Dual-till price-cap regulation
- Single-till ROR regulation

During the sample period of our data, there was not a single unregulated profit-maximizing airport or unconstrained welfare-maximizing airport in the world, so it is not possible to use either as a benchmark for our comparison. Furthermore, our database does not have any airports that were under the dual-till ROR regulation. Therefore, we make comparisons of the base case (the single-till ROR regulation) with those of single-till or dual-till price-cap regulations. Moreover, since the US airports are under either the "compensatory" pricing or "residual cost" pricing systems (Graham, 2002), we classified the airports under the compensatory pricing as the dual-till price-cap airports, and the airports under the residual-cost pricing as the single-till price-cap airports.[9]

The representative regression equations are reported in Table 1, where to avoid perfect collinearity, we dropped the single-till ROR dummy, and the ownership dummy for 100% publicly owned airports, and the continental dummy for Asia. The first two regressions in the table are the capital input productivity regressions based on the 1999 data for 68 major airports in Asia, Europe and North America, while columns 3 and 4 are the capital input productivity regressions based on a much larger data set (110 observations) combining 1999 and 2000 data for a similar set of

[9] An airport under the "residual cost pricing" system charges airlines and other aviation users the total revenue of the airport minus all revenues collected from non-aviation services (such as concessions, airport land and space rentals, car parking, etc) such that the airport is break even. As such, this pricing scheme can be classified as the single-till price-cap regulation, where the price cap for the aviation services includes a fair return to the airport's capital investment on its aviation services. In comparison, an airport under the "compensatory pricing" system charges airlines and other aviation users only for the facilities and services they actually use (i.e., aviation services) such that the airport is break even.

airports. The last column is the TFP regression based on the 1999 data for 50 airports.[10]

4.1 Effects of the form of economic regulation on capital input productivity

The results from the capital productivity regressions confirm by and large our analytical findings. As compared to the base case (the single-till ROR regulation), the airports under the single-till price-cap regulation have a significantly higher capital input productivity. Furthermore, these airports tend to have higher capital input productivity than the dual-till price-cap regulated airports that, in turn, tend to have higher (though statistically insignificant) capital input productivity than the single-till ROR regulated airports. These confirm our analytical results that the single-till price cap such as the one in place for BAA plc. gives an incentive for the airports to under-invest in capacity than the socially optimal capacity level, whilst the airports under a ROR regulation has an incentive to over-invest in capacity (the A-J effect). In addition, the extent of under-investment in capacity is higher under the single-till price-cap regulation than under the dual till. Note that the DUAL variable is not statistically significant in any of the four capital input productivity regressions reported in Table 1.

4.2 Effects of the form of economic regulation on TFP

The TFP regression in the last column indicates that airports under the price-cap regulation, either single till or dual till, achieve a significantly higher TFP than those under the single-till ROR regulation (the base case). This implies that the inefficiency caused by the rate-of-return regulation (due to the A-J effect and lack of incentives to improve efficiency) is statistically greater than the inefficiency caused by the under-investment of capital input caused by a price-cap regulation. Furthermore, because the single-till price cap leads to more severe under-investment of capital inputs than the dual-till price cap (as predicted in our analytical model), the airports

[10] Note that the ATRS global airport performance benchmarking team was able to compute TFPs only for 50 airports due to the data limitation.

under the single-till price cap are expected to have lower TFP than the airports under the dual-till price cap. The empirical result from the TFP regression appears to be consistent with this prediction.

Table 1 Capital productivity and total factor productivity regressions

Independent variable	Capital productivity (1999)	Capital productivity (1999)	Capital productivity (1999 & 2000)	Capital productivity (1999 & 2000)	TFP (1999)
SINGLE	*24.3***	*20.9***	*19.7***	*19.2***	*0.190****
	(2.11)	*(1.89)*	*(2.11)*	*(2.16)*	*(2.21)*
DUAL	*12.5*[1]	-	*8.28*[2]	-	*0.293****
	(1.05)		*(.796)*		*(2.96)*
PAX	1.27E-03****	1.33E-03****	1.27E-03****	1.29E-03****	1.128E-05****
	(4.45)	(4.75)	(5.17)	(5.37)	(4.07)
RATIO_AV	-116****	-115****	-75.5****	-72.0***	-1.102****
	(-3.56)	(-3.50)	(-2.72)	(-2.59)	(-4.19)
EUROPE	38.0****	36.9****	35.4****	33.9****	-0.334****
	(3.66)	(3.56)	(3.06)	(2.93)	(-3.0)
NA	-	-	14.5*	18.3**	-0.255***
			(1.42)	(1.84)	(-2.62)
CONGSTON	28.4***	28.6***	18.9***	20.7***	0.150**
	(2.56)		(2.02)	(2.23)	(1.77)
HUB	-	-	-	-	-0.205****
					(-2.24)
PUB_PRI	-34.8**	-36.9***	-21.9*	-	-
	(-2.21)	(-2.36)	(-1.41)		
PRI	-24.7*	-22.6*	-	-	-0.535***
	(-1.54)	(-1.42)			(-2.13)
CONSTANT	125****	125****	101****	96.2****	1.280****
	(6.78)	(6.80)	(5.96)	(5.74)	(8.28)
# of obs.	68	68	110	110	50

R^2	537	528	407	390	0 642
Adjusted R^2	474	473	360	354	0 561
Root MSE	1129	1131	1373	1383	0 047

Notes: t-value in parentheses; ****, ***, **, * significant at 0.01, 0.05, 0.1, 0.2 levels respectively; [1]: significant at 0.298 level; [2]: significant at 0.428 level

SINGLE: Single-till price-cap regulation or residual cost-plus regulation
DUAL: Dual-till price-cap regulation or compensatory cost-plus regulation
PAX: Volume of passenger traffic (in thousands)
RATIO_AV: Percentage of aviation (airside services) revenue in the total airport revenue
EUROPE: Dummy, equal to 1 if the airport is in Europe
NA: Dummy, equal to 1 if the airport is in North America
CONGSTON: Dummy, equal to 1 if the airport is congested
PRI: Dummy, equal to 1 if the airport is owned 100 percent by private owners
PUB_PRI: Dummy, equal to 1 for mixed ownership with majority public

4.3 Other findings on airport productivities

Aside from the present paper's research focus, the regression equations reported in Table 1 appear to reveal the following:

- The statistically significant positive coefficient of the PAX (passenger volume) variable may be interpreted as an evidence of economies of scale and/or economies of density.
- The statistically significant negative coefficient of the RATIO_AV (percentage of revenue from the airside services) variable indicates that an airport with a large proportion of concession revenue is expected to have higher productivities in both capital input and TFP, than a similar airport with a small proportion of concession revenue.
- The statistically significant positive coefficients of the congested airport dummy (CONGSTON) in the capital productivity regressions indicate that congested airports tend to achieve a higher capital productivity than a comparable airport without congestions. On the other hand, the evidence from the TFP regression is only marginally statistically significant, implying that the effects of congestion on TFP are less clear.
- The statistically significant negative coefficient for the Hub airport dummy in the TFP regression indicates that when an

airport is used as a hub, it tends to reduce TFP of that airport. This may be due to the fact that airlines have been creating "peaking" problems artificially by running highly intensified flight departure and arrival flight banks which make airports over-utilized during peaks and under-utilized during off-peaks (the period between arrival and departure flight banks).

- The negative coefficients of the PUB_PRI (mixed public-private airports) variable in the capital productivity equation imply that the airports owned by public-private partnership (where government agencies own a majority share) tend to achieve lower capital input productivity than pure public airports (the base case).
- The statistically significant negative coefficient for the private ownership dummy (PRI) in the TFP regression implies that a privately owned airport does not necessarily achieve higher TFP than a publicly owned airport. This result may be caused the private airports tend to focus on improving the revenue and profit opportunities rather than focusing on productivity improvement.

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PreBoard Screening Analysis at Vancouver International Airport

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Introduction

After Sept. 11, 2001, air travel became longer as heightened security measures led to new and more complex security screening processes, sometimes resulting in longer lines and decreased throughput at security checkpoints. Immediately following 9/11, it was not unheard of to spend more time in security lines than in the air.

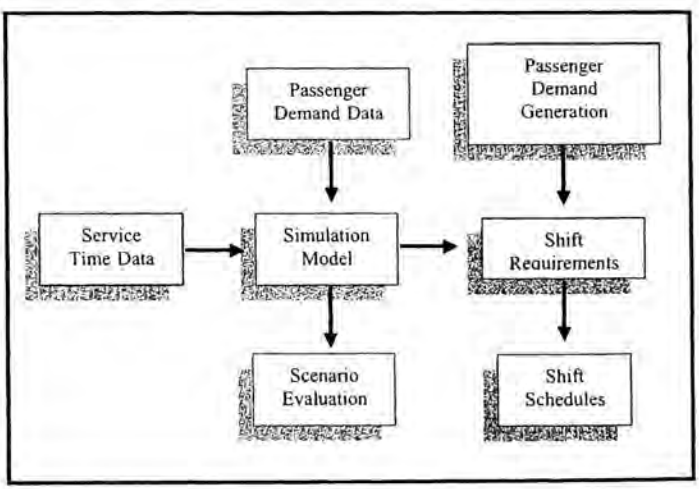
A timely and innovative OR based study carried out by Vancouver International Airport Authority (YVRAA) in conjunction with students, staff and faculty from UBC Sauder School of Business' Centre for Operations Excellence (COE) showed that through efficient scheduling and job deployment, 90 percent of Vancouver International Airport (YVR) passengers could expect to wait no longer than ten minutes at pre-board screening (PBS) security points.

Craig Richmond, the Airport Authority's Vice President of Operations, said of this effort, "At YVR we are firm believers that increased security can go hand in hand with customer service. We've shared the results of this study with the federal agency responsible for passenger screening and hope it will help improve passenger flows and processing across the country."

The Vancouver International Airport is operated and managed by the Vancouver International Airport Authority. This community-based,

not for-profit organization operates under a long term lease from the Government of Canada. Its focus on safety, security and customer service has contributed to YVR's ranking among the 10 top airports in the world. To maintain its excellent customer service standards and in anticipation of new government regulations, airport management sought to take leadership in improving customer flow through its airport security checkpoints. It was at this point that YVRAA turned to the COE for assistance.

The COE carried out a two phase study (see the schematic below) to address YVRAA managerial needs. The study focussed on the operation of the two domestic, the trans-border and the international pre-board screening locations. In the first phase, the research team developed the YVRAA Security Queuing Simulation Model to compare several operational strategies and determine staff levels required to obtain achievable service standards. The second phase was to generate shift schedules that would achieve these standards at minimal cost.



Schematic overview of study components and outcomes.

Pre-Board Screening

While most of us have passed through pre-board screening, it is unlikely that we have paid much attention to the intricacies of this process. With process flow software and stop watches in hand the research team viewed the pre-board screening operation through analysts' eyes.

Team members (primarily students) spent several days, some starting at five a.m., observing the airport's four pre-board security locations. They observed the flow of passengers through the whole screening process, and collected data on passenger characteristics and time spent at each of the individual process steps. This activity alone highlighted some areas for immediate improvement. Recommendations included better signage on payment of the Airport Improvement Fee (AIF), asking passengers to boot up their laptops and place their metal possessions into special containers before entering the pre-boarding screening area and reconfiguring the layout to allow more space for manual searches. Measures like these immediately cut down on bottlenecks and improved the flow of passengers through the pre-board screening area.

Observations were corroborated by interviews with security personnel. Bringing all the pieces together gave us a thorough understanding of the system's processes and procedures and enabled us to develop preliminary process maps. The preliminary maps underwent a number of revisions to ensure that all parties agreed that they accurately represented system flows and operations.

The Airport Authority provided AIF data from each of the airport's four screening points. AIF data was used as a proxy for passenger volumes at each of the four screening points and was one of the main inputs for the simulation model. It was also used to validate the departing passenger generator used in the staff scheduling analysis described below.

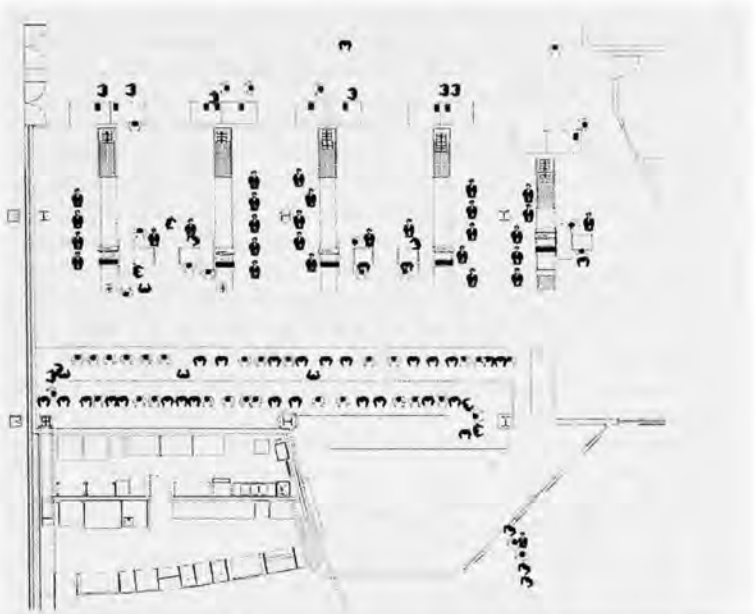
Simulation Development and Benefits

To overcome the complexity of the system, modeling began with only a single screening line. This gave us insight into which aspects of the process we understood well and where we require additional observation and data. Once we were satisfied with our model of a single screening line we extended it to the full system consisting of five parallel screening lines as depicted in our simulation screen shot.

To validate our simulation, we collected additional waiting time and throughput data. We compared the simulation output to this data and revised the logic and service time data until we were satisfied that the simulation output agreed with observations.

Since pre-board screening operations throughout the airport are similar, further data collection allowed us to extend the model to all four screening areas. Changing parameters such as the bag search ratio and the number of bags carried allowed us to model the international and trans-border screening areas in addition to the domestic screening points. After this step was completed, we were able to conduct meaningful analyses and proceed with the next phases of the project.

The YVRAA Security Queuing Simulation which was developed in ARENA 6.0 has become a valuable tool to visualize pre-board screening operations identify bottlenecks and conduct "what-if" analyses. Simulation output statistics provide resource utilization, queue lengths and time spent in the system measurements.

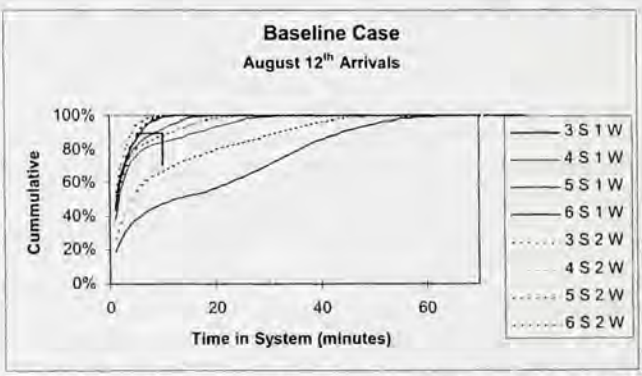


Screenshot of YVRAA Security Simulation showing the pre-board screening configuration in the domestic terminal. Passenger colors indicate the number of bags carried and security are represented in red when active and green when inactive.

Using the YVRAA Security Queuing Simulation, the Airport Authority is able to anticipate the impact of a change in passenger numbers or staffing levels on waiting times. It showed that under some conditions it is more efficient to have two security lines fully staffed than five partially staffed, and that increasing staffing levels could be more effective than acquiring additional expensive machinery. Most importantly, it showed what staffing levels and shift configurations were required to realize the goal of 90 per cent of passengers waiting a maximum of ten minutes in line. YVRAA VP Operations Richmond was extremely pleased with our model. He

noted that "the simulation model helps answer many other questions that may seem simple but can be extremely complex to answer."

We determined the best allocation of staff to the search and wanding tasks by evaluating a range of allocation scenarios. We analyzed each PBS location separately because different passenger characteristics produced different searching and wanding ratios. The simulation model was run using a constant, saturated, unbroken stream of passengers so that system resources were working at full capacity. Throughput was calculated by dividing the number of passengers processed by the number of simulated hours. Results were summarized in tabular form and provided to Airport Authority management. In most cases, the marginal increase in throughput was greater when adding a wander than when adding an additional searcher.



Comparison of Cumulative time in system under a range of staffing configurations

Shift Scheduling

The second phase of the project sought to determine shift schedules to achieve the 90-10 service criteria with a minimum number of staff

hours. Our approach combined a passenger load forecasting model, simulation to determine staffing requirements across the four PBS lines and linear programming to determine an optimal allocation of shifts. Shift schedules were developed on a daily basis and allowed movement of staff between different PBS locations to take into account the different load patterns.

To be useful by YVRAA analysts, our models had to be easy to understand, quick to execute and compatible with readily available analysis tools. Thus we focussed on integrating flight schedules, the simulation and the optimization model through MS Excel.

Demand Generation

In forecasting passenger demand at each PBS location, the objective was to turn a daily flight schedule listing the departure time, gate number and number of seats for each aircraft, into the estimated number of passengers expected at each PBS location at each 10 minute interval throughout the day. Fortuitously, airport improvement fee (AIF) sales data was available to validate our approach. The AIF is paid by departing passengers at collection points immediately preceding the PBS locations. Comparing this data to hand counts revealed that the AIF data was a good proxy for passenger arrival time data.

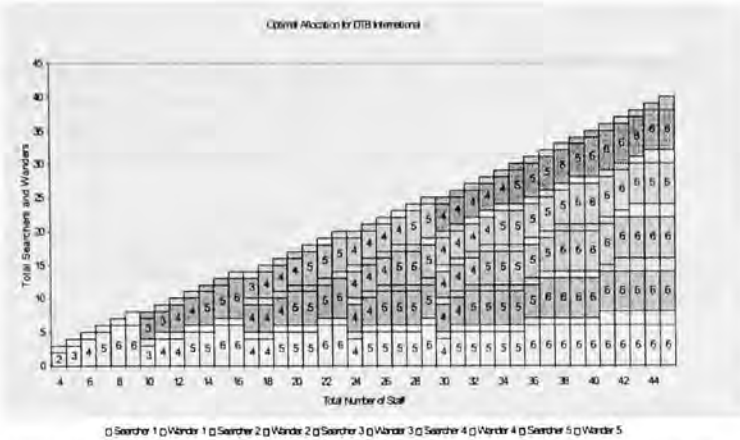
We used the flight schedule to determine the capacity and departure time for each flight and estimated the number of passengers on a flight by multiplying its capacity by the anticipated load factor (LF). We then allocated the estimated number of passengers to a time period prior to departure using a triangular distribution. We aggregated data across flights to determine the number of passengers arriving in each time slot. Using the AIF data for validation, different triangular distributions were evaluated until we found a best one for each PBS location. Passenger connection ratios were acquired to determine the approximate connection ratio to use with the passenger generator for the international pier.

We were very pleased with these results, in general, simple triangular distributions produced a demand profile that consistently mirrored most of the peaks and valleys of the AIF data, and was very close in magnitude at the key morning and evening departure times. We settled on separate distributions for flights to Canadian destinations and flights to the US and other international destinations.

Achieving the Service Criterion

The next step was to translate this demand into staffing requirements. We created a look-up table for each PBS location listing expected passenger demand for a 10-minute interval and the corresponding number of screening staff required to achieve the 90-10 service criterion. The simulation was used intensively at this point. For each demand rate a staffing level was selected and the simulation run at the constant staffing level and constant passenger demand rate. If the service criterion was met over the duration of the simulation, the staffing level was reduced, if not it was increased. The simulation was run until the minimum staffing level to meet the service criterion was determined. This procedure was repeated until the lookup table was populated.

It became apparent that we needed to know how staff were deployed between the wanding and bag searching tasks, as well as how many equipment lines should be open and how the staff were distributed between them. Using the data in the throughput table, an "optimal staff allocation" defined as that with the highest maximum passenger throughput, was determined for each number of screening staff, at each PBS location.



This is a graphical representation of an optimal staff allocation scenario. Different colors represent the number of lines that should be open for each total staffing level and the numbers within the bars represent the allocation of searchers and wanders to each security line.

Developing the Shift Schedules

The final task was to determine a minimum cost shift schedule that achieves the required staffing levels. We aggregated the staffing levels across the four locations to obtain an airport wide staffing requirement. Given a list of the possible shifts, a linear programming model was used to determine the optimal shift schedule that satisfied the airport wide staffing requirements in each time period. A surplus factor was added to account for staff breaks. YVRAA management wanted the flexibility to evaluate a wide range of shift combinations including different durations and different start times. Our approach was sufficiently flexible to do this.

Conclusion

We believe that YVRAA was extremely far-sighted in recognizing the impact OR methods can achieve in improving security operations. This project gave students and faculty the opportunity to work on a challenging and significant applied project which set high standards for managing airport security operations.

For more on this and other exciting applied projects, refer to http://www.coe.ubc.ca. Additional information about Vancouver International Airport is available at http://www.yvr.ca.

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Analysis of Accidents

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Summary

A learning paradigm called LEFAR [1] is introduced. This paradigm learns from association rules. In this paper, we test the new paradigm for data collected by the U. S. Coast Guard for the lower Mississippi River over a five year period. Four pairs of training and test sets were randomly generated from the collected data. The new paradigm was applied to every pair by learning from the training set and predicting the accident type of the records in the test set. The average of correct predictions is slightly over 70 percent. The accident predictive ability of the proposed learning paradigm was compared with the accident predictive ability of the discriminant analysis which was applied on the same pairs of training and test sets. The results reveal the superiority of the accident predictions using LEFAR paradigm over the discriminant analysis.

1.0 Introduction

A discovered association rule from a transportation dataset may be expressed using predicates. For example, *transports* (X, "fresh fruit") $\Rightarrow$ *transports* (X, "milk product") is an association rule that says: The carrier X who transports "fresh fruit" also transports "milk product". A close look at this association rule reveals that all the predicates in this rule have the same type—i.e. "transports". Such a trait makes the association analysis by which the above rule has been discovered a "single-level" one. In contrast, a "multi-level" Association Analysis (MAA) discovers association rules in which more than one type of predicates are involved. For example, the association rule of *owner* (X, "American") $\wedge$ *fleet_Size* (X, ">50") $\Rightarrow$ *transports* (X, "nuclear waist") which is discovered by an MAA has three types of predicates, namely fleet size, owner, and transports. This association rule reads as: "The American carrier X who has a fleet size greater than 50 transports "nuclear waist".

In general, the association rules are used in transactional analysis, market analysis, distribution analysis, client behavioral analysis, patients information analysis, protein analysis, DNA analysis, and drugs reaction analysis, to name a few. The major question that we tried to answer is that can we use the associate rules generated through a multi-level association analysis to predict the outcome of a given set of conditions. The answer to this question was positive and a learning paradigm called LEFAR (Learning from Association Rules) was reported in [1]. The focus of this paper, however, is two fold: (1) testing the LEFAR prediction capability against the data collected by the coastal guard for the lower part of the Mississippi River for 5 years and (2) comparing the prediction power of the LEFAR with the prediction power of discriminant analysis.

