

GRADUATE THESIS CONTEXT RESEARCH | TORONTO ECONOMIC INFRASTRUCTURE

THE MARKET ON THE RAILS

THE URBAN REVIVAL OF RAIL TRANSIT

ARCH 686 COMPETITIONS ELECTIVE

THE 2014-2015 STEEL DESIGN
STUDENT COMPETITION



CLARENCE ZICHEN QIAN 20579222

Contents

Chapter One: Bus or Subway?

Current Traffic Problems

- 1. Traffic Congestion*
- 2. Vehicle Pollution*
- 3. Parking*

Public Transit Solution: Bus, Light Rail Transit or Subway?

- 1. Efficiency: Ridership Comparison*
- 2. Investment: Cost and Construction Time*
- 3. Conclusion*

Chapter Two: Subway, the Basic Transportation

- 1. Workers Flow*
- 2. Local Consumers Flow*
- 3. Tourists Flow*
- 4. Youth Talents Flow*

Chapter Three: Subway, the New Economic Infrastructure

Current Economic Situation

- 1. Country-scale: Economy of Canada*
- 2. City-scale: Economy of Toronto*
- 3. Person-scale: Economy of Average Family*

Potential Industries

- 1. Finance.*
- 2. Media.*
- 3. Tourism.*

4. *Retail.*
5. *Restaurants and Bars*
6. *Landscape and sports facilities*
7. *Educational Institutes and Museum*

Functional Requirement of Project

Chapter Four: Trial_The Market on the Rails

Related cultural background

Concept and Materiality

1. *Moving Products*
2. *Changing Scale*

Chapter One: Bus or Subway?

Current Traffic Problems

1. Traffic Congestion

Traffic jams have become a widely social issue in Toronto. It is even getting worse now, either from the increase in the population and the transportation demand associated with it or from the growth of construction on city streets. According to Tom Tom's fifth annual traffic index ¹, the average commuter loses 84 hours a year being delayed in traffic while the average time lost to transit across the country is almost 79 hours. The average increase in morning peak travel times compared to a free flow situation is around 55%, while the increase in evening peak is about 65%. The high levels of congestion are due in part to the traditional workweek, giving people no choice but to all be on the road network at the exact same time.

2. Vehicle Pollution

Traffic pollution is responsible for approximately 280 of 1,300 premature deaths in Toronto every year, according to a 2009 analysis by Toronto Public Health. What is worse, "Previously people considered the emissions from cars could just travel 100 to 150 meters from the roadway, but we are finding that it is now over 280 meters from the roadway," said Greg Evans, a chemical engineer and one researcher from University of Toronto.

A study by researchers at Virginia Tech in the US

shows that traffic speed limitation can result in significantly higher fuel consumption and emission rates when drivers accelerate aggressively. It suggests that smoother driving patterns with milder acceleration behavior when compared to speed humps and stop signs can achieved significant energy and emission savings.²

3. Parking

Parking is a primo urban issue for motorists in Toronto, and its value grows as chronic traffic congestion grows ever worse. Increasing parking space has become more critical and planning rules require new multi-residential building provide close to one parking spot per person, plus visitor parking.

On the other hand, curbside parking is still available on most major roads, that is to say, a single car is able to block an entire artery for several hours for the price of a few coins in a parking meter. This outmoded way can lead to increasingly choking streets by traffic.

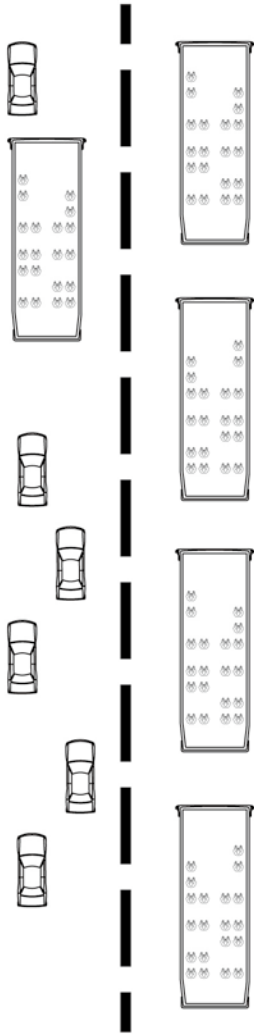
Public Transit Solution: Bus, Light Rail Transit or Subway?

Developed public transit system can efficiently reduce the number of private vehicles. Especially during the rush hour every day, if the public stops are available near the residence and citizens can arrive the workplace conveniently and quickly, nobody will deny the public transit is a better option, needless to say, people can do some reading or get a nap with getting free from intense driving.

1. Efficiency: Ridership Comparison (Figure 1)

Bus. Every bus can contain up to 2,000 riders per hour running in mixed traffic, while the capacity of passengers can reach 8,000 in a separate bus lane.

