

Personal Rapid Transit for Halifax, Nova Scotia

by

Jordan John Rice

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ABSTRACT

As auto-dependent development has forced the urban limits of the city to sprawl, it has put considerable pressure on the transportation corridors that serve the city center. In Halifax, Nova Scotia, this condition is exacerbated by the downtown being bounded by water on three sides. Thus, there are a limited number of transportation corridors onto and off of the peninsula. This thesis examines how transit stations for a proposed public transportation line, within an underused rail corridor, can actively support and engage the communities they serve. A personal rapid transit network is proposed as a mobility-on-demand public transit system within this corridor. This introduction of a new transportation strategy is seen as a paradigm shift for the way transportation is conceived of in Halifax. Thus, the typology of the station will be studied in three different social and topographic environments, to form prototypes for the potential of transit stations throughout Halifax.

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Dayna, my source of strength.

My family, for your constant love and support.

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Dalton Kaun for your encouragement throughout

And to all others who have contributed to this journey.

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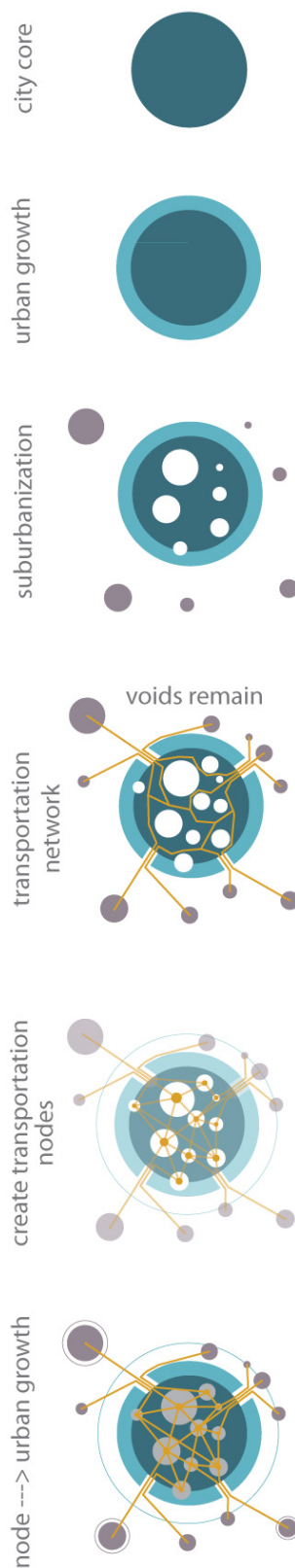
CHAPTER 1: TRANSPORTATION PARADIGM

Public Transportation

Throughout history transportation infrastructure has played a significant role in shaping the cities and towns we inhabit. As the methods of transportation have evolved over time, so has their impact on our psyche and the urban form of cities. Patterns of social interaction were changed as people and products began to be exchanged between cities on a greater scale.

The impact of public transportation was exhibited on a national scale with the advent of the railroads. As the iron rails stretched between cities and across countries, their importance in the civic realm was fervently celebrated through the creation of stations. Brian Edwards describes stations as a source of architectural pride for the communities they served, as they expanded the social and cultural worlds of formerly isolated regions.¹ After World War II, the importance of the train station within the city began to lose prominence, as the principle form of transport began to be catered towards personal travel. After the significant growth of roads in the past century, cities are now struggling to provide the necessary infrastructure to move people efficiently within the confines of the existing urban fabric, as well as, the loss of civic identity with the disappearance of the community station.

¹ Brian Edwards. *The Modern Station: New Approaches to Railway Architecture* (London: E & FN Spon, 1997), vii-xi.



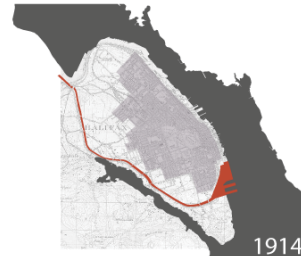
Paradigm shift from suburban to urban growth through the grouping of public transit services.