The remaining of the paper has the following structure. A background about the MAA is covered in Section 2. The methodology is introduced in Section 3. The experimental design and results are the subjects of Section 4. The conclusions and future research are presented in Section 5.

2.0 Background

MAA generates association rules in the form of $X \Rightarrow Y$, where X is a set of predicates of $\{x_1, x_2, \ldots, x_n \mid n > 0\}$ and Y is also a set of predicates $\{y_1, y_2, \ldots, y_m \mid m > 0\}$. Since the rule does not hold for every record in the given dataset, two parameters of "support", s, and "confidence", k, are assigned to each association rule. The support s for the association rule $X \Rightarrow Y$ is: (Number of records in which both X and Y exist) / (Total number of records) and the confidence k for the same rule is: (Number of records including both X and Y) / (Number of records including X). For the details of MAA consult [2, 3, 4, 5].

Mining multiple level associations is done by using several approaches. Three well known approaches are: a modified version of Apriori Algorithm [6], N-dimensional (N-D) data cubes [7], and Formal Concept Analysis [8, 9]. We use the N-D data cube approach for the creating association rules. This approach is presented shortly through an example.

For the sake of simplicity, let us assume that we are interested in mining of multiple associations in a given data set that is composed of three attributes of A, B, and C. Furthermore, let us assume that the contents of these attributes are discretized. The given data set may be stored in a data cube. A data cube is made of a lattice that its nodes are cuboids. The cuboids are multidimensional data structures. For the three attributes in our example, maximum of 4 groups of cuboids exit that are named zero dimensional (0-D), one dimensional (1-D), two dimensional (2-D), and three dimensional (3-D) cuboids. The (0-D) cuboid has no attributes and, in contrast, the 3-D cuboid are made of all three attributes. As a result, there is only one of each. The data cube for the given attributes is shown in Figure 1.

For each lattice node, the dataset is scanned to establish the frequency of the instances for different values of the corresponding attributes in the cuboid. The established frequency of each instance is used to calculate the support value of the instance. If the resulting support value is less than a threshold support value, then the instance value of the combination is dismissed.

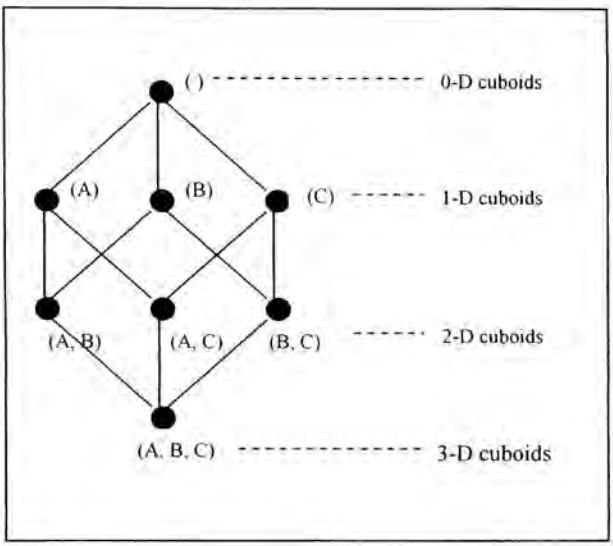


Figure 1: 3-D Data Cube

To explain it further, let us consider the 2-D cuboid of (A, B). If (i) the instance (a34, b9), where a34 belongs to attribute A and b9 belongs to attribute B has the support value of greater than or equal to the threshold support value and (ii) the values a34 and b9 at the 1-D cuboids of (A) and (B) have also an met the support value criteria, then (a34, b9) is a valid association. In general, if for an association that is made of n values the first condition (above) holds, then the second condition must hold for all the possible subsets of the association.

The creation of association rules from each non-empty association takes place in the following steps: (i) Every possible subset of a non-empty association is generated. For example, if the association is {a34, b9, c12}, then all the possible subsets are {a34, b9}, {a34, c12}, {b9, c12}, {a34}, {b9}, {c12}. (ii) Each subset is transformed into a rule that the antecedents are the anded items in the subset and the conclusion is the anded items missing from the subset. As a result the association rules generated from the 3-itemset of {a34, b9, c12} are:

$$a34 \wedge b9 \Rightarrow c12$$
$$a34 \wedge c12 \Rightarrow b9$$
$$b9 \wedge c12 \Rightarrow a34$$
$$a34 \Rightarrow b9 \wedge c12$$
$$b9 \Rightarrow a34 \wedge c12$$
$$c12 \Rightarrow a34 \wedge b9$$

For each association rule of $A \Rightarrow B$, the confidence is calculated and may be used to prune the set of rules further.

3.0 Methodology

The goal is to use association rules in "prediction" arena. As a result, the dataset that lends itself to a prediction process has a special type of internal structure. Each record in such datasets is composed of two parts: a group of independent variables (or conditions) and a dependent variable (a decision). The objective is to use conditions values to predict the decision value. To do so, two steps of "learning" from a training set and "testing" the result of learning on prediction of the decisions for the records of a test set take place. The LEFAR paradigm is used to complete the first step. The result of learning is presented as a set of prediction rules which are manifested in form of *if....,then...*rules. The LEFAR is described as a block diagram in Figure 2. For details, consult [1].

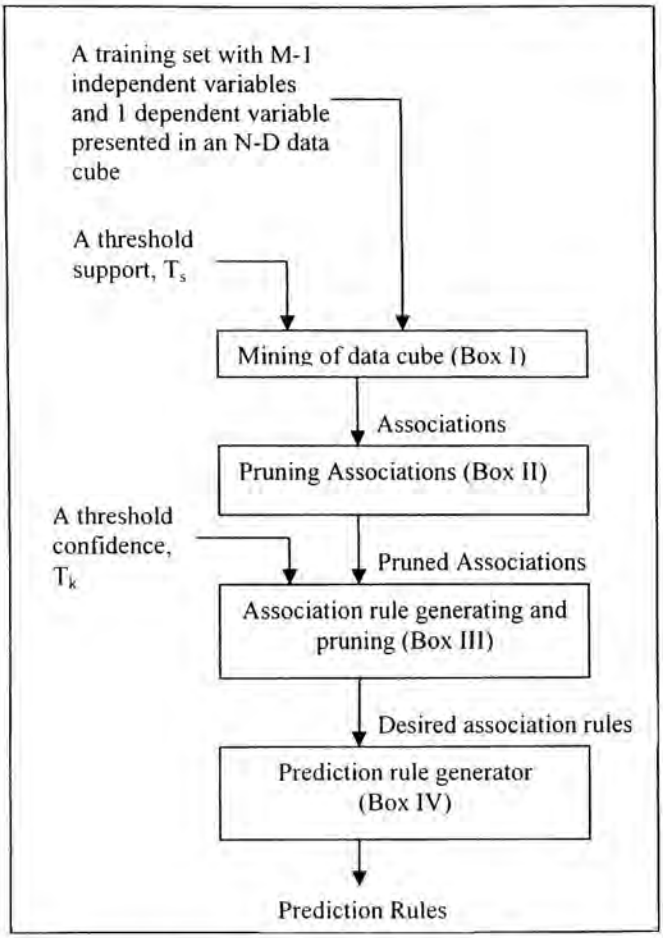


Figure 2: The block diagram of LEFAR.

To describe the behavior of the blocks in Figure 2, the following example is provided. In this example, there is a dataset with two independent variables of A and B and the dependent variable of C, like Table 1. Variables A, B, and C have possible discretized values of (a1, a2, a3), (b1, b2, b3), and (c1, c2), respectively. The data cube for this dataset is shown in Figure 1. All the possible associations for this dataset are:

0-D cuboids

()

1-D cuboids

{a1}, {a2}, {a3}, {b1}, {b2}, {b3}, {c1}, and {c2}

2-D cuboids

{a1, b1}, {a1, b2}, {a1, b3}, {a2, b1}, {a2, b2}, {a2, b3}, {a3, b1}, {a3, b2}, {a3, b3}, {a1, c1}, {a1, c2}, {a2, c1}, {a2, c2}, {a3, c1}, {a3, c2}, {b1, c1}, {b1, c2}, {b2, c1}, {b2, c2}, {b3, c1}, and {b3, c2}

3-D cuboids

{a1, b1, c1}, {a1, b1, c2}, {a1, b2, c1}, {a1, b2, c2}, {a1, b3, c1}, {a1, b3, c2}, {a2, b1, c1}, {a2, b1, c2}, {a2, b2, c1}, {a2, b2, c2}, {a2, b3, c1}, {a2, b3, c2}, {a3, b1, c1}, {a3, b1, c2}, {a3, b2, c1}, {a3, b2, c2}, {a3, b3, c1}, and {a3, b3, c2}

Table 1: A given dataset

A	B	C
a1	b3	c1
a1	b1	c2
a1	b3	c1
a2	b1	c2
a1	b3	c1
a2	b1	c2
a2	b2	c2
a2	b2	c2
a2	b3	c2
a1	b3	c1
a3	b1	c1

Considering a threshold support value 0f $T_s = 0.25$, Box I of Figure 2 delivers the following associations:

({a1}, s = 5/11), ({a2}, s = 5/11),
({b1}, s = 4/11), ({b3}, s = 5/11),
({c1}, s = 5/11), ({c2}, s = 6/11),
({a1, b3}, s = 4/11), ({a1, c1}, s = 4/11),
({a2, c2}, s = 5/11), ({b1, c2}, s =3 /11),
({b3, c1}, s = 4 /11), ({a1, b3, c1}, s = 4 /11).

We are interested in those associations in which the number of values is greater than one and they include either c1 or c2, but not both. As a result, the pruned associations (i.e. output of Box II in Figure 2) is the following set of associations:

({a1, c1}, s = 0.36), ({a2, c2}, s = 0.45),
({b1, c2}, s =0.27), ({b3, c1}, s = 0.36),
({a1, b3, c1}, s = 0.36).

Box III generates the association rules out of the above associations and keep those rules in which either c1 or c2 is in the right side of the implication symbol. The association rules with less than the threshold confidence value of $T_k = 0.7$ are removed. As a result the output of Box III (i.e. desired association rules) is:

$a1 \Rightarrow c1$, s = 0.36, k = 4/5 = 0.8
$a2 \Rightarrow c2$, s = 0.45, k = 5/5 = 1
$b1 \Rightarrow c2$, s = 0.27, k = 3/4 = 0.75
$b3 \Rightarrow c1$, s = 0.36, k = 4/5 = 0.8
$a1 \wedge b3 \Rightarrow c1$, s = 0.36, k = 4/4 = 1

In addition, Box III removes rule $a1 \wedge b3 \Rightarrow c1$ because either of the rules $a1 \Rightarrow c1$ and $b3 \Rightarrow c1$ can cover the rule $a1 \wedge b3 \Rightarrow c1$. Therefore, the final set of desired association rules are:

a1 $\Rightarrow$ c1, s = 0.36, k = 4/5 = 0.8
a2 $\Rightarrow$ c2, s = 0.45, k = 5/5 = 1
b1 $\Rightarrow$ c2, s = 0.27, k = 3/4 = 0.75
b3 $\Rightarrow$ c1, s = 0.36, k = 4/5 = 0.8

The output of Box IV is made of the following prediction rules:

If A = a1, then C = c1 k = 0.8
If A = a2, then C = c2 k = 1
If B = b1, then C = c2 k = 0.75
If B = b3, then C = c1 k = 0.8

4.0 Experimental Design and Results

The dataset on which the experiments are conducted is marine accident data collected by the U.S. Coast Guard for the lower Mississippi River for a period of five years. The records are categorized for two frequent types of accidents (i.e., collisions and ramming). The total number of records in the dataset is 330.

Table 2: The results of predictions using the proposed methodology and the discriminant analysis

Number and Percentage of Correct classification of records:		Learning Paradigms	
		LEFAR	Discriminant. Analysis
Test 1	#	36	33
	%	73.5%	67%
Test 2	#	37	30
	%	75.5%	60%
Test 3	#	33	29
	%	67.3%	59%
Test 4	#	32	33
	%	65.3%	67%
Average	%	70.4%	63.5%

We randomly selected 15 percent of the records for each accident type as a test set. The outcome was a test set with 49 records. The training set totaled 204 records in which the number of records for each type of accident is the same. We randomly generated four pairs of training and testing sets following the above strategy. The new paradigm was applied on every pair by learning from the training set and predicting the accident type of the records in the testing set. The results are shown in Table 2.

In addition, the prediction capability of the proposed learning paradigm (learning by association) was compared with the prediction capability of the discriminant analysis. This comparison was done by applying the discriminant analysis on the same pairs of training and testing sets. The results are also shown in Table 2.

5.0 Conclusion and Future Research

The results in Table 1 reveal that the proposed methodology, learning-by-association, seems to be a powerful prediction tool. In addition, this paradigm enjoys the existing technology for MAA — On-line Analytical Processing (OLAP) [7]. Since we have relatively mature OLAP technology that handles the data cube for a high volume of data, then the learning-by-association is an invaluable tool that can be added to OLAP technology. Such an addition makes the OLAP technology even more powerful.

There are association rules that have a biased interpretation, despite the fact that they have met both the threshold support and confidence values. Such association rules are *weak* rules. As future research, adding an extra layer of pruning to the proposed learning methodology to identify and remove the weak associate rules is under investigation. In addition, the use of formal concept analysis for the purpose of generating prediction rules is in progress. Furtheremore, the process of incorporating the extraction of prediction rules into a SQL-like data language usable in OLAP technology is planned.

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Local Economic Development Initiatives and Border Planning: The Huntingdon-Sumas Border Crossing

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This paper deals with the incentives for commercial development arising from economic discontinuities – in currencies, taxes, regulations and trade barriers – at border crossings, and will focus particularly on those related to the transportation system. These issues will be explored with reference to the Canada-U.S. border crossing between Huntingdon, B.C. and the City of Sumas in Washington State. In this context, the major cross-border discontinuity is the difference in allowable truck weights and dimensions between British Columbia and Washington State.

The existence of these incentives poses interesting problems in the planning and operation of border stations due to potentially differing national and local interests. Both the U.S. and Canadian governments have as an objective the facilitation of trade. This implies a commitment to maintaining a free flow of traffic across the border (insofar as this is consistent with other overriding priorities such as border security). Local governments on the other hand have an interest in maximizing their property tax base and attracting industry to boost the local economy. This is significant because (subject to overriding state or provincial government requirements) local governments have jurisdiction over land use. Where local interests dictate the development of traffic-generating activity in border crossing areas, cross-border traffic mobility may suffer. In fact the development of these areas may force additional investment along the border by the higher levels of government.

The Huntingdon/Sumas crossing is one of four major crossings serving B.C.'s Lower Mainland, second to Pacific Highway in terms of commercial traffic in the area. Over the last fifteen years,

Huntingdon/Sumas has experienced wide variations in the volume of both automobile and commercial traffic which have strained the capacity of border operations. This paper analyzes the impact of a local development initiative adjacent to the border crossing – the Sumas International Cargo Terminal - on the level of commercial vehicle traffic, and the impact on local traffic and border congestion.

Background

The four major border crossings connecting B.C.'s Lower Mainland to Washington State are illustrated in the map below[1]. They are, from left to right, Douglas/Peace Arch, Pacific Highway, Aldergrove/Lynden, and Huntingdon/Sumas. Peace Arch handles only automobile traffic. Pacific Highway is the fourth busiest truck crossing on the U.S.-Canada border. Trucks are also processed at the Aldergrove/Lynden and Huntingdon/Sumas crossing, though U.S. Customs limits southbound commercial traffic at Lynden to "permit" traffic (preregistered for the transport of specific commodities).



[1] Source: International Mobility and Trade Corridors (IMTC) Project.

There are two rail crossings. The Burlington Northern Santa Fe (BNSF) main line crosses the border at Peace Arch and continues all the way north to the Port of Vancouver's inner harbor. A BNSF branch line runs from the border at Sumas south to rejoin the mainline at Burlington. It connects to a CP Rail branch line at the border. The Southern Railway of B.C. (SRY) also connects to BNSF at this crossing. The crossborder rail network is shown below:[2]



The City of Sumas is a small community in Whatcom County situated on the border approximately 4 km south of the Trans-Canada Highway at Abbotsford. In January 1986, the Port of Bellingham – a municipal corporation of Whatcom County – approached the City of Sumas to annex the necessary land, amend the comprehensive plan and zoning ordinance, and provide necessary urban services for a proposed Sumas Cargo Terminal[3]. The port noted that development

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[2] Source: Cascade Gateway Rail Study Wilbur Smith Associates et al: IMTC Project December 2002.

[3] Sumas Cargo Terminal Patti Rao Associates Inc.; Report presented by Port of Bellingham to Mayor and City Council, City of Sumas, January 6, 1986.

of this facility was designed "to take advantage of the Sumas International Border Crossing and the extensive railroad network in order to capture a large segment of the international trade market ... the Sumas Cargo Terminal has potential for a number of rail and/or truck-oriented, containerized or bulk transshipments, including ... lumber, agricultural products, bulk transfer and ancillary uses such as light manufacturing and assembly."[4] The plan included a proposal for development of a Foreign Trade Zone adjacent to the site.[5] The Preliminary Development Plan envisioned construction of an intermodal transshipment yard for containers and other freight, warehousing and distribution facilities, and bulk transfer and storage facilities over a 10 to 12 year period.[6] The required land was annexed by the City of Sumas and the land was rezoned on April 14, 1986.[7] The Foreign Trade Zone authority for the site was granted to the Port of Bellingham by the U.S. Department of Commerce on September 10, 1986.[8]

There was apparently no consideration given to the capacity of the border crossing in planning the Sumas Cargo terminal. The Huntingdon/Sumas border crossing area is tightly constrained by existing infrastructure. It is bounded to the west by the CP Rail/BNSF rail track. On the Canadian side of the border it is bounded to the east by the Southern Railway Line, which actually approaches the border before curving northward through the border crossing area. When the SRY track is occupied, it blocks all traffic both northbound and southbound on the Canadian side of the border. Under normal operations, this occurs only for brief periods twice per day. The road approach to the border southbound is B.C. Highway 11, a two lane road which widens to three lanes just before reaching the U.S. Customs inspection station. The northbound approach to the border is along Cherry Street, the main street of the City of Sumas. A photo of

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[4] Ibid, Section B.

[5] Ibid, Section C.

[6] Ibid; Section 3 Preliminary Development Plan.

[7] Sumas City Council minutes April 14, 1986.

[8] Department of Commerce Foreign Trade Zones Board Order No. 335 51 FR 32238 September 10, 1986.

the border crossing area is shown below. The U.S. and Canadian Customs stations are in the top right; the Sumas Cargo Terminal is to the lower left along the road labeled Bob Mitchell Way.[9]



The existing U.S. Customs station has very limited capacity for commercial traffic. There is one commercial booth located on the western side of the station and very limited space for parking or inspection of trucks. If trucks need to be parked and opened for

[9] Source: Abbotsford-Sumas Border Improvement Project Final Report IMTC Project January 2003.

secondary inspection, they can block access for trucks waiting to access the booth, leading to lengthy delays.

The limitations of the Sumas border crossing for trucks were recognized in a study on the four Lower Mainland crossings which was done for the U.S. General Services Administration (GSA) in 1996.[10] That study recognized a "crisis" in border operations due to rapidly growing commercial traffic and expected recovery in automobile traffic, and suggested four potential options for rationalizing the operations of the four crossings. Three of those options included elimination or reduction of the role of the Huntingdon/Sumas crossing for processing trucks.[11]

As commercial traffic grew through the 1990's, this border crossing began to experience increasing levels of congestion, particularly in the southbound direction. One of the major problems related to the parking of trucks in the approach lanes as drivers left their vehicles and crossed the border to consult with U.S. customs brokers prior to approaching the U.S. Customs processing booth. Following completion of a joint U.S.-Canadian study on options for improvements at Huntingdon/Sumas[12], the Canadian and B.C. governments have undertaken a $2.7 million project to alleviate congestion caused by truck traffic at Huntingdon/Sumas. The project includes a truck staging area and separate approach lane(s) for trucks. This project is part of a $250 million package of joint federal-provincial border and trade corridor projects in the Lower Mainland. Federal funding is being provided through the Border Infrastructure Fund and Strategic Highway Infrastructure Program.

Factors Affecting Border Traffic at Huntingdon/Sumas

This crossing is affected by a number of factors, some of which are common to most major Canada-U.S. border crossings, and some which are unique to Huntingdon/Sumas.

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[10] Western Washington/Lower British Columbia Border Comprehensive Plan Thomas Hacker and Associates 1996.

[11] Ibid.,

[12] Abbotsford-Sumas Border Improvement Project Final Report IMTC Project January 2003.

The common factors include:

1. Exchange Rates

All of the Lower Mainland border crossings experienced significant levels of congestion due to high levels of automobile traffic from 1988 to 1992. This was generally attributed to Canadian cross-border shopping as the value of the Canadian dollar had risen sharply and many retail commodities could be purchased more cheaply in the U.S.. In 1991, the Washington State legislature acknowledged the difficulties facing border communities in coping with the influx by passing legislation allowing local communities to institute a one-cent per gallon tax on locally sold gasoline to fund infrastructure improvements.[13] The City of Sumas instituted local gas, sales and gambling taxes to boost their revenue. In 1993, Whatcom County's Overall Economic Development Plan expressed concern over the growing dependence of the county's economy on Canadian cross-border shopping, noting that "the powerful Canadian influence has created an inordinately large retail sector. Over 25 per cent of all Whatcom County jobs depend on this influence and 30 to 40 per cent of all retail sales depend on the Canadian retail shopper."[14]

The decline of the Canadian dollar through the 1990's substantially reduced cross-border shopping and the level of automobile traffic through the border crossings. The magnitude of the decline is suggested by a decline of 40% in local gas tax revenue in the border community of Blaine between 1992 and 1997[15]. It may also have had an influence in increasing the level of commercial traffic at the border due to its effect in increasing the competitiveness of Canadian

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[13] Cross-Border Shopping and Economic Activity in Whatcom County, Washington: Gasoline Service Stations 1988-98 David E. Merrifield and Paul Storer. Paper presented at the Pacific Northwest economic Regional Economic Conference, Boise Idaho, April 1999; p.17.

[14] 1993-1994 Overall Economic Development Program for Whatcom County State of Washington Prepared by Fourth Corner Economic Development Group in cooperation with the Whatcom County Council of Governments; May 1993.

[15] Merrifield and Storer, p. 19.

exports. The 1989 Canada-U.S. Free Trade Agreement and subsequently the implementation of the North American Free Trade Agreement in 1994 probably also resulted in increased trade in goods across the border.

2. Taxation

Border-related tax exemptions provide a market for duty-free stores.[16] The Duty Free store at Huntingdon is located between Highway 11 and the BNSF track on the Canadian side of the border. The need to ensure access (particularly for automobile traffic) is a complicating factor in management of traffic at the border.