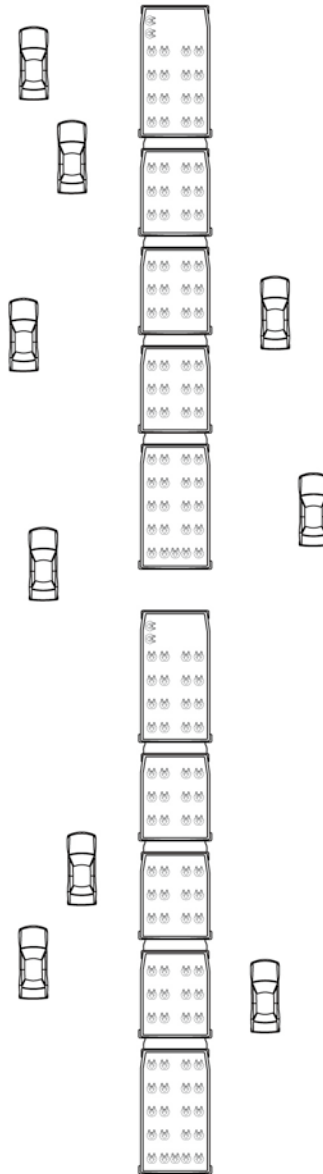
BUS



⊗ 100 persons per hour

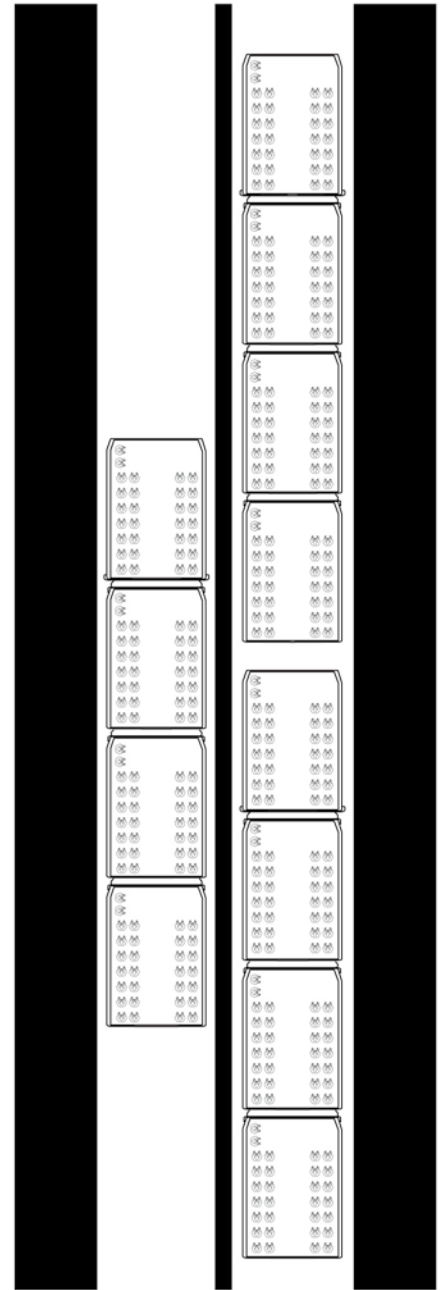
2,000(mixed)/8,000(separate)

LIGHT RAIL TRANSIT



2,000 to 15,000

SUBWAY



15,000 to 36,000

Figure 1: Ridership Comparison

LRT (Light Rail Transit). Depending on different traffic and signal conditions there will exist 2,000 to 15,000 persons on a route every hour.

Subway. As the most efficient transportation way,

BUS



444.3 km
< 18 months

LIGHT RAIL TRANSIT



125.5 km
< 18 months

SUBWAY



35.5 km
> 5 years

Figure 2: Investment: Cost and Construction Time

it can carry 15,000 to 36,000 people per hour per route.³

Overall, the subway ridership is much better than bus and LRT.

2. Investment: Cost and Construction Time (Figure 2)

As a large-scale infrastructure, the possible cost of fund and time should be considered carefully. According to the 2015-2024 Tax and Rate Supported Capital Budget and Plan ⁴, there are three categories associated with the public transportation improvement: TTC \$6,663 million, Scarborough Subway Extension \$3,409 million and Spadina Subway Extension \$592 million. In the next 10 years the government will totally invest about \$11 billion into public transit budget. By this \$11 billion, the bus system, LRT system and Metro system can be built in various length.

Bus. From the 2006 Toronto Transit Commission study, building a BRT in the Finch hydro corridor,

even with a number of construction and design issues such as the Highway 400 crossing, would cost about \$27-million per kilometer in today's dollars. That means if the government put all the fund into bus improvement, about 444.3 kilometers Bus Rapid Transit can be constructed.

LRT. Normally building Light Rail Transit is dramatically cheaper than subways to build: about \$85 million per kilometer. However in Toronto the price expands significantly when it runs in a tunnel like the one on Eglinton, closer to subway costs of up to about \$325 million per kilometer. Except for those special situations, 11billions can support 125.5 kilometers LRT by average construction fee.