Urban Sprawl

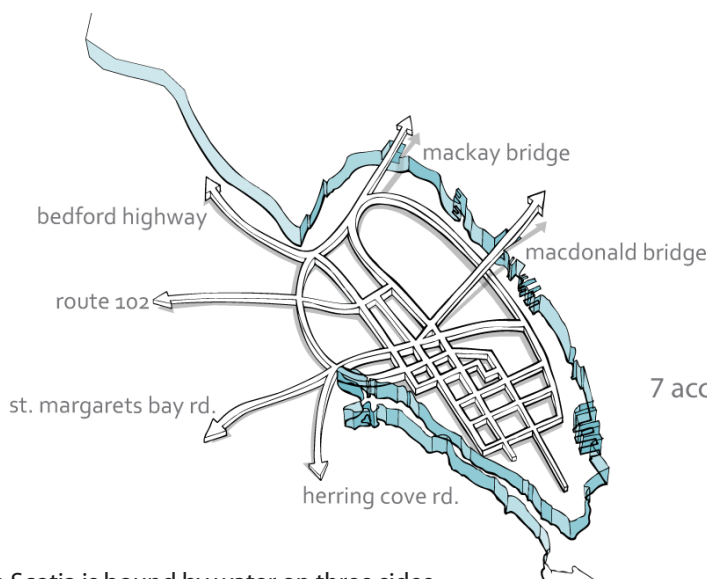
As auto-dependent development has forced the urban limits of the city to sprawl, it has put considerable pressure on the transportation corridors that serve the city center. In Halifax, Nova Scotia, this style of development has led to a significant increase of residents living off the peninsula over the last 50 years. With over 80% of residents that reside in suburban style housing making at least one trip per day by car, the road network is put under continuous stress.² Pedestrians, cars, public transit, and cyclists all vie for space along the few transportation corridors that penetrate the city center.³ This condition is exacerbated in Halifax because the downtown is bound by water on three sides. Thus, the seven access points onto and off of the peninsula are near or at capacity. With a population growth forecast

2 Martin Turcotte, "Dependence on cars in urban neighbourhoods," *Canadian Social Trends* 85 (2008): 24.

3 Sort, *Metropolitan Networks*, 31.



Settlement patterns in Halifax, Nova Scotia from 1914 (the opening of the rail corridor) to 2000.



Halifax, Nova Scotia is bound by water on three sides, which limits access to the peninsula to just 7 points by road.

that sees Halifax grow by a further 82,000 residents over the next 25 years, much of it focused along the Bedford Highway, a new transportation strategy is needed.⁴ The goal of this approach should be to improve access to the peninsula by providing choice and amenity that encourages the use of public transit without competing with the private automobile.⁵

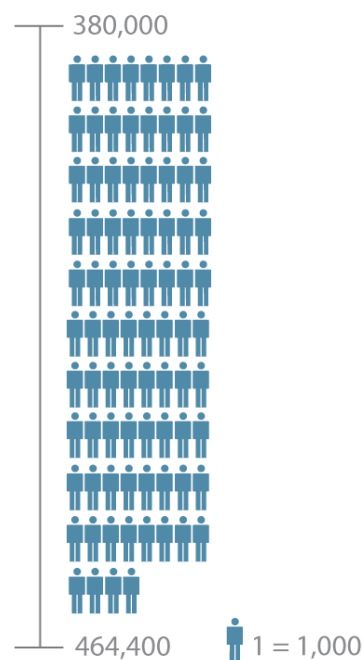
To achieve such a goal, a transportation strategy needs to be developed that does not compete for limited road space, but takes advantage of topography or underused resources to access the city. The rail corridor serving Halifax is one such example, as it has seen a decline in freight and passenger rail traffic in the past decade and is currently operating below capacity. Thus, there is opportunity for the underused corridor to become a barrier free public transit route from the community of Bedford to the South End of Halifax. This North-South passage is in proximity to many of the suburban neighbourhoods that have seen the largest growth in new home construction.⁶ Transit stops along this corridor have the potential to become stable nodes “that bring people together and serve as a focal point for community life.”⁷

4 Clayton Research Associates Ltd. and Cantwell and Company Consulting, “Employment, Population and Housing Projections: Halifax Regional Municipality,” *Halifax Regional Municipality* (August 2004): 36.