3. Tariffs and Trade Barriers

The major cross-border trade impediment at the Huntingdon-Sumas has been U.S. quotas and duties on softwood lumber. From April 1996 to March 2001, Canadian shipments of softwood lumber were subject to quotas applied on a quarterly basis. Exporters were required to obtain export licenses from the Canadian government, and were required to pay export fees (in lieu of U.S. import duties) of US$50 per one thousand board feet (MBF) or US$100 per mbf for shipments over quota. This provided a strong incentive for shippers to ensure that their base quota was filled in each quarter, and that once that base quota was filled shipments were limited until the beginning of the next quarter. Following expiration of the Softwood Lumber Agreement, the U.S. imposed new countervailing and anti-dumping duties averaging around 27%.

4. Truck Size and Weight Regulations

One of the advantages cited for the Sumas Cargo terminal was its ability to accommodate trucks conforming to Canadian weights and dimensions regulations, which allow longer and heavier trucks than U.S. regulations. The Port of Bellingham's original proposal noted: "Due to the fact that Canadian authorities permit larger loads on their public roads than does the State of Washington, there is a need to transfer loads from Canadian trucks crossing at Sumas to American

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[16] U.S. provisions may be viewed on the U.S. Customs and Border Protection website at (http://www.cbp.gov/xp/cgov/travel/leavingarrivinginUS/vacation/know_brochure/dutyfree_exemption.xml)

trucks which meet the state's load restrictions. Alternatives presently under consideration include:

a. relaxation of state restrictions on existing Highway 9 (Cherry Street and West Front Street) between Customs and the Sumas cargo terminal and the proposed FTZ;
b. adding an additional lane to these same streets that are (sic) constructed to meet the standards of the Canadian systems; or
c. acquiring and developing a separate road from the Customs office to the Cargo Terminal and FTZ."[17]

In 1992 the Port of Bellingham received a grant from the U.S. Economic Development Administration to fund construction of a private road (Bob Mitchell Way) accessing the Sumas Cargo Terminal area.

Sumas Cargo Terminal Development

There are currently five major operating enterprises in the Sumas Cargo Terminal area:

1. Desticon Transportation Services operates a lumber reload centre which receives Canadian lumber products by truck and reloads them onto rail cars on the BNSF siding. Operations began in 1989. There is a small volume of reloading onto trucks for further U.S. distribution.
2. North American Reload Inc. established a similar lumber reload operation around five years ago.
3. IKO Pacific established a plant for the manufacture of asphalt shingles in 1998. The shingle plant's major inputs are granules, limestone and wrap.
4. The Sumas Energy 1 gas-fired cogeneration plant began producing power in 1993. Waste steam is used to dry lumber at a co-located lumber drying facility (Socco Forest Products).
5. CedarPrime Inc., a subsidiary of Interfor, operates a cedar siding plant on property leased from Socco. This plant was relocated from Fort Langley to mitigate the impact of U.S. duties in November 2002 and started production in February 2003.[18]

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[17] Sumas Cargo Terminal Section 3 Preliminary Development Plan.
[18] Timber West Journal Sept/Oct 2003.

Telephone interviews were conducted with operators of the facilities located in the Sumas Cargo Terminal to gather additional information. Based on these interviews, it appears that these operations generate approximately around 30,000 southbound truck trips per year, around 22% of the total. Lumber shipments on both sides of the border are generally carried on 8 axle double trailer Super- B train trucks. This configuration is legal in both B.C. and Washington State, but the lower Gross Vehicle Weight (GVW) limit of 105,500 lbs. in Washington State means that trucks carrying a full load of lumber cannot proceed past the border (or in the case of Sumas past the Sumas Cargo Terminal area).

A brief visual survey of the reload operations at Sumas indicates that a large portion of the lumber in inventory originates from interior mills, particularly on the Highway 97 corridor up to Prince George. (The lumber is wrapped in plastic, with the manufacturer's brand name and often the origin clearly visible.) This highway parallels the BC Rail line between Prince George and Cache Creek, which suggests a large portion of the lumber destined for the BNSF at Sumas is sourced from mills located on BC Rail.

It appears that the impetus for development of the reload centres was the availability of lower rail rates for lumber reloaded onto the Burlington Northern Railway. In addition to the Sumas operations, there is a reload centre just north of the border – Mountain View – which began operations in 1989. Rail cars loaded at this facility are transferred across the border at Sumas by SRY. Mountain View started their reload operations in 1986 with a reload centre in Chilliwack on the SRY track.

Impact of Sumas Cargo Terminal on Border Traffic

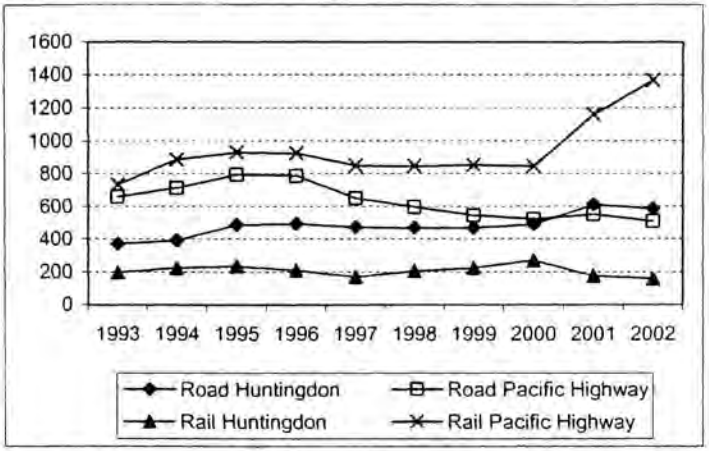
Data on traffic related to the border has been collected from various sources. Statistics Canada provides data on the volume of Canadian exports to the U.S.. U.S. Customs collects data on the number of commercial vehicles crossing the border southbound. In addition, there have been two cross-border surveys of truck traffic done in recent years.

Export Data

Canadian exports through Huntingdon/Sumas consist primarily of lumber products. There are essentially four options for exporting

lumber through the Lower Mainland crossings: by truck or by rail through either Pacific Highway or Huntingdon/Sumas. The relative levels of traffic by those options is shown below:

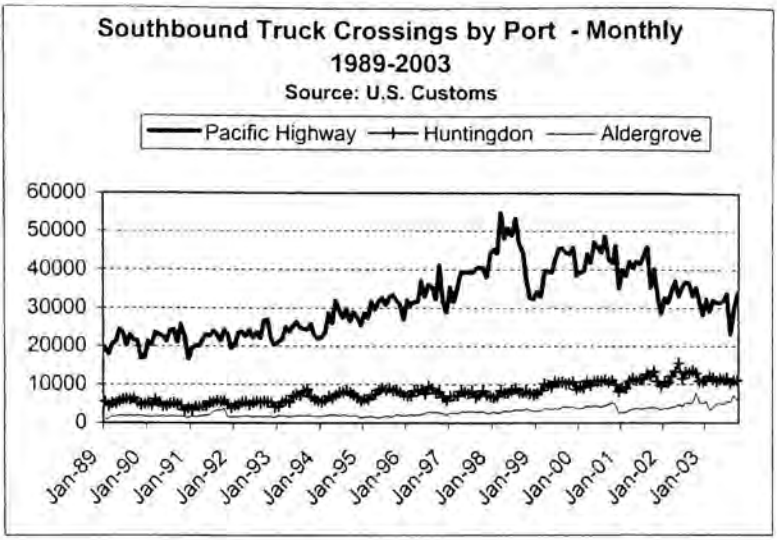
Lumber Exports by Port and Mode 1993-2002 (000 Tonnes)



The most striking feature of this illustration is the dramatic increase in rail shipments via Pacific Highway after at the end of 2001. This is due to the transfer of traffic destined for the Union Pacific (UP) Railway, which was previously transported to Seattle by barge from BC Rail tracks in North Vancouver. However, these figures do seem to show a shift in truck shipments from Pacific Highway to the Huntingdon/Sumas crossing, which has overtaken Pacific Highway as the largest exit port for lumber exports by road.

Border Crossing Data

U.S. Customs figures on trucks crossing at the Lower Mainland ports are depicted in the graph below. It shows steady growth in truck traffic at Huntingdon/Sumas, though the level still remains far below that experienced at Pacific Highway.



Truck Surveys at the Border

In the fall of 1999 data was collected as part of the 1999 Lower Mainland Truck Freight Study[19](LMTFS). Fifty surveys were completed on truck movements southbound to the Huntingdon/Sumas crossing. The responses included 4 trips destined for Sumas, all originating from nearby Fraser Valley locations.

Additional data was collected as part of the Cross-Border Trade and Travel Study [20]prepared for the International Mobility and Trade Corridors Project and the Whatcom County Council of Governments.

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[19] 1999 Lower Mainland Truck Freight Study Translink Strategic Planning Department July 2000.

[20] Cross-Border Trade and Travel Study Final Report and Analysis Results Prepared by Cambridge Systematics Inc. and TSI Consultants for the Whatcom County Council of Governments and the International Mobility and Trade Corridors Project September 5, 2001.

Surveys were conducted in the summer and fall of 2000. The results for the summer survey indicated 10 of 49 trips were destined for Sumas; 5 for IKO Pacific, 4 for Desticon, and 2 for SOCCO. Results for the fall survey indicated 3 of 47 trips were destined for Sumas, all to a reload centre.

If we focus on truck configurations, the LMTFS data indicates that 13 of 49 or approximately 27% of southbound trips used 8 axle trucks. However, the responses recorded for the destinations of these trips indicated that 10 of 13 were destined for points south of Sumas. The Cross-Border Trade and Travel Study aggregated configurations of "6 or more" axles so the data does not allow identification of Super B-Trains specifically; however 32% of southbound trips in the summer survey and 45% of southbound trips in the fall survey were recorded as "Tractor + 2 trailers" with 6 or more axles. Again, the majority of destinations recorded for these trips lay beyond Sumas.

In general, these surveys seem to indicate that the majority of truck movements destined for Sumas originate in the local area (i.e. the Fraser Valley). The small sample sizes suggest that these results are not robust; total daily truck trips southbound at Sumas in 2000 averaged around 338; total truck trips totaled over 123,000 for the year.

Conclusions

What conclusions can be drawn from this information? I suggest the following:

1. The difference in truck size and weight regulations between B.C. and Washington State has provided an incentive for the construction of reload facilities in the border crossing area. It seems likely that the reload facilities in the Sumas Cargo Terminal area account for around 10% of total southbound truck traffic. If traffic generated by the other developments in the Sumas Cargo Terminal area is included, the total may be as high as 25%.
2. The availability of lower rates on the BNSF Railway (before 1995 the Burlington Northern Railway) appears to be the major incentive for use of the reload operations in the border area. To the extent that lumber crossing the border is sourced from sawmills located east of Huntingdon/Sumas, the availability of the Sumas reload centres may be relieving traffic congestion on the Trans

Canada Highway to the west by making it unnecessary to travel further westward for reloading onto the BNSF main line.

3. The existence of the Mountain View reload facilities in Chilliwack and Abbotsford indicates that interchanging rail cars to BNSF via the SRY is a viable option for reducing truck trips at the border. SRY interchanges more traffic with BNSF in New Westminster than at Sumas. They are pursuing options for expanded reload operations in Chilliwack. If successful, this could save around one and a half hours driving time for truckers accessing the BNSF main line at peak hours, and reduce traffic congestion on the regional highway system and at the truck border crossings.

4. The reload centres provide value-added services beyond the benefits of accessing lower rail rates. These include inventory storage, repackaging, supply of rail cars, customs documentation, and other logistics services. The existence of the quotas under the Softwood Lumber Agreement from 1996 to 2001 provided an advantage to reload centres in Sumas because they provided a flexible option for producers to move their inventory across the border in a timely manner.

5. Though the Sumas International Cargo Terminal development has increased cross-border traffic at Huntingdon/Sumas, its location adjacent to the border crossing has not necessarily increased border congestion. The capacity of the crossing has been severely constrained because U.S. Customs commercial operations were limited to a single booth. Extension of the higher weight limits on Washington State roads may have allowed location of the reload centres farther away from the border crossing area but this would not necessarily make a difference to the number of trucks crossing the border.

In conclusion, in this case it appears that development of the Sumas Cargo Terminal adjacent to the border crossing has produced results which are entirely consistent with the broad national policy objective of facilitation of trade. The development of these operations in the Sumas Cargo Terminal area has provided Canadian exporters with valuable services and access to competitive freight rates.

Development of the IKO Pacific plant has resulted in the construction of a new mine by IG Machine and Fibres at Ashcroft to supply basalt

roofing granules. Of all of these developments, only the CedarPrime plant – which was relocated from a Canadian location due to the impact of U.S. softwood lumber duties – might be seen as a negative development from a Canadian perspective.

The increase in border traffic resulting from this activity must be seen as an inevitable consequence of increasing cross-border trade. The congestion that has resulted must be attributed to the failure of federal and provincial authorities to make timely improvements to border infrastructure and operations. Thankfully, this situation is being rectified through the joint B.C.-Canada border project, and increased staffing for U.S. border operations.

It might be possible to reach a different conclusion if this activity was drawing traffic away from an existing underused crossing – but this is not the case. The Pacific Highway crossing is currently the only alternative, and this crossing also experiences significant levels of congestion. In the longer term, it appears the best opportunity for increasing capacity for commercial traffic at the border lies in enhancing the role of the Aldergrove/Lynden crossing for processing trucks.

This example provides a valuable lesson in the need for more integration in planning of land use, commercial development, and infrastructure and operations at border crossings. Locally, significant progress has been made in this area. Since 1997, the International Mobility and Trade Corridors Project, a binational coalition of businesses and government agencies, has been engaged in coordinating planning activities at Lower Mainland/Washington State border crossings. This organization has successfully conducted several crossborder studies, and was instrumental in planning the current border crossing improvements at Huntingdon/Sumas.

The author would like to thank Hugh Conroy, Melissa Miller, and Gordon Rogers of the IMTC Project (Whatcom Council of Governments); David Davidson, City Administrator, City of Sumas; and numerous individuals involved in operations at the border for their assistance in gathering information for this paper.

THE INTERNET AS AN INFORMATION AND SERVICE-DELIVERY TOOL FOR CANADA'S CUSTOMS BROKERS

by

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Abstract

The operating environment of Canada's customs brokers continues to be challenging due to factors such as reforms by Canada Customs and Revenue Agency (CCRA), intense competition, and client demand for seamless/complete service packages. Greater use of Information and communication technology (ICT), especially Internet technology, remains a very highly recommended response to these challenges. That strong recommendation stems primarily from the capability of the Internet to facilitate service delivery, and to inform (potential) clients of a broker's service offerings. To ascertain the brokerage industry's use of the Internet to accomplish ends such as these, the websites of 49 customs brokers were studied in detail. The study addressed: (a) clarity of information about services, (b) completeness of service offerings, and (c) use of the Internet in service delivery. From analysis of the research data, the study highlights the industry's apparent strong and weak points as well as metrics that appear to separate top performing brokers from others. One of the study's key findings is that Internet usage by brokers for innovative services such as supply chain management and reverse logistics is significantly less prevalent than for traditional brokerage services such as preparing and processing international trade documents. The brokers' service packages for non-traditional services were also found to be considerably less comprehensive. This paper discusses both the practical and future research implications of the findings.

Introduction

Use of the Internet by a firm can be placed into two broad categories. One category is to inform interested parties about the firm, its people, its products/services, etc. This category, which is marketing oriented, was clearly dominant in the early days of commercial use of the Internet. The second category, which is of growing significance, is for the Internet to be an integral element in a firm's information and communication technology (ICT) infrastructure. This has a more operational focus, so it positions the Internet to function as an enabler of the firm's business processes. The following example illustrates the importance of both categories of use for customs brokers.

Consider a potential client such as a small company that is about to expand its operations into overseas markets and/or supply sources. To ascertain which broker provides the services required to support the company's import/export operations, that client may, as a start, do Internet-based comparison-shopping. In browsing a broker's site, the client would not wish to encounter any ambiguity about whether or not the customs broker provides the requisite services, and would be impressed if the broker's service package is complete. Additionally, given the value that effectively deployed ICT can bring to the various import/export processes, it is likely that the client would also be impressed with a broker that seems competent in ICT/Web usage for these processes. It is with this background in mind that the present research was conducted to assess service package comprehensiveness of Canada's customs brokers, as well as these brokers' effectiveness in using the Internet to:

(a) inform (potential) clients of their service offerings, and

(b) enable performance/delivery of the international trade services that any client would expect.

The research involved a detailed examination of the websites of 49 brokers listed among the membership of the Canadian Society of Customs Brokers (CSCB). The remainder of this paper reports on the research as follows. The next section provides an overview of the operating context of Canada's customs brokers, with specific

reference to the existing literature. After the overview is the section describing the research methodology. Following that section, the findings, as well as their major insights, are presented and discussed. A section focusing on the research study's key practical and research implications then precedes the paper's conclusions.

Background and Overview: Customs Brokerage in Canada

The contemporary environment in which Canada's customs brokers operate is characterized by ongoing customs reforms by the Canada Customs and Revenue Agency (CCRA), increasingly sophisticated client demands on providers of services to support international trade operations, intense competition among providers, and rapid advances in ICT. Many articles have appeared in the trade press about how these characteristics are impacting the customs brokerage role. A few examples of these articles include Briggs (1997), Mark (1997, 2001), Tausz (2000), West (2000) and Woods (2000). Following the much quoted "automate or perish" line attributed to former US Customs Commissioner, William von Raab in the late 1980s, a common theme in many of these articles is the need for contemporary brokers to "reinvent" themselves or risk their own demise. Although some prognosticators have boldly predicted the utter elimination of the (Canadian) customs broker, more thoughtful analysis suggest that even if the end of customs brokerage as a genuine *industry* can be envisaged, displacement of customs brokerage as a global trade logistics *process/service* is quite improbable (Sowinski, 2002).

In the various articles, the strong advocacy for ICT as a way to raise the likelihood that brokers will "reinvent" themselves successfully is not surprising. For one there is a very heavy ICT emphasis in the various CCRA initiatives (see Table 1). Further, ICT is central to the value proposition of the formidable non-traditional competitors such as Toronto-based Management Systems Resources (MSR) Ltd., Vastera, and Open Harbour. Still, two caveats are in order. First, is that meaningful ICT implementation is rarely easy or inexpensive, and second is that some brokerage processes might not be readily amenable to automation.

In fact, a report by Roberts (2000) on ICT issues among providers of electronic-based support services for global logistics operations offers emphasizes caution concerning the likelihood of various processes becoming commoditized (widely available) and digitized (deliverable via the Web or other digital means). Roberts suggests that apart from broker services involved in export trade compliance, commoditization and digitization is not currently likely for many other services. These include import trade compliance as well as more non-traditional services such as landed costs, supply chain management, reverse logistics, and duty drawbacks. Those opinions comprise relevant reference points for the present study's findings.

Table 1: A Sample of Recent Initiatives Affecting Customs Brokerage Processes in Canada

1. ACI (Advance Commercial Information)
2. ACROSS (Accelerated Customs Release Operations System)
3. AMPS (Administrative Monetary Penalty System)
4. CDRP (Commercial Driver Registration Program)
5. CCEP (Commercial Cash Entry Processing System)
6. CIG (Customs Internet Gateway)
7. CRP (Carrier Reengineering Program)
8. CSA Plan (Customs Self-Assessment Plan)
9. CSCB Gateway
10. C-TPAT (Customs-Trade Partnership Against Terrorism)
11. EXCAPS (Foreign Affairs Automated Permit System)
12. FAST Initiative (Free and Secure Trade Initiative)
13. FIRST (Frequent Importer Release System)
14. PARS (Pre-arrival review system)
15. PIP Programs (Partners in Protection Programs)
16. PVI (periodic verification Initiative)
17. RMD (Release on Minimum Documentation)
18. SBCL (The Small Business Customs Library)

Primary Sources: CCRA Website and Newsletters/periodicals by Canadian Customs Brokers

Research Methodology

This section describes the research procedures concerning sample selection, the data gathering instrument, and data collection/analysis.

Sample Selection

Using the membership listing at the Web site of the Canadian Society of Customs Brokers (CSCB), the process started with the creation of a sample frame of 56 brokers. Given the study's focus on the role of the Internet as both an informational and service delivery tool, the frame of 56 reflected a methodological decision to focus on customs brokers that had a functional website with more than just a home page. From the 56, seven (7) were excluded from the study because their websites were not deemed to be useful in providing meaningful data for the research. In particular, these websites had no more than an extra page or two beyond the home page and had very basic content such as contact information and a few generic promotional statements to the effect that they "can handle your customs brokerage needs". This left 49 websites to undergo detailed study.

Research Instrument

Based on previous studies and reports such as that by Roberts (2000), this author derived 6 main categories of global trade support services for processes starting when goods leave an exporting nation's shipper and ending upon receipt by the importing nation's recipient. Each category, which in effect covers services for "*(forward) international logistics processes*", were then broken down into specific constituent services to yield 37 specific services. Table 2a shows the categories and examples of specific services that fall under one of them. Also specified and then further dissected were four categories of services for "*post-transactional processes*". They were labeled as such since they normally occur outside (often after) the standard forward flow of import/export transactions. Table 2b lists the four categories and shows a sample of specific services that fall under one of them (17 services were specified). The structure in Table 2a and 2b comprised the data collection instrument (covering three questions Q1-Q3), which was maintained in electronic spreadsheet format to facilitate recording and subsequent processing of the data. Appendix A and B define the 10 service categories used in the study.

Table 2a: Categories and Examples of Services that Support Forward International Logistics Processes

1. Export Trade Compliance	**Q1**	**Q2**	**Q3**
Peruse export regulations			
Determine required documents			
Obtain required documents			
Classify products correctly			
Complete/validate documents			
Submit documents to authorities			
Conduct denied party screening			
Conduct embargo screening			
Verify legality of the export			
2. Import Trade Compliance			
3. Generate Trade Documents			
4. Landed Costing			
5. Arrange/Manage Transportation			
6. Supply Chain Management			

Table 2b: Categories and Examples of Services that Support Post-Transactional Processes

1. Reverse Logistics	**Q1**	**Q2**	**Q3**
2. Duty/Tax Drawback			
Obtain relevant regulatory information			
Obtain product data			
Assess product qualification for drawback			
Prepare the drawback application package			
Submit application for drawback			
3. Compliance Auditing			
4. Management Reporting			

Data Collection and Analysis

Using the said instrument, data collection involved detailed perusal of the websites for each of the 49 selected customs brokers. This took place from January to July 2003, and sought to answer the following questions for each of the 54 specified support services:

Question 1:	Does the broker explicitly claim to provide this service for clients?
Question 2:	If not explicitly stated, can it be inferred that the broker provides the service?
Question 3:	Are the "digitally performable" components of the service performed via the website?

Once the responses (Yes, No) were recorded in the spreadsheet, pre-programmed formulas generated three metrics for each broker for each of the 10 support service categories. One metric was for clarity of website information on the services, a second metric was for comprehensiveness of the broker's service offerings, and a third for the extent of the broker's use of the Internet in service delivery; i.e., questions 1, 2, and 3 respectively. The resulting data were then subjected to statistical analysis/testing and organized to yield a profile of Canada's customs brokerage industry. Since the data distributions were found to be non-normal, all statistical tests had to be of the non-parametric variety. Findings from these analyses and the resulting inferences are presented in the next section.