Subway. Technically it is very expensive to build metro system, like TTC usually estimate the cost would reach about \$300 million per kilometer. And underground stations are also typically far more expensive. As a result the government can just own 35.5-kilometer subway system with the 11-billion budget.

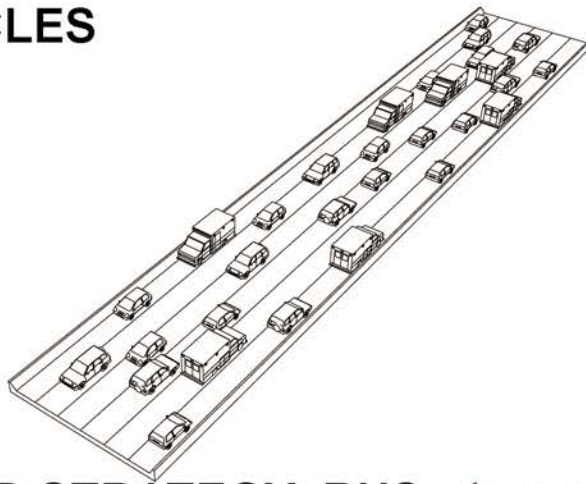
In most situations the construction time of bus and LRT systems will take less than 18 months to finish, while the subway will cost more than 5 years to complete the tunnels and underground stations.

3. Conclusion (Figure 3)

The comparisons make the pros and cons of these three systems very obvious. The quickest and the cheapest way to develop the public transit network is bus system, but at the same time, it can just release the congestion. The way which can really fix the issue is metro system with lots of money and time required.

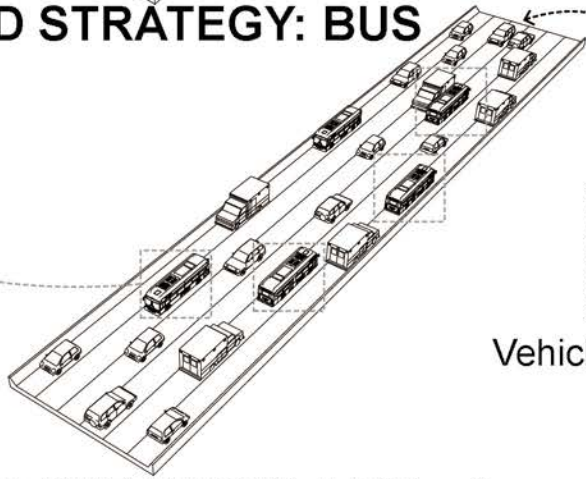
In essence, aboveground strategies like Bus Rapid Transit and light Rail Transit are reducing the traffic volume, like compressing several small private

201X PRIVATE VEHICLES

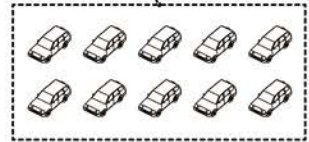


203X ABOVEGROUND STRATEGY: BUS

one public vehicle
replaces the private
vehicles

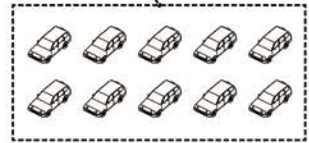
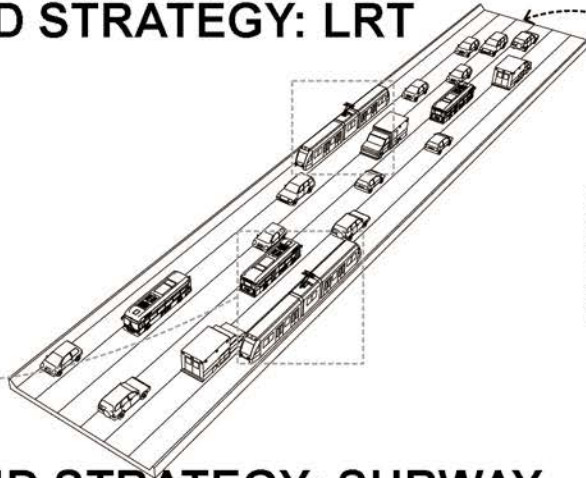
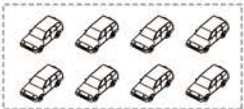