5 Berlage Institute. *Brussels A Manifesto: Towards the Capital of Europe* (Rotterdam: NAi Publishers, 2006), 168.

6 Turcotte, “Dependence on cars in urban neighbourhoods,” 26.

7 Transportation Research Board National Research



population growth in Halifax
25 years @ 22 %

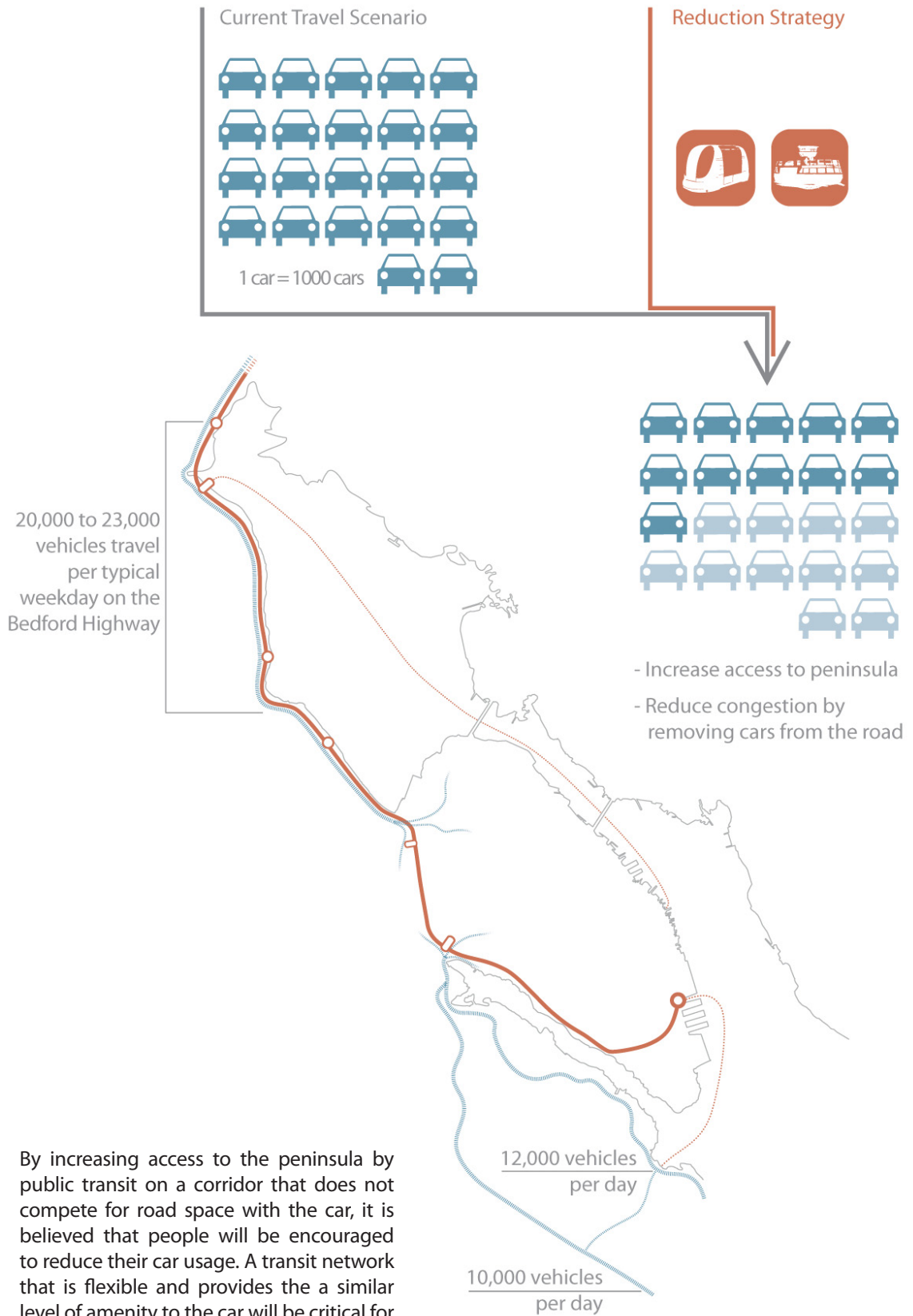


fixed road network
-limited growth



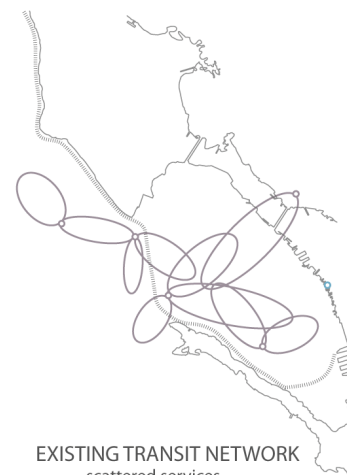
growth potential
- cn rail corridor

New transportation solutions needed to meet a growing population in Halifax, N.S.

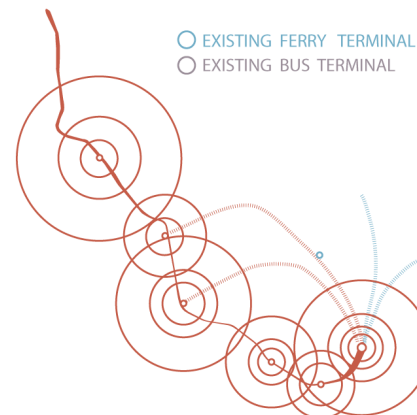


By increasing access to the peninsula by public transit on a corridor that does not compete for road space with the car, it is believed that people will be encouraged to reduce their car usage. A transit network that is flexible and provides the a similar level of amenity to the car will be critical for this to succeed.

Roger Tranick suggests well conceived spatial changes, through concentrating transportation services into nodes, may help to revitalize the sense of community within the urban fabric of the city.⁸ In California, light rail is being considered as a spine onto which transportation nodes can be developed around. By doing this, the city is once again reusing the lost space of the railway corridors that penetrate the center of the city, as a potential solution to the congestion experienced on the streets.⁹ Halifax has an analogous condition to that of California, where the urban rail corridor intersects with major concentrations of potential transit users and existing metro transit bus terminals. Linking these elements with transportation in the rail corridor will allow for the clustering of services into nodes. By grouping transportation networks, each node will add value to the communities they serve by increasing connectivity to and from other parts of the city and reducing transit time. Jane Jacobs suggests that “in a really healthy city, it is something that knits the whole thing together.”¹⁰



EXISTING TRANSIT NETWORK
 - scattered services
 - reduced connectivity
 - long circuits