Findings and Discussion

Industry-Wide Analysis: Industry Strengths and Weaknesses

Table 3 presents the overall means and standard deviations for the three metrics. In using these results to identify the industry's strengths and weaknesses, two conspicuous patterns emerge. First, the clarity of website information is impressive in relation to the other metrics. For example, for 78.9% of all the specified forward logistics services and 86.1% of all the specified post-transactional services, the typical broker's website adequately clarifies whether or not those services are provided. Thus, it is not very likely for the visitor to

customs broker's website would be left in an uncomfortable guessing situation about what services are available or not available. However, with respect to the metrics that may be far more important –(1) the completeness of the service package and (2) the use of the Internet in service delivery– the results were less impressive. For example, the average broker provides only 59.7% of the services for forward logistics processes (24.2% for post-transactional processes) and only about 12.9% of the forward logistics support services are Internet-enabled (2.3% for post transactional services).

Table 3: Means and Standard Deviations for Indices of Clarity, Completeness, and Internet Delivery of Service Offerings

	Clarity	**Completeness**	**Internet Delivery**
Forward logistics processes	0.789 (0.212)	0.597 (0.22)	0.129 (0.169)
Post-transactional processes	0.861 (0.152)	0.242 (0.156)	0.023 (0.076)

The second pattern is that the industry is weaker on post-transactional processes than on forward logistics processes. This was supported by the Wilcoxon signed rank test of paired differences. The test found the margins by which the forward logistics metrics (except clarity) exceeded the post-transactional metrics to be statistically significant (p-values < 0.0001). Thus, Table 3 suggests that in relative terms, completeness of service packages, Internet usage in service delivery, and post-transactional services are areas with room for improvement.

Table 4 and Table 5 reinforce these suggestions and elicit additional insights. These tables provide further details on the metrics for, respectively, the six forward logistics service categories and the four post-transactional service categories. The key insight from Table 4 is that with respect to service package completeness and Internet usage, the metrics for the three categories of conventional customs broker services (import and export compliance, and trade documentation) are better than the metrics for the non-conventional brokerage services such as supply chain management. Table 5 underscores this insight

as the post-transactional services –none of which is conventional for the typical customs broker– all have relatively unimpressive metrics for completeness and Internet usage. These findings cast an interesting light on current beliefs (e.g., Roberts, 2000) about what services are likely to become commoditized (widely available) and deliverable via the Internet (and/or via similar digital channels).

On one hand, the findings provide overall corroboration for the belief that less conventional services are less likely to become digitized and commoditized. Yet at the same time, the findings suggest that a conventional service that some believe is difficult to digitize –import trade compliance– may not be very far from becoming digitized. An underpinning of this common belief is that digitization is harder for trade compliance services on the import side than on the export side because of greater complexity and enforcement rigor of import rules. However, the index for Internet-delivery of import trade compliance services was found to be statistically equal to the corresponding index for export trade compliance (p-value = 0.442 for the Wilcoxon test on the paired differences). So, at least relative to export compliance, the study detects some signal that import trade compliance may be more digitally deliverable than is currently believed.

Another noteworthy insight is that among post-transactional services, duty drawback is the most complete category. On average, 31.6% of those services are available from a broker, compared to the next largest value of 22.7% (for reverse logistics). This may be due to a growing resolve by brokers and their clients to act on the knowledge that retrieval of deserved customs duties is a highly rewarding source of cost recovery in a client's global trade operations.

Performance Differentiators Across Brokers

Table 3 presents the overall means and standard deviations for the Determination of which metrics most significantly distinguish the top performing brokers from others in the industry was based on the size of the difference between each metric's observed maximum and its mean across all 49 brokers. That criterion was chosen over the more established criterion and the maximum/mean ratio criterion because it

provided the clearest indication of how much the few top performing brokers distanced themselves from the other brokers. Table 6 shows the metrics that have the 5 largest maximum-mean differences. This table suggests that the capability Web-enable service delivery is a key source of differentiation among Canada's customs brokers. Further, since 4 of the 5 metrics are associated with non-conventional service categories, it appears that competence in non-conventional services is also a major differentiator. Not surprisingly, the main differentiators have the lowest industry-wide metrics (See Table 4 and Table 5). This shows that even with weak industry-wide performance, there are customs brokers who stand well above their industry peers.

In summary, the research findings suggest that efforts by Canada's customs brokers to use the Internet as a tool to clarify their service offerings have produced quite impressive results. However, another signal from the findings is that most brokers are on shakier ground with respect to Web/Internet service delivery and comprehensiveness of their service packages. This signal is especially strong for services that have not traditionally been among the typical customs broker's offerings. Despite seemingly unimpressive industry-wide metrics for these services, there are brokers with metrics that significantly exceed the industry averages.

Table 4: Means and Standard Deviations for Indices of Clarity, Completeness, and Internet Delivery of Specific Forward International Logistics Services

	Export Comp.	**Import Comp.**	**Gen. Trade Docs**	**Calc. Landed Costs**	**Manage Global Transp.**	**Supply Chain Mgmt.**
Clarity	0.713 (0.218)	0.714 (0.223)	0.792 (0.246)	0.805 (0.218)	0.823 (0.169)	0.883 (0.139)
Completeness	0.645 (0.196)	0.631 (0.209)	0.674 (0.229)	0.547 (0.260)	0.546 (0.186)	0.540 (0.200)
Internet Delivery	0.130 (0.160)	0.121 (0.146)	0.182 (0.229)	0.112 (0.188)	0.117 (0.123)	0.111 (0.146)

Table 5: Means and Standard Deviations for Indices of Clarity, Completeness, and Internet Delivery of Specific Post-Transactional Services

	Reverse Logistics	Duty/Tax Drawbacks	Compliance Auditing	Management Reporting
Clarity	0.872 (0.140)	0.848 (0.146)	0.859 (0.161)	0.865 (0.164)
Completeness	0.227 (0.131)	0.316 (0.135)	0.208 (0.160)	0.217 (0.173)
Internet Delivery	0.017 (0.057)	0.021 (0.064)	0.016 (0.059)	0.040 (0.110)

Table 6: Metrics With the Five Largest Differences Between Best Broker Performance and Mean Broker Performance

Metric	Mean	Max
1. Internet usage in Trade Documentation Services	0.182	0.800
2. Internet usage in Supply Chain Management Services	0.111	0.630
3. Internet usage for Management Reporting Services	0.040	0.500
4. Comprehensiveness of Landed Cost Services	0.547	1.000
5. Comprehensiveness of Compliance Audit Services	0.208	0.650

Implications: Practice and Research

Implications for Practice

One implication that can be drawn from this study' findings is that if one were to seek out potential targets for efforts to sharpen customs broker's response to today's dynamic global trade landscape, the targets would include Web-enabling service delivery and expanding service portfolios. A second and closely related implication is that the potential for such efforts to succeed is not farfetched. That is because a few brokers have shown, for example, that Web-enabling of service delivery can be at a higher level than where the majority of brokers are operating. A third but contrasting implication is that since the majority of brokers appear to be operating at lower levels of

Web-enablement in service delivery and offering less than complete service portfolios then some of them may be doing so either by deliberate choice or circumstances.

The point here is that a low-technology stance might not be a worthwhile target for improvement because for some brokers, that stance works for their clientele and their chosen niches. For example, the research encountered websites where brokers promoted their specialization (expertise) in handling special project cargo[1]. The significance of this observation concerns the ad hoc nature of those customs brokerage services, as well as their significant need for domain expertise and personal touch. Because that type of expertise and personal touch might be very difficult to automate, Internet-enablement of service delivery would probably not be a very value-adding undertaking for those brokers. Similar anecdotal information encountered in studying the brokers' websites suggests that there are exceptions to William von Raab's generally valid "automate or perish" logic since many Canadian brokers appear to be defying that logic with viable low-technology operations.

Research Implications

By using pre-existing information presented at the brokers' websites, this study's data gathering methodology falls within the general class of methods known as archival (see, Berg, 2001 and Sarantakos, 1998 for discussions of these methods). This raises the possibility that the research has produced a picture suggesting a different level of ICT capability than what truly exists. For example, some brokers might be delivering some services by digital channels other than the Web, a phenomenon not covered in this paper. The use of non-Internet ICT in service delivery represents an area that deserves some treatment in the future. Three other areas were also identified as potentially fascinating areas for extending the work reported herein. First is considering geographic scope to ascertain whether the top performing

[1]Unlike the standard import/export movement associated with buy/sell transactions, project cargo generally involves temporary international movements of equipment, etc., to handle finite duration assignments such as concerts, movie production, and coverage of sporting events.

brokers are those that tend to have more global customs brokerage operations. A second area would involve replicating the study among customs brokers based in other countries and among the non-traditional competitors (e.g., MSR Ltd., Open Harbour, and Vastera) in order to compare them with the brokers in this research. A third area concerns the testability and functionality of the services such as document generation. For example, when a broker claims that the document generation/production process is fully automated and Web-enabled, can the potential client test this claim by downloading and completing the document on line?

Conclusions

To the best of this author's knowledge, this study represents the first attempt to systematically gauge the role of the Internet for customs brokers operating in Canada. The study detected more impressive results in Internet usage for information purposes than for service delivery purposes. Despite these relatively unimpressive industry-wide results, the research evidence suggests that some brokers have a significantly higher level of Internet competence than the majority of brokers. The study also detected some signal that for some customs brokers, low levels of service delivery automation may be defensible. The paper identifies the study's practical implications as well as its future research implications. These include the need to examine the issue of digital service delivery via non-Internet channels.

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APPENDIX A

Definitions of Service Categories for Forward Logistics Processes

1. Export Trade Compliance *Ascertain all legal documentary requirements (trade licenses, etc.), and ensure that all documents are complete and correct as per export regulations, and that the export is compliant with these regulations; e.g., via restricted/denied party screening.*
2. Import Trade Compliance *Reference import regulations to ascertain all legal documentary requirements (e.g., customs invoices, NAFTA certificates); ensure that all documents are complete, correct, submitted/filed according to compliance regulations (e.g., duty/tax calculations and product classifications) and that the other requirements for customs clearance (e.g., payment of duties) are satisfied.*
3. Generate Trade Documentation *Obtain/complete international trade documents such as invoices, packing list, and certificate of origin; submit documents to appropriate parties (e.g., banks, carriers)*

4. Landed Cost *Calculates the landed cost (including duty/taxes, and other fees).*
5. Arrange/Manage International Transportation *Book domestic and international transportation with a view to meeting desirable goals such as cost-effective and timely delivery by selecting appropriate carriers, ensuring optimal transportation routes and optimal equipment utilization, etc*
6. Manage global supply chain *Handle flows of product into, within, and out of facilities as it changes time, place, and form. Among these flow management activities are receiving, pick-and-pack, consolidation, and light final assembly/manufacturing. Provide visibility of the flow (e.g. through digital means such as Web-based track and trace).*

APPENDIX B

Definitions of Service Categories for Post-Transactional Processes

7. Reverse Logistics *Ensuring satisfactory completion of the processes involved in when facts dictate consideration of international returns and repairs; i.e., a reverse of the standard transactional process.*
8. Duty/Tax Drawback *It is not uncommon for an import to warrant remission or drawback of customs duties/taxes from Customs authorities; e.g., when goods enter a free zone to be processed for re-export or when goods are otherwise temporarily brought into a country. A key element in the recovery the duties/taxes from the authorities is access to the information to authenticate the drawback request.*
9. Compliance Audit *The CCRA has adopted a policy of relying more heavily on post-transaction audits of importers' (and exporters') international trade records to ascertain compliance. Brokers with the expertise can provide the client with a simulated audit to help identify and correct sources of potential non-compliance.*
10. Management Reporting *By analyzing historical records of transactions (recent and long term) on items such as rates on current and past shipments, release notification dates, etc., some brokers serve as consultants to advise clients on improving their global supply chain operations.*

The Edmonton and Calgary Aviation Markets—A Tale of Two More Cities

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Introduction

Passenger air traffic movements in Calgary and Edmonton were roughly equal in 1963 but, since that time, the Calgary market has grown much larger than that of Edmonton. This Paper examines a number of factors, as well as differences in the airport infrastructures in the two cities, to explain the different air traffic growth patterns. Very similar to the debate over Montreal (Dorval/Pierre Elliott Trudeau airport and Mirabel airport) versus Toronto (Pearson airport),* the reasons for growth in the aviation markets of Calgary and Edmonton (International airport and City Centre airport[1]) often returned to the debate over a divided aviation market as the result of two airports versus one at their major competitor. In both Montreal and Edmonton, it was often suggested that if flights could be consolidated into one airport, they would cease to lose "market share" to the competing aviation market. This paper will examine possible reasons for the differences in the aviation passenger growth in these two major Canadian markets. While the often cited factor was multiple airports, this analysis will pay particular attention to the major socio-economic variables used in airport passenger forecasting

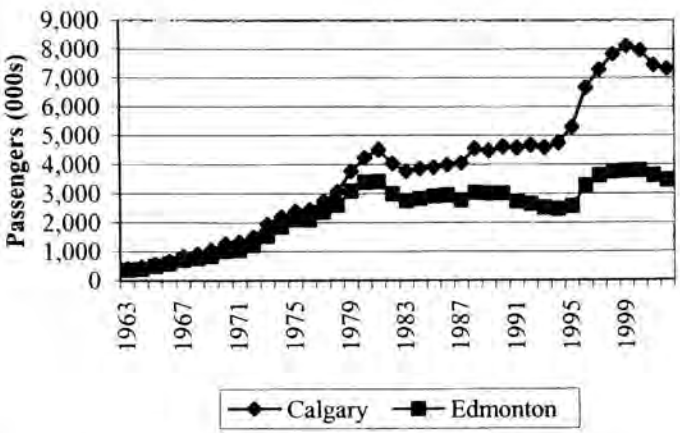
*Gordon Baldwin, The Toronto and Montreal Aviation Markets—A Tale of Two Cities, CTRF Proceedings 1997

by Transport Canada, the US Federal Aviation Administration and others to see if they help to explain the different growth patterns.

Trends in the Calgary and Edmonton Aviation Markets

The total number of passengers enplaned and deplaned at Calgary and Edmonton (International airport and City Centre airport) were similar in 1963. It is shown in Chart 1 that the growth in both tracked quite similarly until the late seventies. The two markets have diverged since, in good times and bad with the passenger volumes at Calgary eclipsing those at Edmonton.

Chart 1 - Enplaned and Deplaned Passenger Traffic, Calgary and Edmonton, 1963-2002



Source: Statistics Canada, Catalogue no. 51-203, Statistics Canada/Transport Canada Internal Reports, Statistics Canada, Catalogue no. 51-501

In 1963, Calgary's enplaned and deplaned passenger total of 425 thousand was 15% greater than that of the combined total of 369 thousand at the two Edmonton airports. By 2002, the number of passengers handled at Calgary exceeded the passengers handled at Edmonton by 3.9 million passengers, 111% greater.

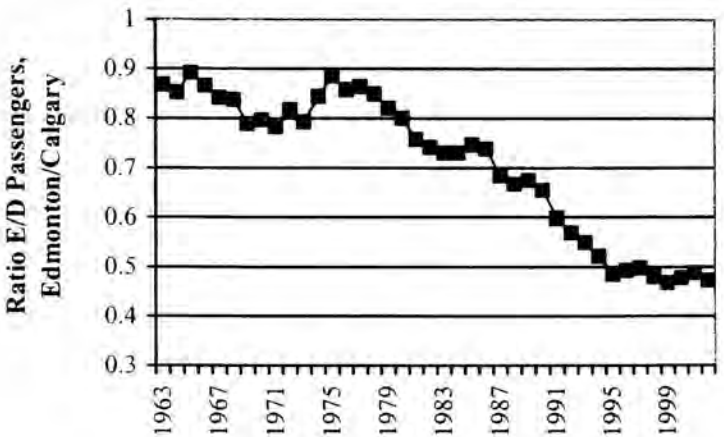
In a 1995 plebiscite, Edmontonians voted to consolidate air passenger service at Edmonton International, which took place in 1996. Many had felt that the frequency of the downtown Edmonton to Calgary air service operated out of the Edmonton City Centre airport funnelled passengers from Edmonton on to the major routes of carriers operating to or from Calgary. Editorials prior to the plebiscite stated that the move to one airport in Edmonton would result in "Edmonton regaining much of the traffic that has been bled off in the past to Calgary".[2] The reason for the loss of traffic was often given as "the presence of two [airports] is splitting our traffic. Instead of using the economies of scale, putting all travellers through one airport, we divide our own market".[3]

The inconvenience of passenger transfers between airports, often cited in the Montreal versus Toronto debate, also was heard here: "With the current two airport situation, passengers who don't want the hassle of being shuttled between airports find it more convenient to bypass Edmonton and make their connections at Calgary instead".[4] The Edmonton Chamber of Commerce stated that "The prospect of [airport] consolidation was an important factor in the planning and decision-making behind the announcements of Royal Airlines, Horizon and Westjet to serve the Edmonton market...".[5]

Chart 2 shows the passenger traffic at Edmonton (both airports) relative to the enplaned and deplaned passenger traffic at Calgary over the period 1963-2002. The declining aviation market of Edmonton relative to Calgary's aviation traffic is shown from the mid-1970's on. Are there explanations other than the often cited "two airports" issue which could help explain this decline? The decline has appeared to flatten in the mid to late 1990's, the period following the movement of most commercial aviation passenger traffic from

Edmonton City Centre airport to Edmonton International airport. This may support the position of those that the "two airports" scenario in Edmonton was a major cause for the growth of the aviation passenger market in Calgary at the expense of the Edmonton market. In this paper, the focus will be an examination of the socio-economic variables used in aviation forecasting models in an attempt to determine if there were underlying socio-economic trends that help to explain the different aviation passenger trends.

Chart 2 - Ratio of Enplaned and Deplaned Passenger Traffic, Edmonton/Calgary, 1963-2002



Source: Aviation Statistics Centre, Statistics Canada

Factors Affecting Air Traffic Growth

Both Transport Canada and the Federal Aviation Administration (FAA) have developed top-down forecasting models for aviation. The models are national rather than airport/city specific and tend to use aggregate variables. Among the key socio-economic variables considered for their forecasts are[6]:

- Adult Population (those older than 20) (Transport Canada and FAA);
- Gross domestic product (Transport Canada and FAA);
- Personal disposable Income (Transport Canada and FAA).

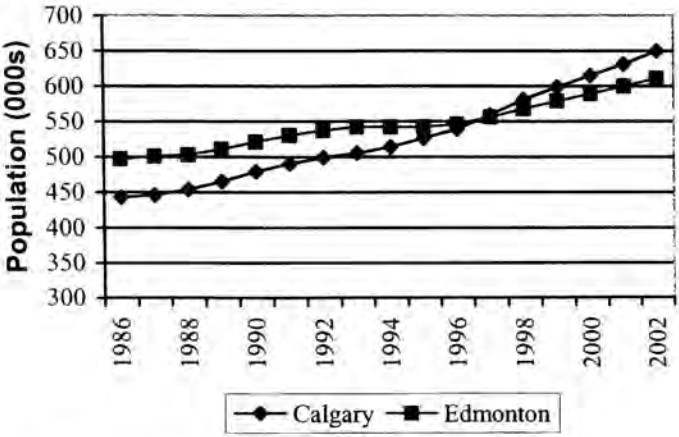
The trends for these variables or proxies for these variables will be examined for the Calgary and Edmonton markets to see if they may explain the different trends observed in these two areas of Alberta.

Population

Population is an important determinant for demand for air travel as a large population centre can generate more origin-destination traffic by the nature of the population around the airport region. The domestic origin-destination passenger total for Calgary grew 24.6% from 1986 to 1996 and a further 7.4% from 1996 through 1999. Edmonton's market declined 5.7% and 1.3% during the same periods. The Canada-United States (transborder) origin-destination data showed a similar picture with Calgary increasing 114.1% from 1986 to 1996 and a further 18.9% from 1996 through 2000. Edmonton's transborder market grew at 72.7% and 10.5% respectively.[7]

In Chart 3, it can be seen that the population trends between the two cities have been relatively constant, both growing with Calgary passing Edmonton only in 1996 for the population aged 20-64. It would appear that population alone would not explain the difference in the larger Calgary aviation market.

Chart 3 - Census Metropolitan Area Population, Edmonton and Calgary, Age 20-64 years, 1986-2002

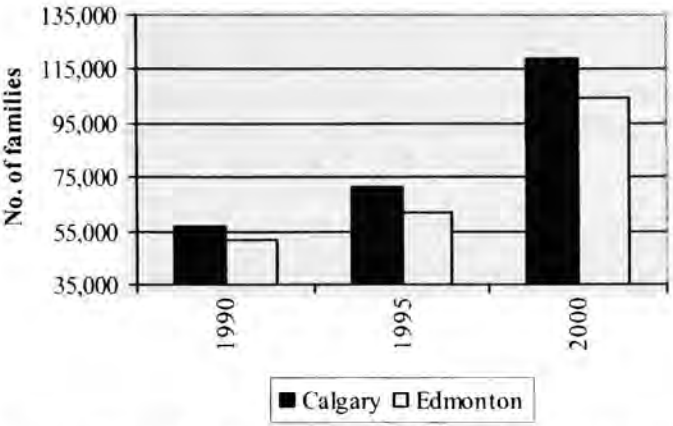


Source: Statistics Canada, CANSIM Table 051-0016, 1996 census boundaries

Income

There is a strong relationship between income and the propensity to use aviation travel. Transport Canada has tried using "average per capita personal income" and "average family income" as the variables to represent "income" in their aviation forecasting models. "There was no significant difference in the performance of the model, whichever of these highly correlated variables was used".[8] The Federal Aviation Administration states that "Non-business travel has grown over the years [as] the incomes of average Americans have grown".[9] The Canadian Transport Commission also concluded in a study on inter-city air travel that the "proportion increased steadily with income".[10]

Chart 4 – Census Families with Family Income $70,000 and over, Calgary and Edmonton, 1990, 1995 and 2000



Source: Statistics Canada, Profiles of Census Tracts catalogues 95-375 and 95-378, 1991 Census; 95-209 and 95-210, 1996 Census; 95F0495XCB01004, 2001 Census

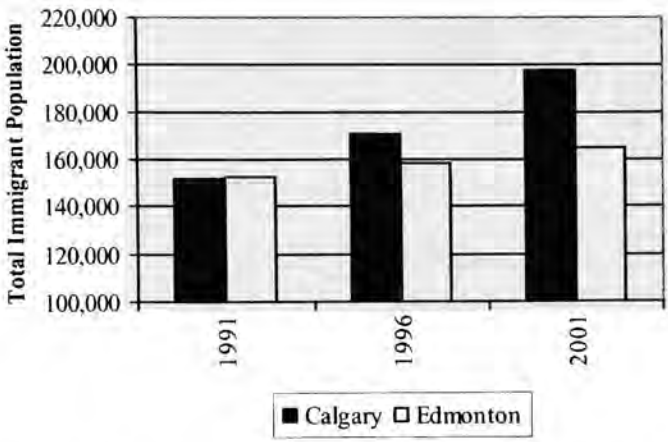
Chart 4 shows that at the time of the 1991, 1996 and 2001 censuses, Calgary had more Census families[11] with family income of $70,000 or greater than did Edmonton. With a higher income is a higher propensity to travel by air. This should favour the demand for air travel from Calgary over that generated by the Edmonton market.