Vehicles increase every year



205X ABOVEGROUND STRATEGY: LRT

one public vehicle
replaces the private
vehicles



207X UNDERGROUND STRATEGY: SUBWAY

one public vehicle
replaces the private
vehicles

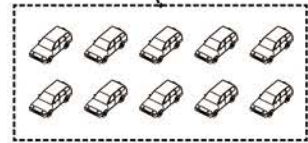
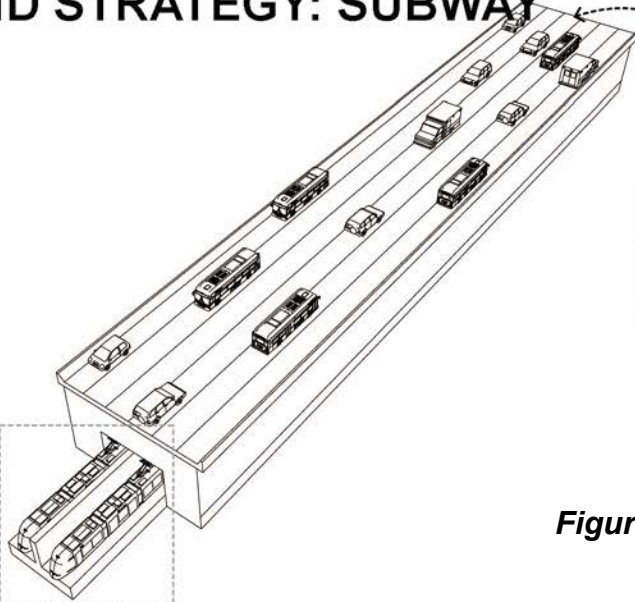
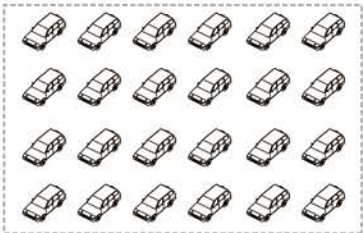


Figure 3: Transit Evolution

cars to one medium public vehicle, but those new public vehicles still exist on the road. However, the underground strategy is taking the traffic volume out of the roads and moving it underground. With the cars' increasing, there will be someday when reducing can not solve the jam, that is to say, even there are not private cars running in the street which can not happen because not all usage of private vehicles can be replaced by public buses, the number of buses can not still make the traffic flow move smoothly, at that time metro will come as a final solution.

Chapter Two: Subway, the Basic Transportation

Actually the subway system is a series of lines which connect different urban functional areas and transport passengers to their destinations with various purposes. Among the transportation, there are several typical people and models: workers between residence and workplace, local consumers from residence to various commercial zones, tourists among scenic spots and youth talents among nearby universities and enterprises.

1. Workers Flow

Considering the bad congestion on rush hours every day, efficient metro network can transport citizens from their houses to the downtown Toronto where many firms locate. With this commuting problem solved, the private vehicles volume will be successfully controlled, resulting in reducing air pollution, saving people's time and reasonable road usage. In addition, the public transit convenience makes it possible for more families own their houses outside Toronto city and extent to other cities like Mississauga.

Take Kipling station as an example. Now there are two rails through this TTC west terminal metro station: Bloor to Danforth subway Line 2 and GO station rail. If all the GO trains stop in Kipling station instead of continuing towards Union Station, then the government can add the trains frequency like 3 minutes interim between Mississauga and Kipling to let people can easily reach downtown for work.

This strategy can both benefit people, firms and government. Personally every family can afford cheaper house without heavy financial burden. Secondly having more human resource the firms can reduce salary cost and find exact suitable person who they want. Lastly as a city, sufficient connection with surrounding cities can maximize and diversify industries, especially to the metropolis Toronto which has no satellite cities challenge in economic status. Moreover multiple industries mean more financial security when some industries get affected by economic crisis, another can still carry on the tax support.

2. Local Consumers Flow

From an interactive survey called “How Canadian Are You” ⁵, the money spent on clothes, restaurants and alcohol occupies 42% of the total average annual bill on the shopping list. (Figure 4) After all most of the family income will be used for property taxes, personal transportation and daycare. With the accessible metro system and booming commerce, more consumption will be stimulated, more job opportunities will be offered and salary level will be improved. In turn the public could have more money to spend on consumption which can create a virtuous circulation.



Figure 4: Canadian Shopping List, Macleans.ca

3. Tourists Flow

As a significant and multi-cultural metropolis, Toronto is the leading tourism destination in Canada, attracting more than 25 million Canadian, American and international visitor annually. Tourism is a key export industry that plays an important role in the city’s economy, generating employment, foreign exchanging earnings, investment and regional development. Visitors spend \$5.1 billion, including \$1.8 billion for transportation, \$1.0 billion for accommodation, \$1.1 billion for food and beverages,

\$339 million for recreation and \$766 million for retail, which generating \$3.8 billion in Gross Domestic Product, almost \$2.5 billion in labor income and \$1.8 billion in total taxes (\$978.5 million in federal taxes, \$786.5 million in provincial taxes and \$14.4 million in municipal million). The Toronto Census Metropolitan Area has over 19,000 tourism- related businesses employing more than 329,000 people who work in tourism, hospitality and related services.⁶

Compared to the traffic congestion now, the public transit convenience can carry more visitors to different districts and bring economic incentive in the local development. What is more, if the metro itself becomes a special landscape attraction, if can connect some tourism districts together and share the consumers to create more value than separated and isolated spots.