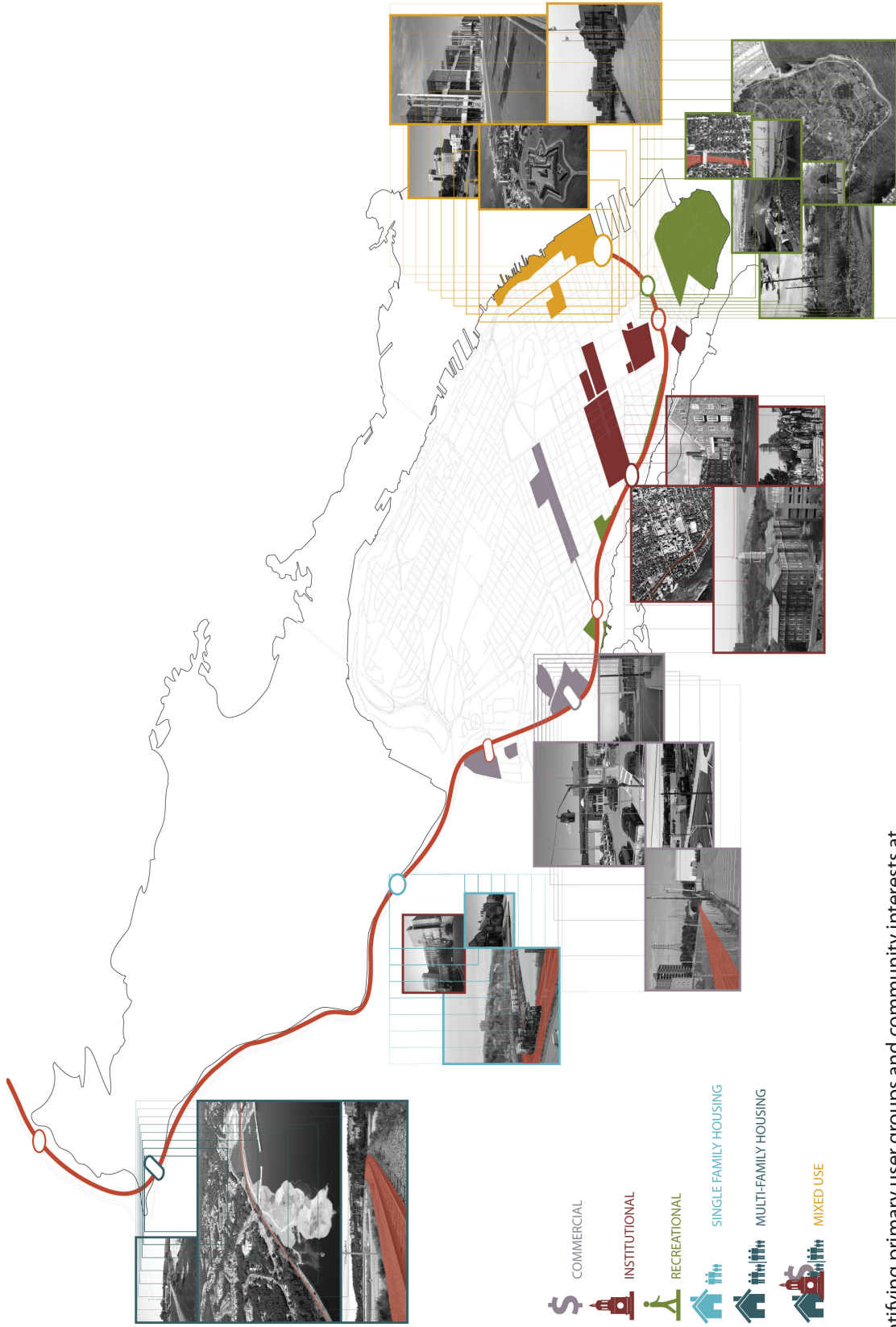


SPINE & TERMINUS PROPOSAL
 - linked services
 - increased connectivity
 - shorter circuits

Gathering public transportation services into nodes (stations) along the rail corridor.

Council. *The Role of Transit in Creating Livable Metropolitan Communities* (Washington: Transportation Research Board, 1997), 21.

- 8 Roger Tranick, *Finding Lost Space: Theories of Urban Design* (New York: Van Nostrand Reinhold Company, 1986), 2-17.
- 9 Martha Thorne, *Modern Trains and Splendid Stations: Architecture, Design, and Rail Travel for the Twenty First Century* (London: Merrell Publishers Limited, 2001), 50.
- 10 Roberta Gatz, *The Living City: How America's Cities are Being Revitalized by Thinking Small in a Big Way* (Washington: The Preservation Press, 1994), xxiii.