Immigration

Immigration is a variable not used by either Transport Canada or the FAA in their forecasting models but which may be another important variable explaining the aviation markets.[12] The 1991, 1996 and 2001 Census data indicate that both Calgary and Edmonton census metropolitan areas have been somewhat influenced by immigration.

As can be seen in Chart 5, in 2001, the total immigrant population in Calgary stood at 200 thousand, up 30% from a decade ago. In 2001, the foreign-born people represented 21% of the total population[13] in Calgary. This compares to an immigrant population of 165 thousand or 18% of the total population in Edmonton. Between 1991 and 2001, the total immigrant population in this city grew by only 8%.

Chart 5 - Total Immigrant Population, by Census Metropolitan Areas, Calgary and Edmonton, 1991, 1996 and 2001

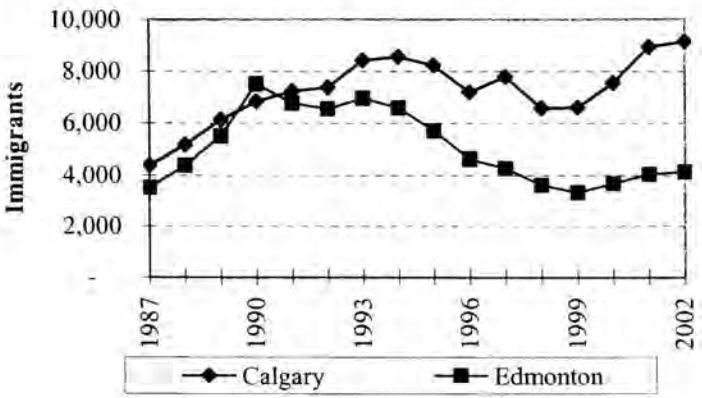


Source: Statistics Canada, Catalogue nos. 93-338 - 1991 Census, 95-209-XPB and 95-210-XPB - 1996 Census, and 95F0495XCB01004 - 2001 Census

Chart 6 depicts the annual immigration during the period 1987-2002. As it can be seen, during this period, the foreign-born population in Calgary exceeded that in Edmonton, except in 1990. Since then, the gap between the two cities has widened, and by 2001, the new immigrants favoured Calgary in a proportion of two to one.

This could help to explain the differences seen in the aviation growth in the two markets: "recent immigrants with a high propensity to generate international travel to their countries of origin (at least for the first and second generation)". [14] The Visiting Friends and Relatives (VFR) market would tend to be positively influenced in two ways in a market with a larger proportion of foreign born residents. This could have a stimulative effect on new Canadians returning to visit their countries of origin. A large immigrant community could also be a draw for those from the "home country" to visit relatives in Canada.

Chart 6 - Immigration by Census Metropolitan Area, Calgary and Edmonton, 1987-2002



Source: Statistics Canada, CANSIM Table 051-0015

Migration

Migration data, derived by comparing addresses supplied on personal income tax returns, indicate that Calgary has a very mobile population.[15] The net migration rate of 17.7 per 1,000 population, led all other census metropolitan areas in Canada, including Edmonton, in 2001/02. Table 1 shows the net migration figures for Calgary and Edmonton for a five year period. Depending on where the migrants came from, this also could have a positive influence on air travel.

Table 1 – Net Migration, Calgary and Edmonton, 1997/98-2001/02

	1997/98	1998/99	1999/00	2000/01	2001/02
Calgary	24,420	16,838	15,190	16,563	17,208
Edmonton	11,440	8,163	8,210	7,885	12,485

Source: Statistics Canada, The Daily, September 25, 2003; September 26, 2002; September 25, 2001, September 26, 2000

Gross Domestic Product

The variable gross domestic product is used in both the Transport Canada and FAA aviation forecasting models. As economic activity increases, so does the demand for commercial aviation services. As economic activity declines, so does the demand for commercial aviation services. In the absence of a city-based gross domestic product, three variables have been examined:

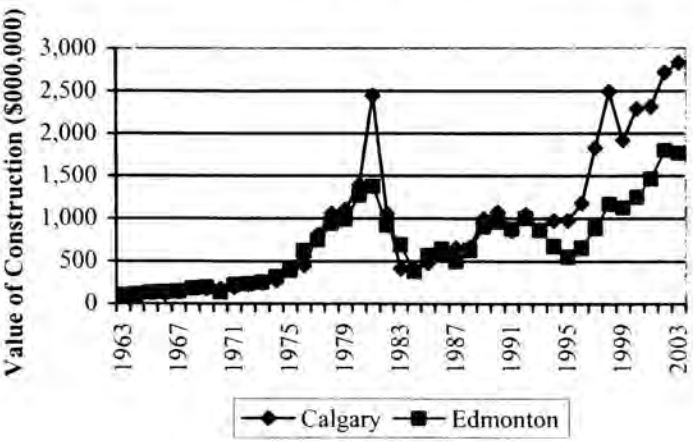
- value of building permits
- employment, and
- head offices.

Value of Building Permits

The traffic to or from a particular city is strongly tied to the economic activity of this city. One of the leading indicators to measure the

economic activity of a city is the value of building permits. In Chart 7, it can be seen that prior to the mid 1990s, with few exceptions, the value of planned construction activities for residential and non-residential sectors tracked quite similarly, in both Calgary and Edmonton. However, since 1995, the value of building permits issued by the city of Calgary outpaced by at least 50% the value of building permits issued by the city of Edmonton. In 1998, the value gap between the two cities widened to reach 113%.

Chart 7 - Value of Total Residential and Non-residential Building Permits, by Census Metropolitan Area, 1963-2003



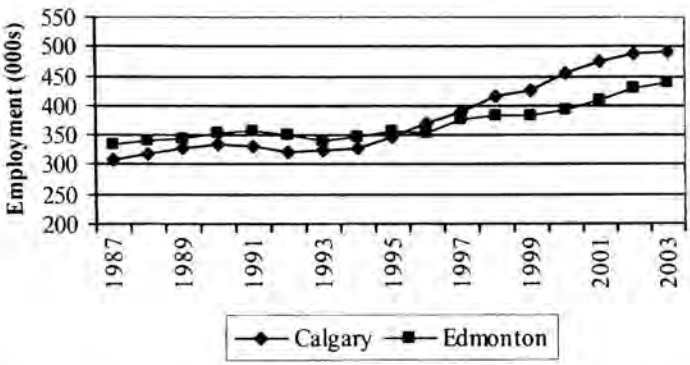
Source: Statistics Canada, CANSIM Table 026-0003 - Computed annual total from monthly series.

Employment

In Chart 8, the full time employment is shown for the period 1987-2003. Edmonton was the leader from 1987 through 1995. Since

1996, Calgary has had the higher number of persons who usually work 30 hours or more per week at their main or only job.

Chart 8 - Full Time Employment, Calgary and Edmonton, 1987-2003



Source: Statistics Canada CANSIM Table 282-0052, both sexes, 15 years and over

Head Offices

Much of the previous analysis and discussion concentrated on personal travel. Another important component of the aviation market is business travel. What factors could influence the volume of business traffic to or from a particular city? One variable could be the presence of head offices. Not only does head office employment in Calgary swamp that of Edmonton, it also has been growing while Edmonton's has declined.[16]

A loss of head office employment in Edmonton could have a negative effect on the demand for business travel originating in Edmonton as well as lessening the demand for trips to Edmonton as a destination.

Table 2 - Head Office Employment, Calgary and Edmonton, 1999 and 2002

	1999	2002	Annual Growth %
Calgary	11,946	16,167	10.6
Edmonton	3,574	3,415	-1.5

Cities are defined using their Census Metropolitan Area.

Source: Statistics Canada catalogue no. 11F0027MIE--No. 019, Table 5, page 15

Conclusion

The Edmonton commercial aviation passenger market has been in a long-term decline in relative size when compared to the Calgary commercial aviation passenger market. While the enplaned and deplaned passenger count has grown at Edmonton over the past four decades, the growth has been stronger at Calgary especially during the past two decades. Size of the municipalities' population does not appear to explain the differences. Income may be one explanatory factor, due not to the average incomes but due to the larger concentration of higher incomes in Calgary. Those with higher incomes do tend to use air travel more. The immigrant population of Calgary has grown faster in the last decade and net migration to Calgary from elsewhere in Canada has been higher than in Edmonton. Both could stimulate the Visiting Friends and Relatives travel market. With respect to the economic activity stimulating the demand for commercial aviation services, Calgary has recently led Edmonton in the value of building permits, full-time employment and head offices employment. The previous examination of the Montreal/Toronto situation appeared relatively clear, with Toronto beating Montreal on all the socio-economic variables examined as well as aviation passenger traffic.[17] In the case of Calgary/Edmonton, the socio-economic variables have favoured Calgary, especially in recent years yet the relative decline of Edmonton's passenger aviation traffic has slowed. This has occurred after the moving of most commercial

aviation passenger flights from Edmonton City Centre airport to Edmonton International airport. This may support the position that Edmonton was losing aviation passenger traffic to Calgary before the consolidation of commercial aviation flights at Edmonton international airport.

Note

The views and opinions expressed in this paper are those of the authors and do not necessarily reflect those of Statistics Canada. We would like to thank Marie-Claire Lauzon, Library and Information Centre, Statistics Canada for her research help. We would like to thank Tim Davis, Rolf Hakka, Robert Masse, Bruce Meyer all of Statistics Canada and Dave Johnston (retired Canadian Airlines International Ltd.) for their valuable comments, corrections and criticisms while retaining all responsibility for any remaining errors.

Endnotes

[1] The airport in downtown Edmonton changed names three times during the period of study: Edmonton Industrial Airport, Edmonton Municipal Airport and Edmonton City Centre Airport. Only the present name will be used in this study.

[2] The Edmonton Journal, editorial by Bob Ambrose, Friday October 13, 1995, page A19

[3] The Edmonton Journal, Thursday October 12, 1995, page A18, "Vote for international a vote for Edmonton"

[4] The Edmonton Journal, September 17, 1995, page E!, Dennis Hryciuk, "THE AIRPORT DEBATE, ROUND 2: TO MAKE CONNECTIONS"

[5] Edmonton Chamber of Commerce, Commerce News, November 1, 1995, page 5, v17, n8, "Consolidation at Edmonton International Airport a vote in city's future"

[6] Transport Canada, Assumptions Report 2003-2017, page 3. Federal Aviation Administration, FAA Aviation Forecasts Fiscal Years 1979-1990, page 46, Federal Aviation Administration, FAA Aviation Forecasts Fiscal Years 1996-2007, pages VIII-10 and II-12.

[7] Statistics Canada, catalogue 51-204 and 51-205.
[8] Transport Canada, PODM: Air Passenger Origin-Destination Model, TP2195E, Volume 1: Summary Report; page II-3
[9] Federal Aviation Administration, FAA Aviation Forecasts, Fiscal years 1996-2007, page II-12
[10] R. Daigle, Personal Travel and Transportation Expenditures in Canada, page 27, (Research Branch, Canadian Transport Commission, Ottawa, August 1978)
[11] Census family refers to a now-married couple (with or without never-married sons and/or daughters of either or both spouses), a couple living common-law (with or without never-married sons and/or daughters of either or both partners) or a lone parent of any marital status, with at least one never-married son or daughter living in the same dwelling.
[12] While not a direct variable, Transport Canada's population forecasts do include immigration estimates.
[13] Richard Fisher in Transport Canada's, Canadian Aviation Forecast Conference, December 8, 1994 Conference Proceedings, page 83.
[14] Richard Fisher in Transport Canada's, Canadian Aviation Forecast Conference, December 8, 1994 Conference Proceedings, page 83.
[15] Statistics Canada, The Daily, September 25, 2003, *Migration 2001/02*. Moves across town or within the same census division are not counted as migration.
[16] John R. Baldwin, Desmond Beckstead and Mark Brown, Hollowing-out, trimming down or scaling-up? An analysis of head offices in Canada, 1992-2002, Statistics Canada catalogue no. 11F0027MIE--No. 019, Table 5, page 15
[17] Gordon Baldwin, The Toronto and Montreal Aviation Markets—A Tale of Two Cities, CTRF Proceedings 1997

Is there a latent transit potential in Waterloo Region?

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1. Introduction

The use of transit in our dispersed city systems has decreased with the primacy of the automobile. Increasingly, the financial, social and environmental costs of the car are making it difficult for governments to maintain control of the modern transportation system. Issues such as pollution and who pays the costs of car-supporting infrastructure are now a part of societal debate. Attempts to increase the use of public transit, particularly for trips and for populations for which it may be a competitive option have become an important counter to the 'technological fix' for the car. Alternative visions for urban transportation that incorporate transit rely on the existence of certain land use characteristics (a higher density, a mix of uses, pedestrian-friendly streetscapes) and certain demographic characteristics (the young, the old, the journey-to-work trip).

The Regional Municipality of Waterloo is the upper-tier of local government for the cities of Cambridge, Kitchener and Waterloo in southern Ontario. The mid-sized Canadian urban area has experienced rapid recent growth and is expected to reach the 700,000 mark within 35 years (Region of Waterloo, 2002b). With this rapid growth have come concerns about environmental protection, preservation of agricultural lands, and maintaining quality of life. Much of the recent growth has been of a dispersed nature, leading to auto dependency, which is characteristic of most mid-sized cities (Filion, Bunting & Curtis, 1996; Bunting et al., 2000). On this basis, the Regional Municipality and its transit provider, Grand River Transit, have begun the process of developing a higher-order transit line (i.e. light rail and/or busway), with the hope of directing future growth in a more transit- and pedestrian-oriented fashion. There is the perceived need to redirect growth away from greenfield

development sites, towards reurbanization of existing built-up areas, consistent with 'smart growth' (Froehlich, 1998). It is hoped the Central Transit Corridor (CTC) being forwarded as a key part of the Region's growth management strategy (Region of Waterloo, 2002b), can serve as a focus of the reconcentration.

This paper details the general land use and socioeconomic characteristics of areas surrounding the planned corridor. Beyond exploring the geographical pattern of current transit use, this paper seeks to find the areas in the region where higher order transit might have the greatest impact. The subsequent section provides an overview on travel mode choice and its influencing variables. This is followed by a brief discussion of methodology. Finally, the results and conclusions indicate the geographic areas expecting the highest potential transit use.

2. The Research in Context

Much of the literature on modal choice (the choice between transportation modes) has focussed on the factors involved in individual decision-making. For example, Ben-Akiva and Lerman's (1985) classic research pioneered the use of the logistic regression technique in formulating a model of an individual's choice of transportation (car versus transit). This literature on individuals, however, tends to lack the view of wider patterns operating over geographic space. Since this study takes a future perspective on attributes of transit riders, with a view to the location of future transit infrastructure, research which focuses on patterns at work in the aggregate and in geographic areas rather than the individual was investigated. Some of this research is theoretical, arguing that certain attributes of the environment or the population should encourage higher transit use (Shinbein, 1997). More commonly, empirical work examines the variables that can be used to distinguish transit riders from non-transit riders (TRB, 1996; 1998; 2000).

Two major themes emerge in research on transit-user characteristics: socioeconomic/demographic attributes, and land use/urban form attributes. A large group of socioeconomic and demographic factors, including gender, income, age, education, immigrant and ethnic status, vehicle ownership, and work/mobility

limitations, have been found to help define a transit "market niche". TRB (2000) found that the existing market for transit in Canada was among 18 to 24 year olds, those with household incomes less than $20,000, students, single parents, the unemployed, single people without children, and people active in community life.

Messenger and Ewing (1996) and Kain (2001) found income to be involved in transit modal share, through helping to determine auto ownership patterns. Higher incomes have been associated with transit use near subway stations (Filion, forthcoming). Family status has been found to influence mode choice (Dieleman et al., 2000). The presence of children tends to increase auto use (Yee and Niemeier, 1998). Garrett and Taylor (1999) define "transit dependents" as a major market for transit. These are people who are too young, old, or lack the income to drive, and those who have mobility limitations. Transit use tends to be much lower than average among the 'blue collar', middle class workforce, a lifestyle which often also relates to location choice (i.e. the middle class suburbs). Gender has also been found to impact transit use, with fewer men opting for transit (Pooley & Turnbull, 2000). Overall, the significant socioeconomic variables seem to be dependent on the method of study (individual versus aggregate), the time period, available data sources, and certainly the geographic region under study.

The role of density and styles of urban development required for increasingly sophisticated transit service has been recognized for decades (e.g. Pushkarev & Zupan, 1977). In general, changing employment and population density are considered important trends that will impact on future transit markets (TRB, 1998). Factors such as CBD job density and population density near transit stations have been found to influence LRT ridership exponentially (TRB, 1996). As Badoe and Miller (2000) conclude, the findings in the literature on urban form's impact on transit travel behaviour have been mixed at best. Some studies confirm the role of higher density and mixed land use in reducing auto travel and increasing transit and walking, but others find only weak relationships. Nevertheless, collectively, the literature does suggest at least some role for land use in helping to foster transit ridership.

3. Rationale and Method

As is evident from reviewing the literature, the transit potential of urban areas, particularly from an empirical basis and for specific urban areas, has been a neglected part of the body of knowledge within urban geography and transportation studies. Although several research papers have discussed U.S. or Canadian urban areas with regards to current or past demographic and land use variables related to transit, little attempt has been made to suggest the implications of current patterns on future transit use. An additional rationale for the timeliness of this research is the fact that the Waterloo Region transit proposal is still in its developmental stages; the results of this research can affect upcoming decisions.

The corridor selected for investigation was based on several converging sources. An approximated depiction is included in the Region's Official Policies Plan (RMOW, 1998). More detailed plans for the St. Jacobs to Kitchener section of the corridor were available from the Region's LRT funding proposal (Region of Waterloo, 2002a). Candidate transit nodes used in other recent studies have been incorporated. The options map of the region's growth management strategy also depicts the proposed higher-order transit corridor (Region of Waterloo, 2002b).

In larger urban areas, Statistics Canada data is provided according to Census Metropolitan Areas (CMAs), further subdivided into census tracts. In 1996, there were 82 census tracts (CTs) in the Kitchener CMA. However, due to the very low population in one of these (106.03) and the resultant suppression of data, the statistical data is available for only the remaining 81 tracts. The transportation data was obtained from the University of Toronto Transportation Tomorrow Survey. Data were available as UTM co-ordinates of the origin and destination points for trips and could be joined to the census tract boundaries using GIS. Thus, census tracts were used for both census and transportation data sets.

The first of the three major components involved in the analysis portion of this research was the creation of a generalized, "unweighted" index of all the land use and demographic factors suggested in the literature on transit-supportive characteristics. This index was achieved by summing the calculated values for all relevant

variables for each tract; to account for differences in the measurement of different variables (e.g. density and FAR measures as compared to proportions of the population), all variables were first standardized to z-scores. The variables suggested in the literature to encourage transit use were assigned a positive sign; conversely, those said to detract from transit use were assigned a negative sign.

The second component was the calculation of a weighted index, attempting to more accurately represent the importance of factors in relation to one another. TRB (1998) provides aggregated rider characteristics from both larger and smaller U.S. transit systems. Weights for each attribute are provided, indexed to the average U.S. transit rider. This weighting system, based only on socioeconomic variables, was deemed appropriate to use for Waterloo Region since the data from the larger U.S. cities should inflate the weights enough to estimate those potentially found in a mid-sized Canadian urban area. To calculate the weighted index, attribute values from Kitchener CMA census tracts were multiplied by the appropriate weighting factor from TRB (1998). Then, for each subtype of variable (e.g. age, gender, immigration, household income), the weighted values for its constituent variables (e.g. males and females for gender, the different age groups for age, etc.) were added together and divided by the number of constituent variables. The result was a single value for each variable subtype (e.g. one value for age, one for gender, one for income, etc.). These resultant values were summed to create a single index value for each census tract.

A final component of the analysis was to determine which (if any) of the socioeconomic and land use factors used to define the indices actually help to define who uses transit based on *current* (1996) transit trip patterns in the region. Multiple regression was used to determine the relationship between 36 different variables and the dependent variable, the proportion of all trips by transit for each census tract. A stepwise regression procedure was followed.

4. Results

The current level of transit modal split for all trips is depicted in Figure 4-1. As evident from the map, the census tract containing the Kitchener Transportation Centre bus terminal (at 14

per cent), as well as the tract containing Resurrection High School on the west side of Kitchener-Waterloo (at 12 per cent) have the highest percentage of current transit patronage, by a large margin. The pattern indicates the downtown focus of the bus system in Kitchener in 1996, together with bus traffic to and from the commercial core, a traditional market for transit. The large apparent role of high school students in the transit market is also suggested. Several other areas of Kitchener show moderately high modal splits for transit (five to nine per cent). In Cambridge, the areas with the highest transit use (only about four per cent) are in the downtown Galt core and parts of the West Galt residential area. In the City of Waterloo, the highest transit use is along King Street in the uptown core and University Avenue (student housing areas associated with the city's two universities).

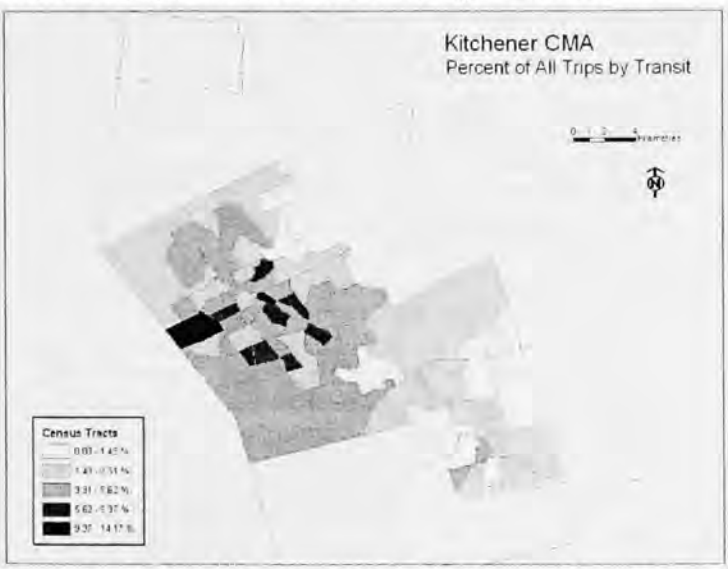


Figure 4-1 Modal split for transit in the Kitchener CMA (1996).