4. Youth Talents Flow

Youth talent is the most valuable resource for the city, especially when it aims at developing multiple industries. With the intelligent support, those industries can realize long-term profit. Great Toronto Area has a huge advantage at this point because of surrounding by several excellent education institutions like University of Toronto, York University, Ryerson University, OCAD University, University of Waterloo, University of Guelph, Queen's University and McMaster University. The economic and fast public connection between industries and universities can ensure the personally social value achievement, universities' reputation, enterprises' success and city's boom.

Chapter Three: Subway, the New Economic Infrastructure

The Toronto Transit Commission has just recovered generally its operating costs from the fare box. With provincial operational subsidies ended by Harris Progressive Conservatives in Ontario in 1996, the municipal government has to suffer the financial burden alone. In order to facing the difficulties, the Toronto City Council voted to introduce new taxes to help pay for city services, including the TTC. Now the TTC becomes the largest transit operator in Anglo-America not to receive provincial and state subsidies. However, it is also considered one of the costliest transit systems per fare price in North America. For the 2011 operating year, the TTC had a projected operating budget of \$1.45 billion, 70% covered by fare revenue and 30% originated from the municipal subsidy.

On one hand, as a public service, TTC should not become a profit firm benefiting from fare. Most of the fare from citizens' pockets, increasing the transportation cost means raising the living cost in Toronto and resulting in talents loss especially for those poor young intellectuals, which seriously harm the long-term profit of the city. On the contrary, the fare may be decreased to offer cheaper commuting service and vibrancy. The only thing is avoiding the waste of transportation resource.

On the other hand, the operation revenue should also be perfectly solved. If the money must not be stole from residents' pockets, some industries have to pay for it. This is the most essential reason to develop subway system as an economic infrastructure. In

this proposal, TTC will promote several industries by offering convenient access of consumption activities, talents transportation and recreation service.

Current Economic Situation

1. Country-scale: Economy of Canada

As with other developed nations, the Canadian economy is dominated by the service industry, which employs about three quarters of Canadians. However, Canada is unusual among developed countries in the importance of the primary sector like logging and oil industries.

Canada also has a sizable manufacturing sector, based in central Canada, with the automobile industry and aircraft industry being especially important. With a long coastal line, Canada has the 8th largest commercial fishing and seafood industry in the world. It is one of the global leaders of the entertainment software industry.

In the GDP by sector and labor force by occupation, agriculture occupies 1.7% of the total products and offers jobs for 2% of population. Industry creates 28.5% profit, while manufacturing and construction provide respectively 13% and 6% occupation for the labor force. In addition, the services take up 69.8% of GDP and creates 76% of the total jobs.

The service sector in Canada is vast and multifaceted. The largest employer is the retail sector, employing almost 12% of Canadians. The second largest portion is the business service and hires only a slightly smaller percentage of the population, including the financial services, real estate and communication industries. This portion has been rapidly growing in recently years and is concentrated in the major urban centers like Toronto.

The education and health sectors are two of



Figure 5: Toronto Stock Exchange, wikipedia.

Canada's largest, but both of them are largely under the influence of the government. The health care industry has been quickly growing, which leads to problems for government to find money to fund it.

Canada also has a significant high tech industry, and burgeoning film, television, and entertainment industry creating content for local and international consumption.

2. City-scale: Economy of Toronto

The economy of Toronto plays a vital role in Canada's economy and that of the world. Toronto itself has diversified into service-based industries. It is the center of the Anglophone media industry in Canada, the advertising industry, the entertainment industry, the fashion industry, the pharmaceutical industry, the retail industry and the center of the financial industry in Canada. Toronto has also developed the software and tourism industry.

Finance. As one of the world's largest financial centers and the business and financial capital of Canada, Toronto hosts the Toronto Stock Exchange (Figure 5) which is the third largest stock change in Americas by market capitalization and seventh in the world. The financial district in Toronto, with approximately 205,000 staff in the Canada's biggest banks and brokerages, centers on Bay Street, the equivalent to Wall Street in New York City.

Media. Toronto is one of the centers of Canada's films and television industry, due in part to the lower cost of production in Canada. The city's streets and landmarks are seen in a variety of films, mimicking the scenes of American cities like Chicago and New Your City. Filmport is the largest film and television studio complex in Canada. The city also hosts the annual Toronto International Film Festival and Hot Docs Canadian International Documentary Festival.

Tourism. Toronto is home to sprawling and diverse commercial infrastructure. The Eaton Center is the primary tourist attraction with over one million visitors a week, while the PATH network is the world's largest underground shopping complex. The Toronto Islands are a major tourist draw, attracting people for the beauty of the scenery, the ban of private motor vehicles on the island outside of the airport. Because of cultural diversity, Toronto boasts a wide variety of different high-end cuisines and ethnic shopping malls.