Identifying primary user groups and community interests at the transit stops for the proposed transit network.

Railway Infrastructure

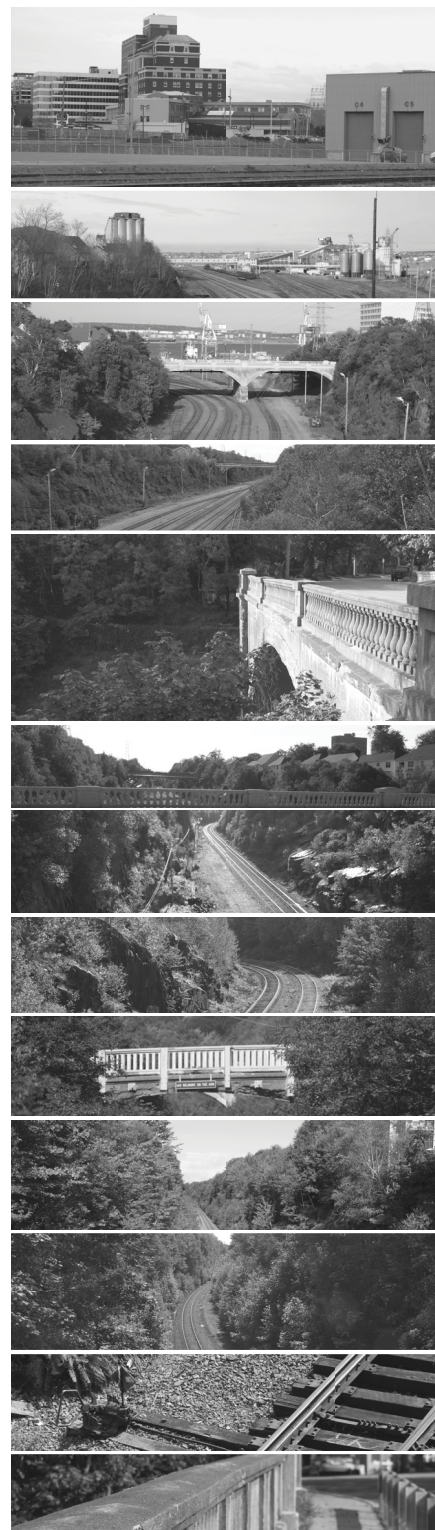
The railway infrastructure that at one time established connections, has recently been viewed by city planners as a fracture in the fabric of cities. Now that many of these rail corridors are underutilized, movements have begun to remedy the isolation and barriers to growth that these areas have come to be.¹¹ As Roger Tranick suggested, these spaces are now being re-evaluated for their potential. This Thesis proposes a personal rapid transit network as a mobility-on-demand system within the Halifax urban rail corridor. This system has the potential to link suburban communities and eventually the airport with the city center.

In New York, Diller, Scofidio and Renfro's 'High Line', a disused freight corridor above the streets on the west side of Manhattan Island; is being envisioned as a corridor for pedestrian movement in a park atmosphere above the city streets.¹² In Germany, the growth of the high speed train network has led to the redevelopment of rail corridors and city center stations.¹³ Examples such as this, provide the basis for identifying the corridor within Halifax as a potential transportation resource. This corridor can be considered for development because