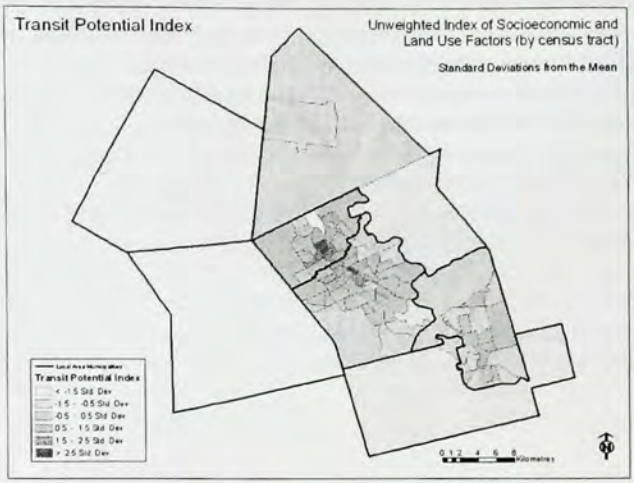


Figure 4-2

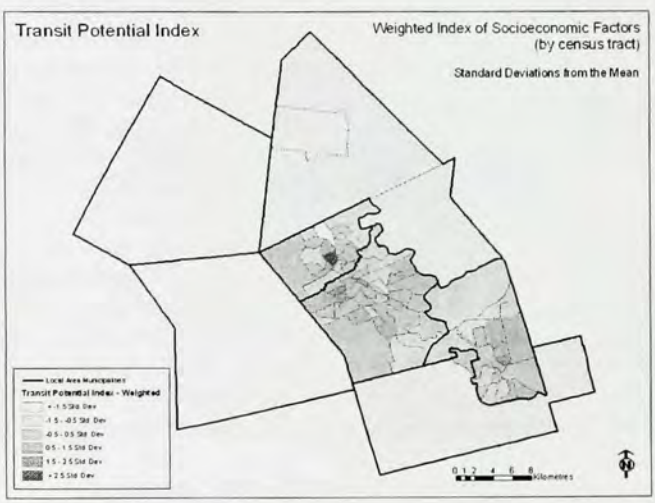


Figure 4-3

A multiple regression analysis of the socioeconomic and land use variables suggested in the literature to be important in determining transit-riders revealed very few factors associated with the Kitchener CMA's transit ridership numbers for 1996. In the stepwise regression procedure adopted, a total of four model solutions resulted. The first variable entered was the dwelling ratio (ratio of high density to single family dwellings). This had a significant and positive relationship to transit use. In subsequent model solutions, three other variables emerged as significant. Population density was found to have a positive relationship to increasing transit patronage. This echoed much of the literature on residential density. However, employment density was *not* found to be significant, contrary to the density literature. With a negative relationship to transit modal split, in line with the literature, was the proportion of the population that was non-immigrant in a census tract (thus demonstrating a positive relationship between transit modal split and the percentage of the census tract population classified as "immigrants"). Somewhat curiously, there was also a negative relationship between transit patronage levels and the proportion with an elementary school education. This seems to suggest that census tracts with higher numbers of people with only an elementary education will, in the Kitchener CMA at least, *not* have a greater propensity to use transit; in fact the opposite is true in these areas, with a greater propensity to have a lower transit use rate. This seems not only counter-intuitive, but it is also inconsistent with the research. Although, of the four significant variables, this was the one with the least significance.

The unweighted index of transit potential for Waterloo Region census tracts for various socioeconomic and land use factors is presented in Figure 4-2 (based on standard deviations around the mean). Figure 4-3 depicts the relative values for the weighted transit potential index based on socioeconomic variables alone. There are some minor differences in the results of the two indices. The weighted index of socioeconomic factors (without land use variables included) provides for a more dispersed pattern of transit potential because of its ignorance of density factors in cores. The unweighted index more clearly demonstrates the extremes in transit potential between urban cores, and suburban nodes and peripheral areas.

Despite these differences, the two indices do correlate at a moderate to high level for the census tracts in the CMA (correlation coefficient, *r*, of 0.67). Both indices provide similar spatial results: the greatest transit potential lies toward the core areas (Downtown Kitchener, Uptown Waterloo, Preston and Galt) and along corridors, such as Queen Street and Victoria Street (in Kitchener), University Avenue (in Waterloo), and certainly the traditional main street of the region, King Street/Coronation Boulevard/Highway 8 running from the universities in the north to Galt in the south.

As evident in the results presented, very little by way of socioeconomic or land use factors influence people to use transit, relative to other modes, in Waterloo Region. The current transit usage pattern (in terms of modal split) is also very low and characteristic of many mid-sized cities in Canada (see, for example, Miller, 2000, for a comparison of auto dominance for travel by city). Several reasons exist for this low transit use: some of them are general factors experienced in most mid-sized cities, and some are due to local patterns. In mid-sized cities in general, there tend to be dispersed travel patterns, a deconcentrated urban form, and a city centre that is not the primate location for office or retail uses, and consequently a relatively limited transit system, in terms of service frequency and ridership (Filion, Bunting & Curtis, 1996 on 'the dispersed city'; Bunting et al., 2000). The fact that Waterloo Region and the Kitchener CMA are also very multi-nodal (that is, there are several major employment and retail nodes, both traditional urban cores and suburban employment and retail centres) means that this local factor – the intervening opportunities in Cambridge and Waterloo relative to the Kitchener downtown – makes for an even more decentralized travel pattern and an absence of focus for good transit service provision (as would be the case in Toronto's downtown, for example) (Bunting et al., 2000).

5. Conclusions and Implications

This paper has added, generally, to the literature on Canadian transit and the factors involved in transit use and, specifically, to the examination of the feasibility and potential of Waterloo Region's Central Transit Corridor. The *current* spatial

pattern of transit use revealed the highest levels in the Kitchener core, followed by selected suburban areas of Kitchener and parts of Waterloo and Cambridge (mainly the inner city). The lowest levels were found in the newer suburbs, the two townships under study, and across much of Cambridge.

A number of socioeconomic and land use factors which are characteristic of transit riders in other communities have been identified. Applying them to the current transit patronage levels revealed that only a select few of these, namely the density ratio and population density (among land use variables) and immigrant status and elementary education (among socioeconomic factors), currently help to define Waterloo Region's transit passengers.

Working on the assumption that a *latent potential* exists for transit patronage among residents beyond that which already occurs on the current bus system and based on the factors that appear to drive transit ridership in other communities, two indices of relative transit potential were calculated. Together these indices, with a moderate correlation, indicate that the census tracts in the region with the highest transit potential are found in the city core areas and selected major arterial routes, including the King Street/Highway 8 corridor.

By defining the transit potential geographically, this exercise has indicated that the linear corridor currently under consideration by the Regional government is indeed the most beneficial place for transit improvements attempting to attract more transit riders. This is particularly the case for the Waterloo to Kitchener section, where a majority of the tracts with highest transit potential are located.

Regarding the potential placement of rapid transit nodes, two locations proximate to the CTC clearly stand out: the downtown tract in Kitchener and the tract between the two university campuses in Waterloo (within walking distance of a proposed LRT station). Based on the areas with the next highest levels of transit potential, additional stations could be placed in the Uptown Waterloo core, and in the Cedar Hills area immediately southeast of Downtown Kitchener (consistent with an LRT station proposed for the east part of downtown). There is also relatively high transit potential for the tract adjoining Fairview Mall in southcentral Kitchener, which lies

along the CTC. As such, and given its relatively close proximity to Cedar Hills, Fairview could also be considered for an early stage in the development of rapid transit. This might necessitate the extension of the first phase of service under consideration as far southeast as Fairview Mall.

Concerning bus service that can integrate with the rapid transit corridor and provide rapid transit access to more potential riders, a number of sites outside of the corridor demonstrate a high latent potential (relatively speaking) that might be captured. Candidate transit service nodes and potential bus routings to connect with the CTC are shown in Figure 5-1. The suggested Fairview Mall extension is also shown.

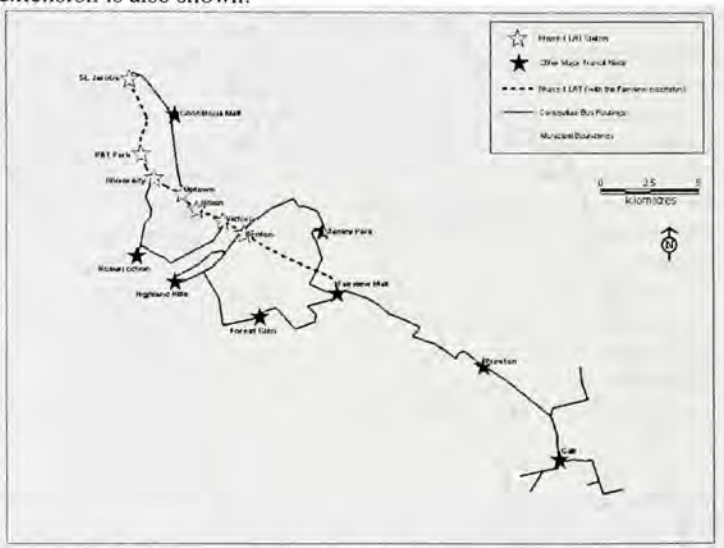


Figure 5-1 Conceptual Map of the First Phase of the CTC and Potential Bus Connections

Assuming the Central Transit Corridor is implemented along the planned alignment, the potential for increased transit use exists in many areas adjacent to the corridor, including several nodes already planned as rapid transit stations. From the perspective of its

placement in areas with the highest *potential* for enhanced transit use and where riders *could* be drawn onto a technology such as LRT, the present CTC proposal is the most feasible one. This being said, the question still remains whether the potential for increased transit patronage will indeed be unlocked by introducing rapid transit service. This is especially a question when the fact that most of the areas with highest potential already receive the greatest levels of relative transit service in the region by the existing bus-only system.

While it remains to be seen whether the transit potential identified in this study will come to fruition with the introduction of rapid transit, there are several indications that it will have success, particularly in the longer term and given adequate policy instruments. This policy could be modelled on the 'transit first' guidelines used by the City of Ottawa to concentrate transit-supportive development around its downtown and suburban nodes (Khasnabis, 1998). A longer-term view of success for the corridor is consistent with the 40-year planning horizon currently discussed for the Region's growth management strategy, of which the CTC is a component.

In summary, this paper has shown, to the extent that typical transit users are concentrated in many parts of the Central Transit Corridor and other areas, some potential for increased transit patronage does exist in the region; however, more research is needed. Questions still remain regarding the low level of current use and the limited number of factors defining the transit sub-market locally. These outstanding issues can only be addressed through a radical change in people's perceptions about auto use and the low-density, greenfield, suburban focus of development prevalent in mid-sized cities such as the Kitchener CMA. The growth management strategy and rapid transit may represent such a dynamic effort in the marketing of lifestyles and in public policy constraints to start achieving a major shift in attitudes and perceptions (and ultimately behaviour), with regards to land use and travel choices.

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Appendix: List of Variables

SOCIOECONOMIC VARIABLE SET

AGE: 0-14 Population (U,M)
AGE: 15-29 Population (U,M)
AGE: 17-29 Population (W)
AGE: 30-39 Population (W,U,M)
AGE: 40-49 Population (W,U,M)
AGE: 50-59 Population (W,U,M)
AGE: 60-64 Population (W)
AGE: 65-69 Population (W)
AGE: 60+ Population (U,M)
GENDER: Male Population (W,U,M)
GENDER: Female Population (W,U,M)
MIGRATION: Immigrant Population (W,U,M)
MIGRATION: Non-immigrant Population (W,U,M)
WORKFORCE: Blue Collar Population (U,M)

WORKFORCE: White Collar Population (U,M)
ETHNICITY: "White" Population (W,U,M)
ETHNICITY: "Black" Population (W,U,M)
ETHNICITY: "Hispanic" Population (W,U,M)
ETHNICITY: "Asian" Population (W,U,M)
EDUCATION: Less than high school (U,M)
EDUCATION: University educated (U,M)
EDUCATION: Elementary only (W,M)
EDUCATION: Grades 9-13 (some) (W,M)
EDUCATION: High school (W,M)
EDUCATION: Some college (W,M)
EDUCATION: College (W,M)
HOUSEHOLD INCOME: less than $10,000 (W)
HOUSEHOLD INCOME: $10-20,000 (W)
HOUSEHOLD INCOME: $20-30,000 (W,U)
HOUSEHOLD INCOME: $30-40,000 (W,U)
HOUSEHOLD INCOME: $40-50,000 (W,U)
HOUSEHOLD INCOME: $50-60,000 (W)
HOUSEHOLD INCOME: $60-70,000 (W)
HOUSEHOLD INCOME: $70,000+ (W)
HOUSEHOLD INCOME: Less than $20,000 (U,M)
HOUSEHOLD INCOME: Greater than $50,000 (U,M)
Car Driver Population (U,M)
Non-Car Driver Population (U,M)

LAND USE VARIABLE SET

Employment Density (U,M)
Population Density (U,M)
Coverage (all buildings) (U,M)
Coverage (institutional/commercial/industrial) (U,M)
Employment/Population Ratio (M)
Dwelling Ratio (high density vs. single family) (M)
Dwelling Type: High density share (U,M)
Dwelling Type: Low density share (U,M)
Dwelling Type: Single family (M)

DEPEDENT VARIABLE

Trips by Transit

W = included in weighted index (from TRB, 1998)
U = included in unweighted index
M = included in multiple regression (current transit use)

STONE MASTIC ASPHALT:
A ASPHALT PAVEMENT ALTERNATIVE FOR THE NEW CHALLENGES OF HIGHWAYS

A Technical Report for Pavement Management System

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Table 1 Range of grain-size in Germany. 6

1 – Introduction

According to Lu (1997), the asphalts have been used as surface layer in the flexible pavements for more 100 years. However, in the last two decades the more and more roads made with conventional binder (asphalt cement), have lost their functional capability more quickly than was imagined. This has been due to a combination of factors: increase of the traffic volume, axle load, tire pressure, and inefficient maintenance. The degradations suffered by the pavement are revealed in the form of severe permanent deformations in wheel path, precocious cracking and loss of the covering material.

Roads and highways have some big challenges: carrying increasing traffic volume with higher axle loads, requirements for noise reduction, preferred use of recyclable materials, improved safety aspects, increased durability/longest possible lifetime, driver comfort- and to accomplish all of this with economical restrictions.

This technical report analyses the main characteristics of SMA, Stone Mastic Asphalt, as an asphalt pavement alternative with high durability.

2 – Definitions

SMA mixture is called Splittmastixasphalt in Germany, Stone Matrix Asphalt in the USA or Stone Mastic Asphalt elsewhere.

According to New Zealand Bitumen Contractors' Association (BCA) (2002), SMA is a gap-graded mixture with a high proportion of coarse aggregate, high rates of the binder, filler and stabilizing additives, with relatively little fine aggregate particles, when compared with the traditional Hot Mix Asphalt (HMA). Figure 1 illustrates HMA and SMA schematically.

The high stone content of the SMA mixture forms a skeleton-type structure offering high resistance to deformation. The stabilizing additives. or modifier. prevent binder drainage during manufacture. transportation and laying. The mixture is very durable. rut-resistant and has low air void with high levels of macro texture when laid. resulting in a waterproof layer with good surface drainage. It can provide a surface texture between 0.5 mm and more than 1.5 mm. depending of the mix design.

3 – History

Stone Mastic Asphalt (SMA) was developed in the Germany in the late 1960's. The main objective was to give to the asphalt mix a greater capacity of resistance to superficial wear and greater resistance to permanent deformation.

Gradually this technique was implemented. In the 1980's. with the introduction of the binder modified for polymers and the use of the natural or synthetic fibers in the European Market, SMA took a new step forward. The first specification for the SMA as published in 1984 in Germany

According to "Heavy duty surfaces – The argument for SMA". published by the European Asphalt Pavement Association. several European countries. listed below. have used a high portion of their roads with SMA.

- Germany: 100 millions square meters
- Spain: 69 millions square meters
- Sweden: 50 millions square meters
- Holland : 32 millions square meters
- France: 18 millions square meters

4 – Characteristics

Basically a SMA mixture is composed of:

- A stony skeleton of high performance with almost 70 - 80% of the coarse aggregate
- Asphalt cement. The proportion of the asphalt in the mixture is around 6.0 - 8.0% of the total weight.
- Mineral filler with high quality to compose mastic.
- Cellulose fiber (organics), mineral fibers, or fiber glass with the proportion ranging between 0.3% and 0.7% of the total weight of the mixture.
- Low air void (around 2.0 - 4.0%)

The stony skeleton is responsible for high stability of the mixture. The mastic, made by combination of the asphalt, filler and fiber is responsible for linking and adhesion of the stony skeleton. In addition, the mastic allows the mixture to have higher durability and flexibility, even in the lower temperatures.

One negative characteristic of SMA is that when it is new, it has a thicker film of the asphalt, compared with HMA, harming part of its initial macro texture. After some months, the traffic wears this film and re-establishes the roughness defined in design. (Reis et al., 2002)

Addition of cellulose fibre does not chemically modify bitumen, but rather enhances physical property of the finished product by allowing the use of higher bitumen contents. It tends to thicken or bulk the bitumen so that it does not run off the aggregate prior to compaction. (Brazilian Petroleum Institute – IBP, 2000)

5 - Performance Characteristics of Stone Mastic Asphalt

When mixed and applied correctly, the SMA has the following performance characteristics:

- High rut resistance, even at high temperatures
- High stability
- Better flexibility at low temperatures, when compared with the traditional HMA
- High adhesive capacity between the stone granules and the bitumen
- A mix with no tendency to separate.
- Thickness around 1.5 – 6.0 cm (in the special cases, until 10.0 cm)
- Higher surface friction
- Noise reduction

5.1 - Permanent Deformation

The stone-stone contact of the mineral skeleton provides one high internal friction of the aggregate, resulting in increase in the rutting resistance in the wheel way. This improves the longitudinal and transversal regularity of the surface under heavy traffic in order to guarantee greater comfort to the user. (Reis et al., 2002)

According to results of the EAPA (1998), the resistance to the permanent deformation of SMA mix increased 4 times when it was used with binders modified with polymer instead of conventional asphalt 45/60 (penetration grade bitumen) and in 5 the 10 times in relation to the dense asphalt concrete.

Four experimental pavements with SMA have been constructed and evaluated in Canada, confirming the potentiality of the mixture for the reduction of the permanent deformation (Emery et al., 1997).
In Leipzig - Germany, an experimental section with SMA, which used binder modified with polymer, was constructed in 1997 and

monitored periodically. The authors confirm the good surface's performance under heavy traffic, mainly its resistance to the permanent deformation. (Marchand et al., 2000)

5.2 – Cracking and Ravelling

The excellent durability of the SMA is due the nature and amount of mortar (filer-sand- asphalt) that exist in the matrix of the aggregate, giving high cohesion and impermeability for the mixture, as well as resistance to the asphalt's oxidation. (Reis et al., 2002)

Based on comparison of SMA with dense graded asphalt mix in different European countries, it was concluded that fatigue cracking and ravelling due the range of temperatures, traffic and water action are not significant in SMA, because of its superior flexibility and wear resistance. (EAPA, 1998)

According to NCAT, SMA presents higher rutting resistance in the wheel path and increases the pavement life cycle because its higher resistance for the fatigue cracking and segregations in adverse climate and traffic conditions. (NAPA, 1999)

International evidence has shown that SMA resists the reflection of cracks in underlying layers. The relatively high binder content of SMA mixes confers improved fatigue life and hence reduces fatigue cracking. (New Zealand Bitumen Contractors' Association – BCA, 2002)

6 – Design

The design of a particular SMA is critical for providing an aggregate grading that will accept the high bitumen content that provides durability without binder drainage. If this design is not correct, it will result in binder drainage in the lorry bodies and fatted areas of the surfacing.

A larger amount of binder provides a greater thickness of the bitumen film that involves the aggregate, improving the resistance of the surface to the fatigue, wear and aging (seasoning). (Whiteoak, 1990)

Conversely, an aggregate design that require a lower binder content to prevent binder drainage will result in a bituminous mixture that will be less durable and have a reduced life.

Only crushed aggregates are specified for the SMA to ensure suitable aggregate interlock. The use of natural aggregates containing polished or rounded particles, such as sand, is not permitted. At least 90% of the aggregate must have 2 faces crushed. (NAPA, 1999)

Because SMA relies on stone-to-stone contact to provide its strength and a mastic mortar is rich in binder (generally between 6% and 7%), stabilizing additives are needed in the mastic, in order to prevent the binder from draining into the mix. It must be added to the SMA to ensure binder drainage does not occur during storage, transportation or construction.

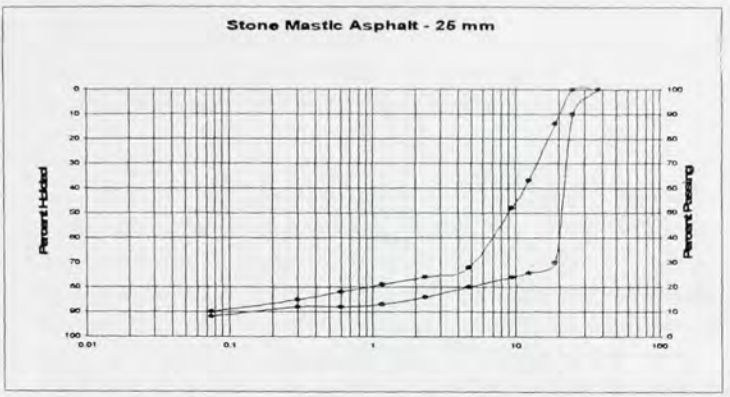
7 - Examples of the design particle size distribution

7.1 – Germany

Table 1 – Range of grain-size in Germany

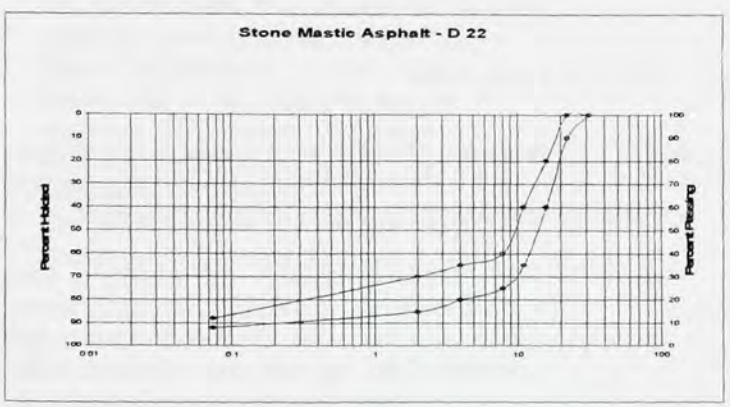
Sieve (mm)	Mixture Designation			
	0/11 S	0/8 S	0/8	0/5
	Percentage Passing Sieve			
> 11.20	≤ 10			
> 8.00	≥ 40	≤ 10	≤ 10	
> 5.00	60 – 70	55 – 70	45 – 70	≤ 10
> 2.00	75 – 80	75 – 80	70 – 80	60 – 70
< 90.00 (μm)	9 – 13	10 – 13	8 – 13	8 – 13

7.2 – USA

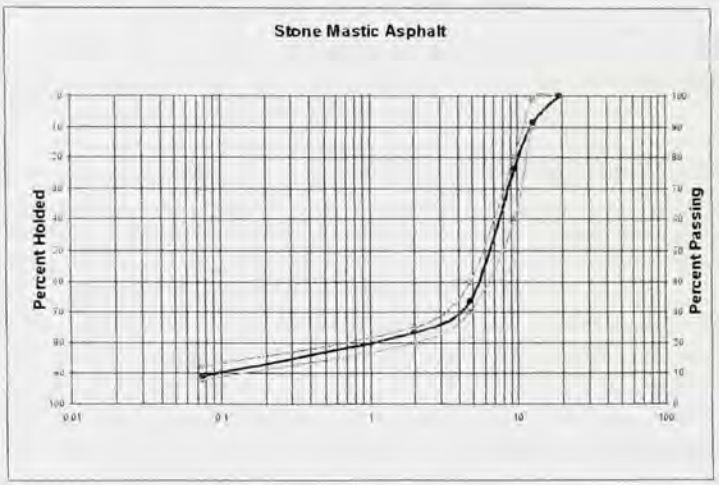


Graphic 1 – Example of grain-size curve of SMA in USA.