3. Person-scale: Economy of Average Family

From the interactive survey completed by Maclean's, a modest Canadian family who brings \$68,000 a year would spend less than \$450 a month on groceries, \$250 on utilities, \$172 on restaurants and \$52 on the cellphone. (Figure 6) On the average Canadian's annual shopping list, restaurants, clothes and alcohol cost much money, with \$2,066, \$1,991 and \$905 respectively. The person from Ontario will spend most on property taxes, personal transportation, daycare and hair grooming. ⁷

Potential Industries

The current TTC system just has two lines, and there are another two existing rails across the city. In the proposal, these two rails will be reconstructed as the economic infrastructure with mixed functions like metro, commercial, culture, education .etc. Other branches of the subway system would be built underground. Based on the self-funded concept and the general economy analysis of Canada and Toronto, the potentially beneficial industries or related services are as follows:

1. Finance.

Finance industry itself like banking, insurance and investment does not need much except for high-



Figure 6: Average Canadian consumption, Macleans.ca



Figure 7: Gherkin, London, Designed by Foster + Partners

quality office space. (Figure 7) But considering their fast-paced and stressful working circumstance, the resting function like hotels which exist nearby and offer quiet suites, and entertainment function such as bars, sports facilities which can offer exciting and stimulating activities will be popular among those people, especially when they can afford expensive consumption with high income.

In addition, abundant natural parks are always welcomed by office workers, because they can relax themselves in the nature when they are tired of sitting in front of desk for the whole day.

The fast and convenient connection to airports is very important to those businessmen flying everywhere for trade.

2. Media.

The excellent architecture and structure of the infrastructure can become landmarks used as filming scenes and benefit from tourism. Some special area may designed as theme park (Figure 8) serving for local people and attracting international visitors.

3. Tourism.

Another economy profit of tourism is domestic products' sales. As the multiple cultural metropolis, Toronto has its different background residents living in separated communities, which would result in cultural isolation and social instability. However in the new plan, there will be one complex with metro station and local market, and the market will exhibit cultural products and host ethnic festival.

4. Retail.

Except for domestic souvenir, the local consumption also has a sizable market. Citizens will continuously need daycare products, and as a famous North



Figure 8: Universal Studios Hollywood

American metropolis, Toronto has a huge potential fashion market.

5. Restaurants and Bars

Not only would the tourists like to taste the characteristic food, but also the common Toronto residents love to eat out with their families and friends in their free time. This is very obvious when you walk in the street on a sunny weekend, every bar will be filled with people talking and drinking happily.

6. Landscape and sports facilities

Compared to Toronto, Vancouver has lots of beaches, mountains and natural parks offering totally different entertainment resources in a modern city, which is admired by most people. ⁸ When it comes to artificial scenery, High Line in New York City (Figure 9) as a recreated project also brings in an impressive landscape. At this point, natural landscape can give the public a distinguishing urban experience, so people can be free to take part in the outdoor sports from their offices, which is pretty attractive. At the same time, the vegetation can fresh the air and improve the air quality.

7. Educational Institutes and Museum

Talents are precious resource to a city, on this economic infrastructural complex it is very necessary to build several educational institutes which could provide intelligence and research to manage and continuously promote this system.

Also the art products from design schools like OCAD can be exhibited and sold as domestic special souvenirs instead of the common goods which can be seen almost everywhere.

Functional Requirement of Project



Figure 9: High Line in New York City

From the analysis of current economy of Canada, Toronto and average Canadian, the functional requirement - the potential industries – is as follows:

1. Transportation: subway rails and stations
2. Retails: shopping malls, local markets, restaurants, bars
3. Entertainment: theme parks, sport courts and theaters
4. Education: universities, museums and galleries.
5. Residence: hotels and apartments
6. Service: parking
7. Green space: landscape and natural parks

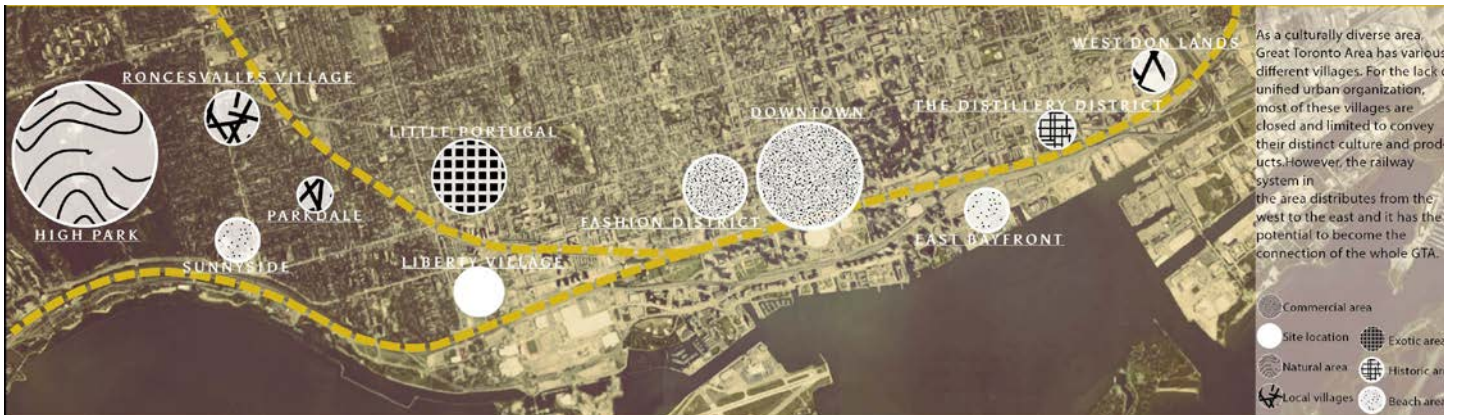


Figure 11: Toronto Exsiting Urban Analysis: Closed Area and the Railway System

Chapter Four: Trial_The Market on the Rails

As an important part of future economic infrastructure, the market (Figure 10) function is flexible to work as experiment. After confirming functional requirement, the design process would transfer to the spatial relationship and local tectonic. The moving market project tries to describe the function in a relative open way.

Related cultural background

People in Toronto from different background prefer to live with those who have the same culture, which lead to cultural isolation to some extent. If this phenomenon is controlled before a small independent society existing, it will not affect the city's security. Based on the current distribution, the rail market can both bring profit to the communities and promote communication among nations. (Figure 11)

Concept and Materiality

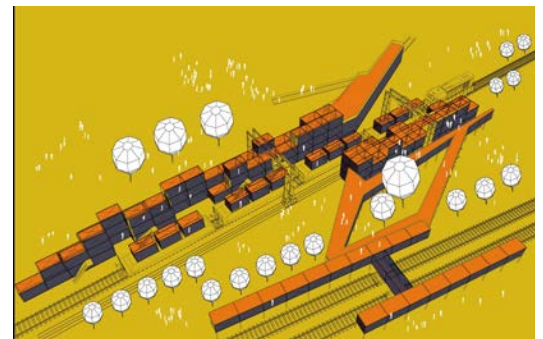


Figure 10: The Market on the Rails



Figure 12: Market on the Railway | Flexible Location

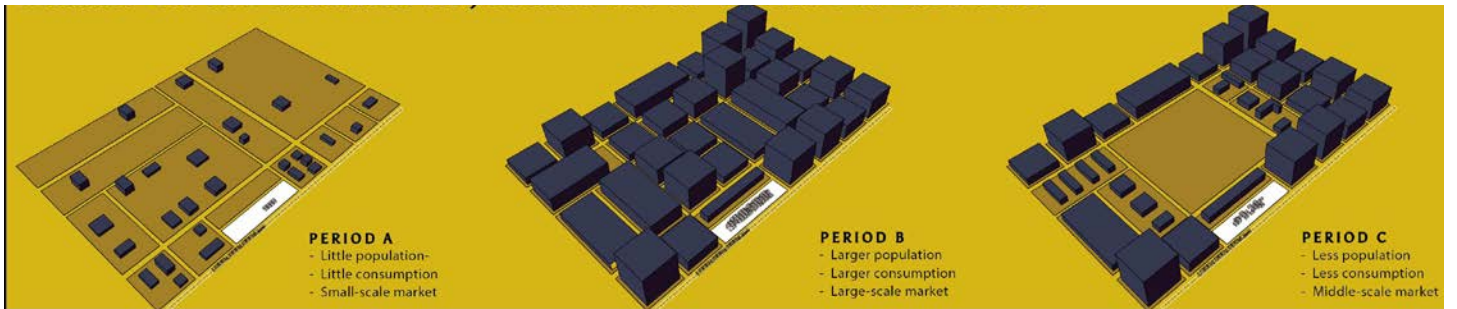


Figure 13: Market on the Railway | Adjustability in Urban Development

The old steel system – GO train rails – will provide the transportation possibilities for the new market. There are two typical concepts in the operation: moving products and changing scales.

1. Moving Products

Those farms which produce the goods for market normally locate in the suburb, the farmers will transport their products to the nearest stations and place them in the market units. Then the train will carry them to the downtown which can save the producers' transportation cost and relieve the traffic pressure of the city.

When the train gets to the market site, the loading equipment will move the market units with products from train to the site. (Figure 12) This system also offer the possibility that one unit can appear in different sites on one day, that is very convenient when the city hosts festival. It is more efficient to distribute all the characteristic and domestic products.