7.3 – E.U.



7.4 – Brazil



Graphic 3 – Example of grain-size curve of SMA in Brazil.

8 – Production / Construction

The SMA productive process (production, transport and application) demands the same basic cares as with HMA. However some special cares must be taken to meet SMA's higher technical standards.

According to Brazilian Petroleum Institute – IBP (2000), fat spots are one of the most objectionable occurrences in SMA mixtures. They can be either cosmetic or functional. Cosmetic fat spots usually occur on only the surface of the mat and wear off under traffic. Functional fat spots usually extend throughout the thickness of the

Fat spots may result one or more of the following conditions.

- Lack or inconsistent distribution of fibres
- Excess release agents in bed of haul
- Excess temperature, particularly with modified
- Excess tack coat
- Inconsistent mineral filler feed
- Excess moisture in mineral filler
- Excess haul time, or haul vehicle waiting on project

Others cares

- Due to the gap-graded structure of SMA it is necessary to establish an adequate quality control system for the incoming aggregates and to maintain the stock piles properly.
- Inadequate mixing effort may produce material of variable consistency which may not comply with the specification, although feed to the plant is accurate.
- Generally the fibers are added during the mixing to avoid the mixture's segregation during SMA transport, to make easier its application and to avoid the drainage down of the binder. According to the JRS - Solutions for Roads Construction - the use of automatically controlled feed systems for additives and fibers are recommended. Modern material handling systems provide sufficient flexibility to add different types of additives, pigments, binders and polymers.
- Overheating of the aggregate must be avoided. This can cause reduction of the asphalt film around of the aggregate or even to burn the asphalt during the mixing. Of course, this will bring damages to SMA life cycle.
- The asphalt-polymer's viscosity-temperature curve must be considered during the mixing and during the compaction.

9 – Conclusion

Stone Mastic Asphalt is a high stiffness, high macro texture bituminous mixture suitable for use in high demand and/or high speed areas. The high macro texture allows good surface drainage hence reducing the risk of aquaplaning. It also reduces traffic noise when compared with chip seals or HMA.

Generally the reports about failures are linked with production/construction mistakes - for example, segregation and flushing. These problems can be corrected with a good control of the aggregates and range of design, appropriate dosage of the binder rate and fibres and control of the temperature during the mixing and compaction. (Reis et al., 2002)

In Europe, where heavy traffic is higher, SMA has been indicated for use. Its high initial cost, when compared with traditional solutions, is not an important reason for it not be used. A life cycle cost analysis will provides good reasons to adopt it. (Morilha Jr., 2001)

SMA's longer service live gives it a better return on investments than most alternative materials even though the initial costs may be higher. Given that a life span increase of at least 5-10 years can be obtained and that additional advantages covered earlier are gained, it is clear that the choice of SMA can be a good investment. (Brazilian Petroleum Institute – IBP, 2000)

After more than 30 years, the excellent performance of SMA in highways with heavy traffic has proved that it is an efficient solution to reduce the rutting in the wheel way and the surface wearing caused by attrite between the tire and surface. In general, SMA meets all of the challenges listed in the introduction.

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The Effect of the Darling Report on Canadian Coastal Trade Legislation

Abstract

In 1969, H.J. Darling led the Water Transport Committee of the Canadian Transport Commission on an Inquiry to produce a report on the laws respecting the coasting trade of Canada (Darling, 1970). It was to be reported to the Minister of Transport. The purpose was to determine the suitability of the coasting trade laws with respect to the needs of the national transportation policy.

The purpose of this paper was to review the main recommendations of the Darling Report, and determine how these recommendations affected current Canadian coastal trade legislation. This was completed by presenting a chronology of marine policy events and discussing the implications of each event with respect to each other.

It was discovered that the main recommendations of the Darling Report were the template for today's Coasting Trade Act specifically- a Canada-First-if-possible policy for coasting trade. In the years following the report, many of those involved with drafting new coasting trade policies used the Report as a basis. Since the Darling Report recommendations were implemented 22 years after drafting, serious questions remain regarding their suitability to today's technologies and economies.

1.0 Introduction

In 1969, H.J. Darling led the Water Transport Committee of the Canadian Transport Commission on an Inquiry to produce a report on the laws respecting the coasting trade of Canada (Darling, 1970). It was to be reported to the Minister of Transport. The purpose was to

determine the suitability of these laws with respect to the needs of the national transportation policy. The inquiry and report looked at:

1. The application of part XIII of the Canada Shipping Act and related provisions, and exemptions from this legislation
2. How coasting trade was affected by international obligations
3. Expanding the application of these provisions to dredging, salvage, and other services other than passengers and goods
4. Marine requirements related to off shore oil drilling
5. Investigating demand for drilling rigs, auxiliary and specialized craft regarding Canadian resource exploration in territorial waters and on the continental shelf.

The purpose of this paper is to review the main recommendations of the Darling Report, and determine how these recommendations affected current Canadian coastal trade legislation. This will be done by presenting a chronology of events and discussing the implications of each event with respect to each other.

2.0 History of coasting trade – Pre-Darling Report (1763-1967)

2.1 Early Canadian coasting trade, 1763-1952

The early settlement of Canada and the resulting trade was wholly dependent on ships to transport goods and people. Settlements tended to be along coastlines and waterways because transportation technology could only move goods and people efficiently using ships. In 1763, the Treaty of Paris allowed all British Commonwealth ships to participate in the Canadian coasting trade, whether registered in Canada or elsewhere in the Commonwealth (Spence, 1957). It was not until 1902 when Canada developed a law that limited coasting trade to British ships, and required licenses for foreign-built British ships. These licenses were to be obtained through the Minister of

National Revenue, and non-adherents would face a fine of $500 per voyage (Canada Shipping Act, 1952a). Licenses were to cost 25% of the total value of the ship.

Over the next few decades, Canadian shipping began to mature. The World Wars brought great technological advances, many of which were realized in the marine industry. In 1944, the Canadian Shipbuilding and Ship Repairing Association had many worries for Canadian shipping after the Second World War, and had proposed at that time that coasting trade should be restricted to vessels built and registered in Canada (Spence, 1957a). In terms of legislation however, little changed in the Canada Shipping Act.

2.2 Canada Shipping Act, 1952

In 1952, the Canada Shipping Act, Part XIII, dealt solely with coasting trading and provided several regulations regarded ships wishing to participate in the coasting trade. Foreign built British ship were allowed to participate in Coasting trade if they applied for license and paid a fee of 25% of fair market value of the hull, machinery, furniture, and appurtenances (Canada Shipping Act, 1952b). The Act was very specific regarding coasting trading. It stipulated "no goods shall be transported by water, or land and water from one place in Canada to another place in Canada, either directly or by way of a foreign port, or for any part of the transportation in any ship other than a British Ship" (Canada Shipping Act, 1952c). However, a clause was provided that would allow the Governor in Council to suspend this as he or she saw fit.

2.3 Spence Commission, 1957

In 1955, the Spence Commission was appointed as a Royal Commission to report on matters relating to the coasting trade of Canada. The Commission had various purposes: investigating the relationship between the coasting trade of Canada with Canadian shipping and shipbuilding; the effects of the development of the St. Lawrence Seaway upon the Coasting trade of Canada; as well as

making recommendations regarding any new policies to be developed for the coasting trade of Canada (Spence, 1957b).

Submissions were made to the Government by various organizations including, the Canadian Shipbuilding and Ship Repairing Association (CSSRA), whose members included virtually the entire industry, and by the Dominion Marine Association (DMA), whose members included most operators of Canadian ships on the Great Lakes and canals. They requested that the coasting shipping of Canada be restricted to vessels built and registered in Canada, a sentiment they repeated almost 30 years later to the Standing Committee on Transport (SCOT).

Even in 1955, the Commission recognized that Canadian ships could not compete with Commonwealth ships in trade, except in the Great Lakes. At that time, the restrictions on the St. Lawrence River made it virtually impossible to get a ship of any size into the Great Lakes; consequently the Canadian ships achieved somewhat of a monopoly on the Great Lakes trade and shipbuilding.

The Spence Commission had several concerns regarding limiting the coasting trade to Canadian built vessels. The first was that industries that currently relied on coasting trade, i.e. Cape Breton coal mines, would pay 67% more for hauling the coal that if it were hauled by a U.K. flag carrier on the Atlantic coast (Spence, 1957c). On the Pacific coast, it was estimated that it would cost 8% more to haul by a Canadian flag carrier. One reason for the difference would be the different types of cargo, coal, and iron ore, in the East, logs, pulp and paper, in the West. On the Great Lakes, the Commission estimated an increase by 29%, as they would haul mostly grain (Spence, 1957d). The Commission seriously doubted if the coasting trade alone would keep Canadian vessels fully employed unless the domestic demand for goods increased, hence the hesitation in recommending limiting coasting trade.

2.4 Opening of the St. Lawrence Seaway, 1965

In 1965, the St. Lawrence Seaway was opened, and for the first time enabled large ships to trade from the Atlantic to the Great Lakes. Previously, Great Lakes trade had never been faced with competition from outside. Contrary to the recommendations of the Spence Commission, the Canadian Government amended the Canada Shipping Act restricting the coasting trade from points west of Anticosti into the Great Lakes solely to Canadian ships. Commonwealth ships were allowed to carry cargo in and out of the area (Darling, 1970). It is very possible that this restriction was enacted as a protectionist measure, similar to the US Jones Act, to ensure investment in ships in the Great Lakes was not devalued.

2.5 National Transportation Act, 1967

In 1967, the Federal Government produced the National Transportation Act, along with a Policy governing its implementation. The main idea of the policy was to establish an economic, efficient and adequate transportation system that would be the lowest cost for the users, but still protect their interests. The Policy urged competition, and promoted regulation insomuch that modes could still remain competitive with one another. It also proposed that users pay the total cost of their use of the system. One problem with this policy was that it did not give direction for regulation and competition intramodally, i.e., coasting shipping (Canada Transportation Act Review, 2001).

3.0 Issues and recommendations from the Report on Coasting Trade in Canada, 1969

In 1969, H.J. Darling led the Water Transport Committee of the Canadian Transport Commission on an Inquiry to produce a report on the laws respecting the coasting trade of Canada. It was to be reported to the Minister of Transport. The purpose was to determine the suitability of these laws with respect to the needs of the national transportation policy.

The Darling Inquiry was established because there was concern with Commonwealth shipping participating in transporting grain from Thunder Bay to Halifax. The problem was that while Commonwealth ships were allowed to participate in the coasting trade, several new Commonwealth countries emerged since the signing of the original agreement. While these countries probably did not want to participate in this trade, there was nothing stopping other shippers from using these countries as a flag of convenience. The Inquiry recognized the gap between Canadian and British wages had increased, as British ships employed many low wage earners from other Commonwealth countries (Darling, 1970a).

Both the Darling Report and the Spence Commission were to look at the future of coasting trading, but they ended up with two different conclusions. The Spence Commission recommended no change in the legislation based on the BCMSA since it would harm the economy by restricting competition. The Darling Report believed this economic policy would treat coasting trade as any other industry in Canada. The reports scope differed in the sense that the St. Lawrence Seaway had been opened for several years prior to the Darling Report, therefore Darling had more information regarding the implications on coasting shipping (Darling, 1970b).

The Report outlined 15 recommendations on marine policy regarding coasting trade. The most sweeping recommendations are presented below:

1. Canadian coasting trade would be for Canadian Flag vessels only, therefore Canada would withdraw from the British Commonwealth Merchant Shipping Agreement
2. The same would apply to marine activities of dredging, salvage, seismographic, supply and support vessels in off-shore drilling, excluding drilling platforms or rigs, unless self-propelled

3. Coasting trade law should apply to the Canadian Continental Shelf where resource exploration and exploitation should take place
4. Shipping policy agents should be allowed to issue permits to non-Canadian flag vessels to participate in coasting trade where it finds Canadian vessels are unavailable, insufficient or inadequate for the purpose
5. Permit issuing policy should be aimed towards replacing foreign vessels by Canadian vessels in the Canadian coasting trade
6. Reduce the restrictions and contradictions between the US and Canada laws regarding towing operations between the Great Lakes and the Atlantic Ocean
7. Temporary duty permits should be based on $1/60^{th}$ of the value of the hull per month
8. The granting of rights of exploration and exploitation of resources in the Territories, Arctic islands, or off shore areas should contain conditions on use of Canadian shipping
9. Government assistance to new industries should have attached, where feasible, conditions on the extent of use of Canadian shipping
10. Feasibility of government guaranteed marine insurance scheme for Canadian Flag vessels to assure reasonable rates and dates of application for navigation in winter season or in ice-infested waters should be investigated

These recommendations were a radical departure from the existing Canada Shipping Act (1952) regarding coasting shipping (Part XIII). It could be stated that Part XIII was an anachronism; its provisions regarding British ships could be traced back to the 18^{th} century. Part XIII was very limited in scope, especially considering the huge implications of new Commonwealth countries that could be used for flags of convenience. The Darling Report challenged both this section of the Act, as well as the Spence Commission's position on keeping the status quo.

4.0 History of coasting trade – Post-Darling Report (1969-1992)

4.1 Events timeline, 1970's

Following the release of the Darling report, internal discussions were held between interested government departments as well as official discussions with the provinces most directly affected by changes in coasting trade policy (Lang, 1977). In 1973, Jean Marchand, then Minister of Transport, announced Government's intention to proceed with a program regarding the coasting trade. This resulted in a partial withdrawal from the British Commonwealth Merchant Shipping Agreement, however this did not automatically change the Canadian Law. Lang identified the need for Canada to update the Canada Shipping Act.

In 1975, the Federal Government introduced Bill C-61 in parliament. This was to establish a Maritime Code to replace the Canada Shipping Act. Since the parties involved could not agree on coasting shipping policies, these provisions were removed from this Maritime Code. The Maritime Code was reintroduced as Bill C-41. Discussions were to be held in regards to a separate Coasting Trade Bill, which were summarized in Lang's position paper.

The new Coasting Trade Bill was designed to facilitate greater participation by Canadian Ships in the coasting trade as well as providing for service by foreign ships where Canadian ships could not provide adequate service to the public (Lang, 1977a). However, this Bill rested in limbo for several years.

4.2 Freedom to Move, 1985

In 1985, a landmark white paper was produced entitled "Freedom to Move: A Framework for Transportation Reform". The paper proposed legislative change "which will free Canada's transportation system from the burden of excessive economic regulation" (Government of Canada, 2003). In October of 1985, then Minister of Transport Don Mazankowski, announced in the House of Commons

proposing to amend the Canada Shipping Act to restrict the coasting trade to Canadian shipping "and would extend the act's jurisdiction to at least 200 nautical miles offshore while expanding the act to cover all commercial marine activities except fishing" (Government of Canada, 1985). Mr. T.N. Hall, then President of Dominion Marine Association: Canadian Shipowners Association, indicated his organization's support for the Minister's proposed amendments, a position that this organization had taken over 40 years earlier.

4.3 Canada Shipping Act – 1990 Part X Coasting Trade of Canada

By 1990, there were only minimal changes to the Coasting Trade part of the Coasting Shipping Act. Several parts of the section comprised of similar text to that of the 1952 Canada Shipping Act. It was evident that this part of the Act needed revision. Some of the fines had not changed since 1952. In 1990, Part X referred exclusively to British ships, and that Canadian ships fell under that jurisdiction. Similar to 1952, no foreign-built British ship, whether registered in Canada or elsewhere, was entitled to take part in the coasting trade of Canada without a license from the Minister of National Revenue (Canada Shipping Act, 1990).

4.4 Coasting Trade Act – 1992

In 1992, the Coasting Trade Act was enacted into law. This Act replaced Part X of the Canada Shipping Act. The Act provides for protection for Canadian ships by reserving the coasting trade for Canadian flag carriers. Only if a Canadian ship were unavailable to perform a task would a foreign carrier be used. The Act only allows foreign carriers and non-duty paid carriers to operate in the coasting trade with a license. However, there are various provisions for foreign vessels conducting research for the Department of Fisheries and Oceans, and vessels with permission from the Minister of Foreign Affairs to conduct scientific research (Coasting Trade Act, 1992)

A significant change from Part X of the Canada Shipping Act (1990)

to the Coasting Trade Act was the definition of "coasting trade". In Part X, the "coasting trade of Canada" included the carriage by water of goods or passengers from one port or place in Canada to another port or place in Canada. The definition of "place" could have various meanings, and this was clarified in the Coasting Trade Act. Coasting trade in the Coasting Trade Act also included the areas in and around the Continental Shelf, as well as "the carriage of goods only in relation to the exploration, exploitation or transportation of the mineral or non-living natural resources of the continental shelf of Canada" (Coasting Trade Act, 1992a).

4.5 Straight Ahead Policy Document, 2003

In 2003, Transport Canada released its strategic policy document *Straight Ahead* as the transportation blueprint for Canada (Straight Ahead, 2003). *Straight Ahead* continues the federal governmental doctrine of economic deregulation and privatization of transportation set out in *Freedom to Move*. *Straight Ahead* does mention that the US cabotage restrictions are what prevent Canada from considering bi-lateral liberalization but offers no concrete action for resolution (Straight Ahead, 2003a). There is also no outline for a national shipbuilding strategy that would be make the best use of a protectionist measure such as the Coasting Trade Act.

5.0 Comparing the Darling Report and the Coasting Trade Act (1992)

The Coasting Trade Act brought for the first time in Canadian coasting trade law a direct reference to the Continental Shelf as a limit to the Canadian coasting trade jurisdiction. This was a recommendation by the Darling Report, primarily in response to the possibility of petroleum extraction from that area. Through an examination of various sections in the Coasting Trade Act, it is evident of the Darling Report's influence on this legislation.

5.1 Recommendations adopted into legislation

The following is a list of Darling's abridged recommendations followed by the corresponding adopted sections in the Coasting Trade Act (1992).

1. Canadian coasting trade would be for Canadian Flag vessels only, therefore Canada would withdraw from the British Commonwealth Merchant Shipping Agreement

This is reflected in the Coasting Trade Act (1992) Section 3, subsection 1:

(1)Subject to subsections (2)to (5), no foreign ship or non-duty paid ship shall, except under and in accordance with a license, engage in the coasting trade.

1. The same would apply to marine activities of dredging, salvage, seismographic, supply and support vessels in off-shore drilling, excluding drilling platforms or rigs, unless self-propelled
2. Coasting trade law should apply to the Canadian Continental Shelf where resource exploration and exploitation should take place

Both these recommendations are reflected in the Coasting Trade Act (1992) Section 1, definitions of coasting trade, as well as Section 2, subsection 2:

For the purpose of the definition "coasting trade" in subsection (1), a place above the continental shelf of Canada includes any ship, offshore drilling unit, production platform, artificial island, subsea installation, pumping station, living accommodation, storage structure, loading or landing platform, dredge, floating crane, pipelaying or other barge or pipeline and any anchor, anchor cable or rig pad used in connection therewith

3. Shipping policy agents should be allowed to issue permits to non-Canadian flag vessels to participate in coasting trade where it finds Canadian vessels are

unavailable, insufficient or inadequate for the purpose.

Coasting Trade Act (1992), Section 4, subsection 1a:
(1)Subject to section 7, on application therefor by a person resident in Canada acting on behalf of a foreign ship, the Minister of National Revenue shall issue a licence in respect of the foreign ship, where the Minister is satisfied that

> *(a) the Agency has determined that no Canadian ship or non-duty paid ship is suitable and available to provide the service or perform the activity described in the application;*

Darling's other policy recommendations were not incorporated into the Coasting Trade Act. This could be for several reasons. It is possible that they made their way into other legislation relating to customs and national revenue, or they had already been implemented, such as the withdrawal from the BCMSA. It is also possible that by the time the legislation for the Coasting Trade Act was introduced, the recommendations no longer were applicable due to industry changes, i.e. the growth of containerization, the consolidation of Canadian ports, the growth of trucking over rail, and the growth of remote airports. This makes sense due to the fact that the first several recommendations broadly refer to coasting trade in general, while the latter recommendations are more specific.

6.0 Conclusions

It can be said that the main recommendations of the Darling Report were the template for today's Coasting Trade Act specifically- a Canada-First-if-possible policy for coasting trade. In the years following the report, many of those involved with drafting new coasting trade policies used this Report as a basis. History has shown that protectionist coasting shipping policies have never been a priority for the Government, and that Darling's report was the first real policy document that ventured beyond the view of Canada as a colony. Essentially it is a protectionist measure for Canadian shipping, yet

enough clauses exist in the current legislation so that other flag carriers can participate in coasting trade with proper permits.

6.1 Observations

The main concern with this process was that it took 22 years for the government to fully implement the main ideas of the Report, and it was during these years that so many technological and economic changes affected the transportation industry. Consequently, it is very possible that the effect of the Darling Report on Canadian coasting trade may have a much different impact than what was originally envisioned. On the other hand, the Report did have some great foresight, as large scale petroleum extraction on the Continental Shelf only recently have been successful, including Sable Island natural gas, and Hibernia. These projects would be governed by the Coasting Trade Act, therefore Canadian shippers should see some benefit.

6.2 Final Commentary

A more cynical view may be to consider Darling's recommendations and the Coasting Trade Act actually conceding shipbuilding to other countries, with a view that if Canada cannot build them, at least it can profit in terms of a duty. This could be based on the uncertainty if a strictly protectionist measure could result in increased shipbuilding in Canada (unless it can be proven that enough traffic exists to offset the higher costs).

As a protectionist measure of Canadian shipbuilding, the Coasting Trade Act cannot be considered a success. Since its implementation, shipyards including Saint John (NB) Shipbuilding have closed. Since the Act is flexible in allowing foreign-built ships to participate in the coasting trade, carriers can still built ships elsewhere, pay the 25% duty on the hull value, and have it cost less than if it were built here in Canada. This sentiment was reflected by a Shipping Line Owner that recently gave a lecture at the University of New Brunswick in 2003.

The *Straight Ahead* document highlights two conflicting federal government philosophies regarding marine policy today: that of allowing market forces to dictate the provision of transportation services; and the necessity of protecting Canadian shipping interests contrary to market forces. Unfortunately, neither philosophy has been particularly well practiced.

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Prediction of Freeway Crash Potential for Real-Time Crash Prevention

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Abstract

This paper proposes a probabilistic model that predicts vehicle crash potential on the basis of real-time traffic flow data and also discusses the potential application of the model to real-time safety intervention for freeway crash prevention. The proposed crash potential model indicates that high turbulence of traffic flow generally yields high crash potential. For practical application of the model to real traffic conditions, we need to have a mechanism or intervention strategy, such that, when necessary, driver behaviour can be influenced to reduce crash potential. It is expected that intervention would only occur when the crash potential exceeds some predetermined thresholds. Consequently, this study suggests guidelines for determining appropriate thresholds of crash potential and discusses a method for evaluating the safety benefit of one specific crash intervention strategy (variable speed limits) within a proposed integrated evaluation framework.