2. Changing Scale

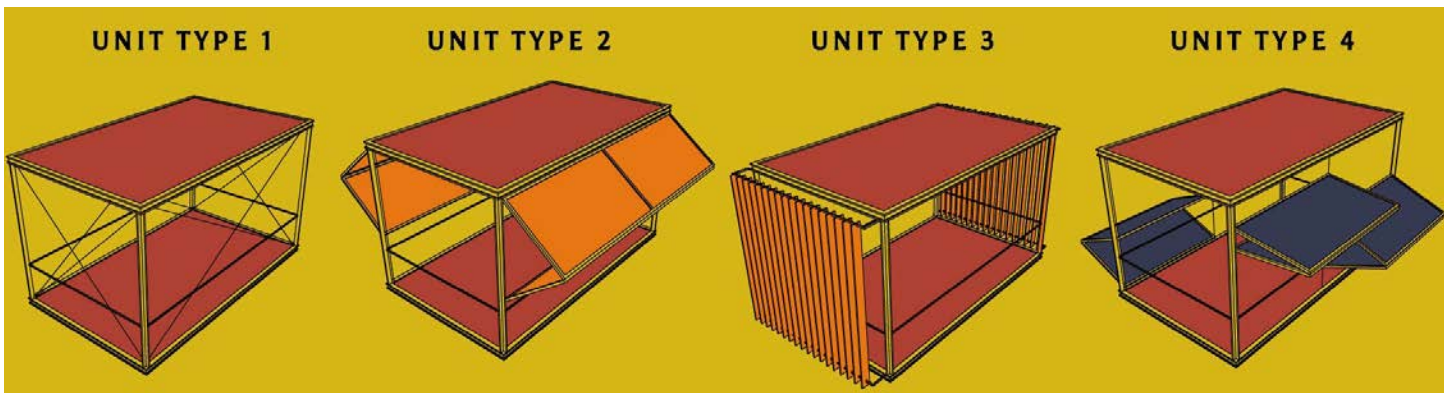


Figure 14: Market on the Railway | Market Unit Typology

The city is alive, and its population will change. Compared to traditional market building, this new market can adapt to the population changing and planning modification. (Figure 13)

When the city has small population, there will be limited market demand, so the market will just has several units. With the growth of population, the number of market will increase by actual economic calculation. If the government would change the function of this area, like build a huge urban park, with the requirement of markets changes, the scale can be easily modified. The old steel system, train rails, and the new steel system, market units, will cooperate this characteristic moving market. (Figure 14)

This is just a trial of architectural experiment in the economic infrastructural complex. More analysis about Toronto physical conditions (like weather, economical materials), Canadian architectural context (traditional style, living habit and ethnic cultural influence), spatial experience and atmosphere, tectonic techniques will be developed in the thesis.

Image Credit

Figure 1 Graphic by CQ

Figure 2 Graphic by CQ

Figure 3 Graphic by CQ

Figure 4 Tamsin McMahon, Nicholas Kohler and Andrew Stobo Sniderman, How Canadian are you?, <<http://www.macleans.ca/news/canada/how-canadian-are-you/>>

Figure 5 Author unknow, <https://en.wikipedia.org/wiki/Toronto_Stock_Exchange>

Figure 6 Tamsin McMahon, Nicholas Kohler and Andrew Stobo Sniderman, How Canadian are you?, <<http://www.macleans.ca/news/canada/how-canadian-are-you/>>

Figure 7 Author unknow, <https://en.wikipedia.org/wiki/30_St_Mary_Axe>

Figure 8 Author unknow, <<http://allamericanthrills.com/forum/universal-studio-27s/888-universal-studios-hollywood-discussion-thread>>

Figure 9 Author unknow, <<https://sallanscorner.wordpress.com/tag/high-line/>>

Figure 10 Graphic by CQ

Figure 11 Graphic by CQ

Figure 12 Graphic by CQ

Figure 13 Graphic by CQ

Figure14 Graphic by CQ

Bibliography

1. TomTom Traffic Index, Measuring Congestion Worldwide, <http://www.tomtom.com/en_gb/trafficindex/#/> Accessed: August 8, 2015.
2. T Reid, Speed limits reduce deaths, but can they also cause more pollution? <<http://www.theguardian.com/environment/2010/apr/19/ask-leo-20mph-speed-limits-pollution>> Accessed: August 8, 2015.
3. Kalinowski, Tess, Subway, LRT or bus: the pros and cons, <http://www.thestar.com/news/gta/transportation/2013/10/28/subway_lrt_or_bus_the_pros_and_cons.html> Accessed: August 8, 2015.
4. City Budget, <<http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=729c6cbd2b95a410VgnVCM10000071d60f89RCRD>> Accessed: August 8, 2015.
5. McMahon, Tamsin, Kohler, Nicholas and Stobo, Sniderman, How Canadian are you? <<http://www.macleans.ca/news/canada/how-canadian-are-you/>> Accessed: August 8, 2015.
6. Tourism Sector Contact Information, <<http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=580b6fe8341da310VgnVCM10000071d60f89RCRD&vgnnextchannel=401132d0b6d1e310VgnVCM10000071d60f89RCRD>>, Accessed: August 8, 2015.
7. McMahon, Tamsin, Kohler, Nicholas and Stobo, Sniderman, How Canadian are you? <<http://www.macleans.ca/news/canada/how-canadian-are-you/>> Accessed: August 8, 2015.
8. Vancouver, <<https://en.wikipedia.org/wiki/Vancouver>> Accessed: August 8, 2015.