1. Introduction

Freeway crashes are one of the most common types of automobile collision in Ontario. Many of freeway crashes occur when vehicles travelling at a high speed suddenly encounter a queue of slower moving vehicles ahead. In particular, crash potential will be much

higher under condition of poor visibility due to fog and snow. The term "crash potential" refers to long-term likelihood that a crash will occur for given traffic, environment, and roadway conditions. Clearly, the crash potential strongly depends on time-dependent factors such as variation of traffic flow, weather, road condition, driver behaviour, etc.

However, most existing crash prediction models have only used static measures of traffic flow and they are not suitable for the application to real-time traffic control. For the estimation of crash potential in real-time, the traffic conditions that contribute to changes in crash potential in time (referred to as crash precursors) need to be identified.

In this regard, a probabilistic crash prediction model that estimates real-time crash potential based on the current traffic flow condition was developed. The objectives of this study are: (1) to develop a real-time crash prediction model relating crash precursors to changes in crash potential; (2) to describe a method for defining tolerance levels of crash potential estimated by the proposed model; and (3) to suggest a framework by which the safety benefit of a method of real-time intervention (variable speed limit) can be evaluated.

2. Prediction of Real-Time Crash Potential

2.1. Proposed Model

In the proposed real-time crash prediction model, crash potential is expressed in a function of crash precursors and a number of external control factors. The traffic factors such as speed variance and density that are closely related to turbulence or stability in traffic flow condition were considered initially as candidate crash precursors. These precursors were measured for both traffic conditions at time of crashes and normal non-crash traffic conditions. Normal non-crash traffic conditions represent the conditions where crashes did not occur with controlled for road geometry, weather condition, and time period. The detailed description of crash precursors was determined

by comparing the distributions of crash precursor values between these crash and non-crash cases.

Using a sample of crash and traffic data, the following three crash precursor variables were identified: (1) the coefficient of variation of speed (= standard deviation of speed divided by average speed) upstream of a specific location (CVS); (2) average difference in speed between the upstream and downstream of a specific location (Q); and (3) average cross-sectional (between adjacent lanes) covariance of volume difference between the upstream and downstream of a specific location ($COVV$). A detailed description of these three precursors is provided as follows:

$$CVS = \frac{1}{n}\sum_{i=1}^{n}\frac{(\sigma_s)_i}{\bar{s}_i} = \frac{1}{n}\sum_{i=1}^{n}\left(\sqrt{\frac{\frac{\Delta t}{t_p}\sum_{t=t^*-\Delta t}^{t^*}(s_i(t))^2-\left(\sum_{t=t^*-\Delta t}^{t^*}s_i(t)\right)^2}{\frac{\Delta t}{t_p}\left(\frac{\Delta t}{t_p}-1\right)}}\Bigg/\frac{\sum_{t=t^*-\Delta t}^{t^*}s_i(t)}{\left(\frac{\Delta t}{t_p}\right)}\right) \quad (1)$$

where,

t^* : actual time of crash occurrence;

Δt : observation time slice duration (seconds);

$(\sigma_s)_i$: standard deviation of speed on lane i computed over period Δt upstream of a location;

$\bar{s}_i$: average speed on lane i computed over period Δt (km/hour) upstream of a location;

t_p : time interval of observation of speed (seconds);

$s_i(t)$: speed on lane i at time t (km/hour) upstream of a location;

n : total number of lanes.

$$Q = |\bar{s}_1 - \bar{s}_2| = \left| \frac{t_p}{\Delta t} \sum_{t=t^*-\Delta t}^{t^*} \left(\frac{1}{n_1} \sum_{i=1}^{n_1} s_{1i}(t) \right) - \frac{t_p}{\Delta t} \sum_{t=t^*-\Delta t}^{t^*} \left(\frac{1}{n_2} \sum_{i=1}^{n_2} s_{2i}(t) \right) \right| \quad (2)$$

where,

Q : average speed difference between upstream and downstream of a location (km/hour);

$\bar{s}_1, \bar{s}_2$: average speed computed over period of Δt upstream and downstream of a location, respectively (km/hour);

$s_{1i}(t)$: speed on lane i at time t upstream of a location (km/hour);

$s_{2i}(t)$: speed on lane i at time t downstream of a location (km/hour);

n_1, n_2 : number of lanes upstream and downstream of a location, respectively.

$$COVV = \frac{1}{n-1} \sum_{i=1}^{n-1} \left| \mathrm{cov}(\mathrm{V}_i, \mathrm{V}_{i+1}) \right| = \frac{1}{n-1} \sum_{i=1}^{n-1} \sum_{t=t^*-\Delta t}^{t^*} \left[\left(\Delta v_i(t) - \Delta \bar{v}_i \right) \left(\Delta v_{i+1}(t) - \Delta \bar{v}_{i+1} \right) \right] \quad (3)$$

where,

$\Delta v_i(t)$: volume difference between upstream and downstream of location on the lane i at time interval t;

$\Delta \bar{v}_i$: average volume difference on the lane i during Δt;

$\mathbf{V}_i$: arrays of $\Delta v_i(t)$ during Δt (i.e. $\mathbf{V}_i = \{\Delta v_i(t_0), \Delta v_i(t_0+1), \ldots, \Delta v_i(t_0+\Delta t\ \}$).

* Lane i and lane $i+1$ are adjacent lanes.

In addition to the three crash precursors, several external traffic and environmental conditions that affect crash potential were considered as control factors. These control factors are (1) road geometry (road sections with no ramp and road sections with on or off-ramps) and

(2) the peak/off-peak traffic pattern (peak period (7-10 am, 4-7 pm) and off-peak period (other than peak period)). To investigate the relationship between crash potential and crash precursor variables, a crash prediction model is developed as follows:

$$\ln(F) = \theta + \lambda_{CVS(i)} + \lambda_{Q(j)} + \lambda_{COVV(k)} + \lambda_{R(l)} + \lambda_{P(m)} + \beta \ln(EXP) \quad (4)$$

where,

F : the expected number of crashes;
EXP : the exposure in vehicle-kilometers of travel;
β : the parameter for the exposure;
θ : constant;
$\lambda_{CVS(i)}$: effect of the crash precursor variable CVS having i levels;
$\lambda_{Q(j)}$: effect of the crash precursor Q having j levels;
$\lambda_{COVV(k)}$: effect of the crash precursor $COVV$ having k levels;
$\lambda_{R(l)}$: effect of road geometry (control factor) having l levels;
$\lambda_{P(m)}$: effect of the peak/off-peak traffic pattern (control factor) having m levels.

In this study, crash rate is used as an input to establish crash potential. Crash rate is expressed as the number of crashes over some functions of exposure. In Equation 4, all the variables except exposure are defined as categorical inputs in the model. Exposure is defined in terms of vehicle-km of travel and included as a continuous offset term (in log transform). The number of categories and the boundary values for crash precursors depends on the analyst's subjective judgment. Thus, the reliability of the model estimates for different categorizations must be insured.

2.2. Description of Data

To estimate the above parameters of the proposed model, the model was applied to incident logs and traffic flow data extracted from 38

loop detectors along a 10-km stretch of the Gardiner Expressway in Toronto, Ontario. These data were collected for weekdays over a 13-month period from the beginning of January 1998 to the end of January 1999.

During the observation period, a total of 234 crashes were visually confirmed and recorded by the traffic control center. Crashes are a subset of all incidents that are reported by the center. In this study, only confirmed single-vehicle and multi-vehicle crashes were used because the purpose of the model is to predict the variation of crash potential that occurs as a result of the vehicle interactions under different traffic conditions. Other incident types, such as stalled vehicles, spilled loads, etc., were excluded in the data. The incidents are typically first detected by the loop detectors using automated incident detection algorithms and subsequently confirmed visually by an operator at the traffic control center through closed-circuit TV camera feeds. The traffic flow data from loop detectors contain 20-second average speed (space-mean speed), volume, and occupancy on each lane. The incident logs contain the information on date and time of detection, type of incident, lane block pattern, and the loop detector station immediately *upstream* of the actual crash site.

2.3. Calculation of Crash Precursors

Crash precursors were computed on the basis of a time series static measurement obtained from a particular loop detector. Consequently, the calculation of the precursor values requires that the appropriate loop detector be specified (i.e. location) and the length of time for which detector data will be considered in the calculation of the precursor value, must be specified. In terms of the location, crash precursors were measured at detector stations immediately upstream of the crash site because crash precursors represent the traffic condition experienced by drivers before they reach the location of the crash. The time duration of measurement is some observation time period prior to the actual time of the crash. However, since the actual time of crashes is not readily available in crash records, it is estimated using an analytical method (e.g. shock wave analysis).

The observation time duration prior to the crash occurrence is determined for each crash precursor individually such that the difference in the distribution of crash precursor values for given time duration between crash and non-crash cases is maximized. The optimal observation time durations for CVS, Q, and COV were found to be 8, 2, and 2 minutes, respectively.

2.4. Results of Calibration

With all the crash precursors and external control factors, the log-linear model was calibrated using the Gardiner Expressway data. Due to uncertainty associated with the number of categories and the boundary values for crash precursors, the model parameters were estimated for different categorizations. The goodness of fit of the log-linear model was measured by comparing the distribution of expected number of crashes and the crash frequency in the observed data, and the similarity of distribution can be evaluated with chi-square test. For the case of three categories, it was found that the models consistently fit to the observed data very well for all nine cases of categorization since chi-square values were lower than critical values for a 95% confidence level as shown in Table 1.

In the table, lower coefficients indicate less impact on crash potential with respect to aliased cells. The results generally agreed with our expectation, in that higher crash precursor values associate with higher crash potential. The results also suggest that crashes are more likely to occur on road sections with ramps and in peak hour when traffic is more congested. When compared for 9 different cases, higher precursor values tend to reflect higher crash potential. The model appears to yield consistent and reasonable results. For different categorization, the values of parameters were observed to change slightly but the general relationships remained the same, such that model results were not sensitive to subjective categorization.

Table 1. Estimated Parameter of a Log-linear Model

Parameters	Assumed Proportions of Crash Precursors (%Low/%Intermediate/%High)								
	20/60/20	20/50/30	30/50/20	33/33/33	40/40/20	40/30/30	50/30/20	50/20/30	60/20/20
θ	3.0	3.0	3.0	1.0	2.8	1.9	2.8	2.9	2.9
$\lambda_{CVS=1}$	-4.9	-4.3	-3.2	-3.0	-3.0	-3.4	-2.9	-3.0	-2.4
$\lambda_{CVS=2}$	-1.3	-2.5	-1.7	-1.9	-1.8	-2.0	-1.6	-2.1	-1.6
$\lambda_{CVS=3}$	0	0	0	0	0	0	0	0	0
$\lambda_{Q=1}$	-2.6	-2.2	-2.2	-2.1	-2.3	-2.6	-2.5	-2.4	-1.9
$\lambda_{Q=2}$	-1.0	-2.4	-1.4	-2.0	-1.6	-2.1	-1.4	-2.2	-1.4
$\lambda_{Q=3}$*	0	0	0	0	0	0	0	0	0
$\lambda_{COVV=1}$	-2.6	-2.3	-2.0	-1.9	-2.0	-2.5	-2.2	-2.2	-1.5
$\lambda_{COVV=2}$	-0.6	-1.6	-1.0	-1.2	-1.2	-1.2	-1.0	-1.2	-1.0
$\lambda_{COVV=3}$*	0	0	0	0	0	0	0	0	0
$\lambda_{R=0}$	-0.4	-0.6	-0.4	-1.0	-0.5	-0.8	-0.5	-0.6	-0.5
$\lambda_{R=1}$*	0	0	0	0	0	0	0	0	0
$\lambda_{P=0}$	-0.4	-1.0	-0.5	-2.4	-0.8	-1.7	-0.8	-0.9	-0.6
$\lambda_{P=1}$*	0	0	0	0	0	0	0	0	0
Likelihood Ratio	65.5	28.9	61.2	20.2	49.7	23.3	47.8	33.6	68.7
p-value (α=0.05)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

* Aliased cell serves as the basis against which log-linear parameters are applied to obtain crash frequency for any combination of crash precursors.

Description of parameters

θ: Constant;

$\lambda_{CVS=1}$, $\lambda_{CVS=2}$, $\lambda_{CVS=3}$: Effect of CVS (=1 (low), =2 (intermediate), =3 (high));

$\lambda_{Q=1}$, $\lambda_{Q=2}$, $\lambda_{Q=3}$: Effect of Q (=1 (low), =2 (intermediate), =3 (high));

$\lambda_{COVV=1}$, $\lambda_{COVV=2}$, $\lambda_{COVV=3}$: Effect of $COVV$ (=1 (low), =2 (intermediate), =3 (high));

$\lambda_{R=0}$, $\lambda_{R=1}$: Effect of road geometry (=0 (straight section), =1 (merge/diverge section));

$\lambda_{P=0}$, $\lambda_{P=1}$: Effect of time of day (=0 (off-peak), =1 (peak));

3. Framework of Real-Time Crash Prevention

This section discusses how the proposed model can be applied to real-time freeway crash prevention. Figure 1 shows the framework of real-time crash prevention. As an input to the real-time crash prediction model, traffic flow data are collected from traffic surveillance systems in real-time. Using these data, crash precursors are calculated. After these precursors are categorized into different levels, the real-time crash prediction model estimates crash potential at different time intervals. Then the estimates of crash potential are compared to pre-specified threshold values. If they exceed the thresholds, crash intervention measures are introduced. Otherwise, no action is taken. The intervention measures will affect traffic conditions and they will also change the corresponding crash precursor values. The changes in precursor values, in turn, affect crash potential in the next time interval and so on. The intervention remains in effect until crash potential drops below the threshold values.

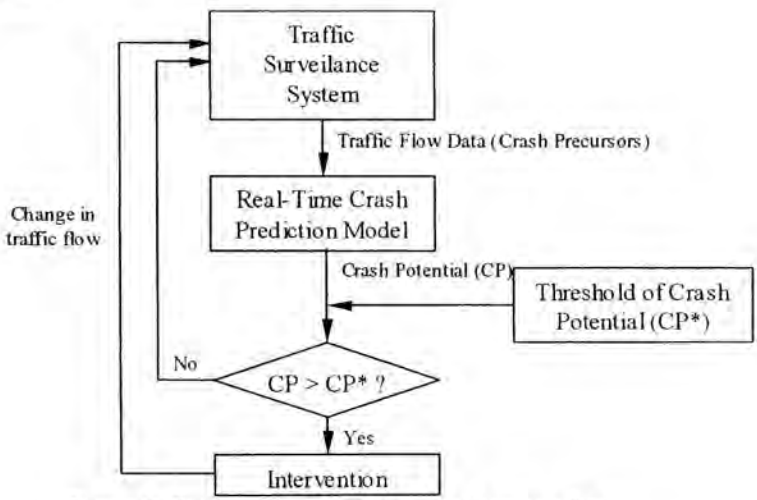


Figure 1. Framework of real-time crash prevention

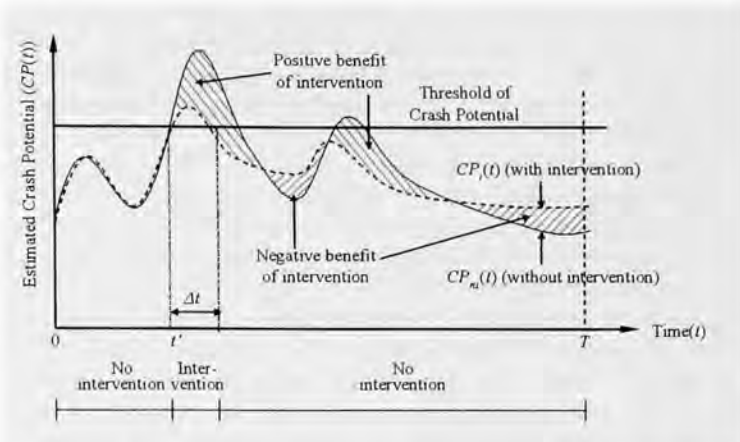


Figure 2. Comparison of estimated crash potential between the cases with and without crash intervention

To define thresholds of crash potential (CP^*), the benefit and cost of intervention must be compared. In this study, the reduction in crash potential is considered as the benefit of intervention and traffic delay and operation cost as the cost of intervention. The benefit of intervention can be quantified by measuring the reduction of crash potential after intervention is undertaken. As illustrated in Figure 2, the estimated crash potential is compared between two cases: one without intervention and one with the intervention. Assuming that intervention is in effect for the duration of Δt, the total difference in crash potential, accumulated over time, between the two cases reflects the benefit of real-time crash prevention (Equation 5):

$$B = \int_{t'}^{T} \left[CP_{ni}(t) - CP_i(t) \right] dt \tag{5}$$

where,

B : benefit associated with reduction in crash potential

t' : time when intervention starts (i.e. when $CP_{nt}(t) >$ threshold of crash potential);

T : end time of comparison;

$CP_{nt}(t)$: estimated crash potential at time t in the case without intervention;

$CP_t(t)$: estimated crash potential at time t in the case with intervention.

However, as the benefit of intervention increases, the cost of intervention such as traffic delay and operation cost will also increase. Thus the benefit needs to be compared to these additional costs. From the comparison, we can identify the point where the rate of increase in benefit for additional cost becomes less pronounced and intervention becomes less cost-effective.

The effectiveness of intervention strongly depends on the form of intervention strategy. A number of intervention strategies such as variable speed limits, ramp metering, etc., can be considered. In this paper, we confine the scope of the study to variable speed limits.

A number of European studies have shown both theoretically and empirically that the use of variable speed limits can stabilize traffic flow in congestion and thereby decrease the probability of crashes (Hines, 2002). Before the implementation of variable speed limits, we need to understand how drivers normally react to change in speed limits and how driver's behaviour changes traffic flow characteristics. In the past, many researchers examined the effect of variable speed limits on changes in traffic flows (e,g, Rämä, 1999; Smulders, 1990). In these studies, it was commonly observed that when the speed limit was reduced, mean speed, speed variance, and the proportion of short time headways were also reduced. This result implies that speed limit changes homogenize individual drivers' speeds and maintain the stable traffic flow.

4. Evaluation of Real-Time Intervention

To evaluate the effectiveness of variable speed limits in the reduction of crash potential, the relationship between speed limits and traffic flow changes must be examined. This relationship can be observed either from field experiment or simulation. However, to avoid the complexity, cost, and safety issues associated with staging field experiment and directly measuring drivers' reaction especially under the condition of change in speed limits, a microscopic traffic simulation model is used instead.

A microscopic traffic simulation model tracks individual vehicles' movements for the duration of their entire trip and therefore, it is more advantageous than a macroscopic model in evaluating the operation of real-time traffic management and control. In experimenting variable speed limits using a microscopic model, the following conditions must be met. First, the model should permit changes in posted speed limits without resetting the simulation so that crash potential profiles can be estimated continuously before and after speed limit changes. Second, the model should provide instantaneous traffic flow data for individual vehicles and drivers, which can be aggregated to give speed and volume of entire traffic stream. These aggregated data are used to calculate crash precursors that are input to the real-time crash prediction model.

However, due to possible discrepancy between real-world driving behaviour and the simulation model, the simulation results must be validated against the observed field data. In this study, a microscopic traffic simulation model INTEGRATION (Van Aerde, 1998) was selected for the validation.

In the validation of the model, a 4-km section of the Gardiner Expressway (Figure 3) was selected for which we estimated the parameters such as speed, speed variance and density. The study area is a three-lane roadway section and all the parameters are averaged over three lanes at the location of six detector stations.

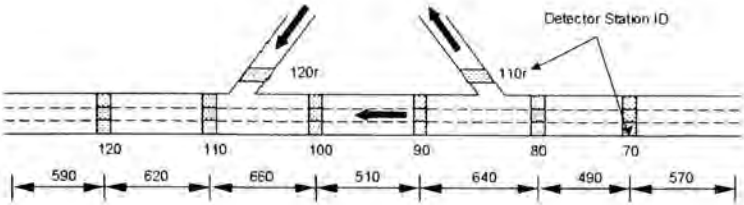


Figure 3. Schematic drawing of the westbound three-lane Gardiner Expressway (Distances between detector stations in meters)

The profiles of speed, speed variance and density were obtained for a two-hour period (3 – 5 pm) at the current posted speed limit of 90 km/hour. In a similar fashion, the profiles were also obtained using INTEGRATION. In INTEGRATION, the input parameters associated with macroscopic traffic flow relationship such as free-flow speed, speed at capacity, capacity and jam density were chosen to reflect the prevailing traffic conditions in the study area. These parameters can reflect the effect of speed limit changes in the simulation model because speed-flow-density relationship normally changes when speed limit changes (Sailer et al., 1997)

In comparison of the observed and simulated speed, speed variance and density profiles at the selected road segment, we observed that a simulation model could yield a good representation of changing traffic conditions affected by speed limits and we can apply the simulation model to examine the effect of changing speed limits on crash potential.

After the simulation model is validated, the appropriate intervention strategy (in this case, the reduction of speed limits) must be determined when crash potential exceeds thresholds. For this task, different estimates of total crash potential are obtained for different speed limits for the given duration of intervention. In each scenario, the total crash potential is compared with the total crash potential

without intervention to estimate the benefit of speed limits reduction. Finally, the speed limit where the benefit of speed limits reduction is cost-effective is selected as the optimal speed limit.

5. Summary and Recommendation

This study developed a real-time crash prediction model using the selected crash precursors and discussed the application of the model to real-time crash prevention. The model overcomes the limitations of the existing static crash prediction models that relate crashes to fixed geometric and non time-dependent traffic flow characteristics. Unlike the existing models, the model takes into account the short-term variation of traffic flow to estimate crash potential in real-time.

In the implementation of real-time crash prevention using the model, we must determine the form of intervention strategy. Among a number of real-time intervention strategies, the variable speed limits are selected for the analysis because the restriction of speed is effective in leading to stable traffic condition by reducing speed variance. To apply the model to variable speed limits, it is important to examine whether crash precursors are greatly affected by the speed limit changes and how the change in values of crash precursors has an impact on crash potential.

To evaluate the performance of variable speed limits, this study suggested to use a microscopic traffic simulation model since it allows us to diagnose the effect of different speed limits on temporal variation of traffic flow, and furthermore the variation of crash potential. The simulated traffic conditions were validated by comparing with the observed data and they were found to realistically reflect real-world driving behaviour. This result indicates a simulation model can be used as a tool to analyze safety benefit of real-time crash intervention.

In future work, the robustness of the model needs to be examined as to whether it realistically reflects crash potential in real world. This can be evaluated by validating the model for different data set

(collected from different freeways) that was not used as a part of the calibration. Work needs to be done to examine the effect of different compliance rates on safety benefits of speed controls. It is difficult to make any definitive conclusion on the effectiveness of variable speed limits using INTEGRATION alone, in the absence of more extensive field testing. Driver responses can be inferred through the observation of common changes in driver behaviour when the speed limits change based on the past experimental studies. The effect on crash potential of variable speed limits can be analyzed on the basis of interaction among vehicles that comply and those that do not using the simulation model.

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