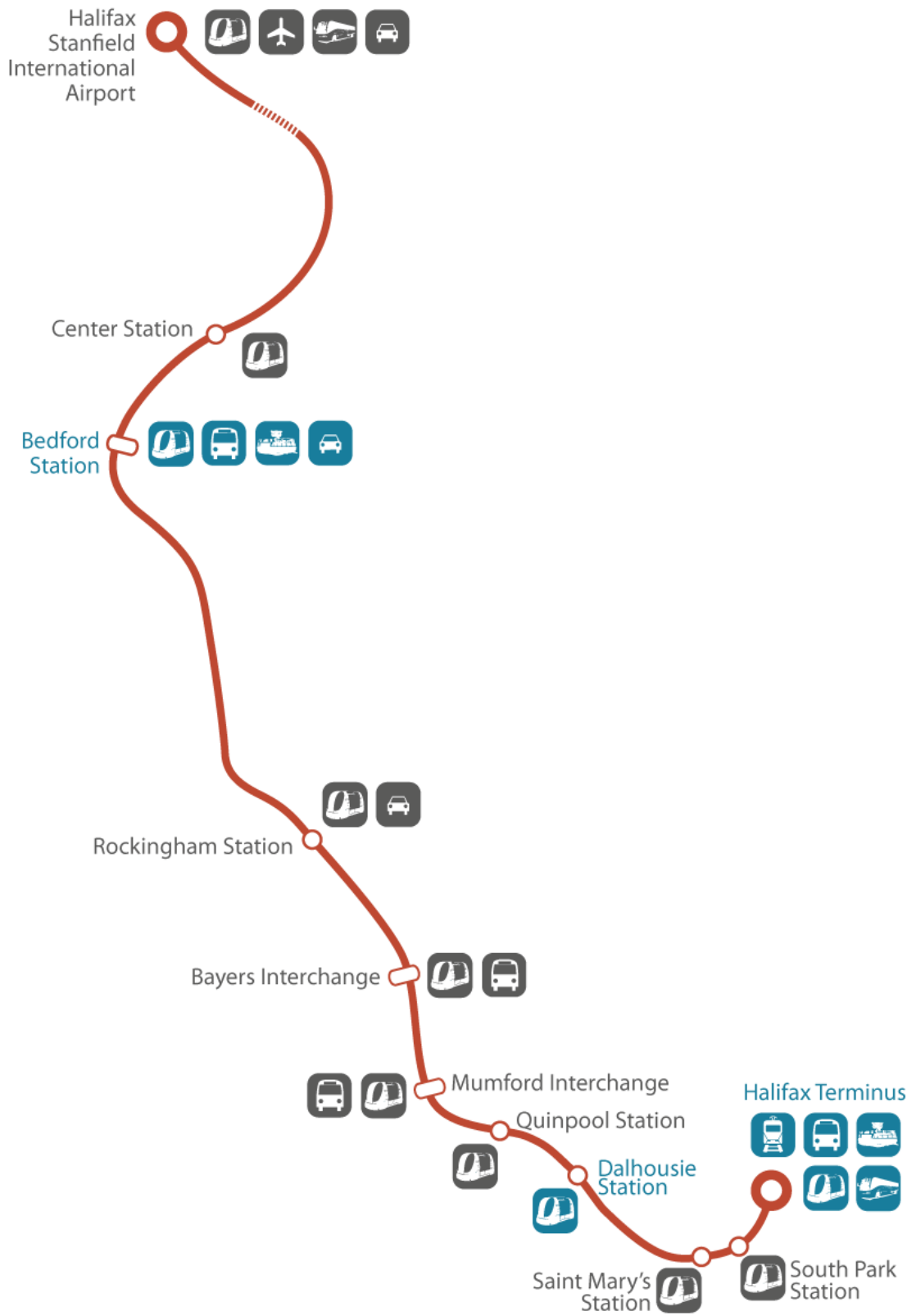
11 Kelly Shannon and Marcel Smets, *The Landscape of Contemporary Infrastructure* (Rotterdam: NAI Publishers, 2010), 9.

12 Friends of the High Line and Diller Scofidio and Renfro, *Designing the High Line: Gansevoort Street to 30th Street* (New York: Friends of the High Line, 2008), 7.

13 Clemens Niedenthal, *Stations in Germany: Modern Urban Centers*. (Berlin: Jovis Verlag, 2008), 29.



Profile of the rail infrastructure in the corridor through Halifax, Nova Scotia.



Proposed transit network and multimodal connections for the rail corridor in Halifax, Nova Scotia.

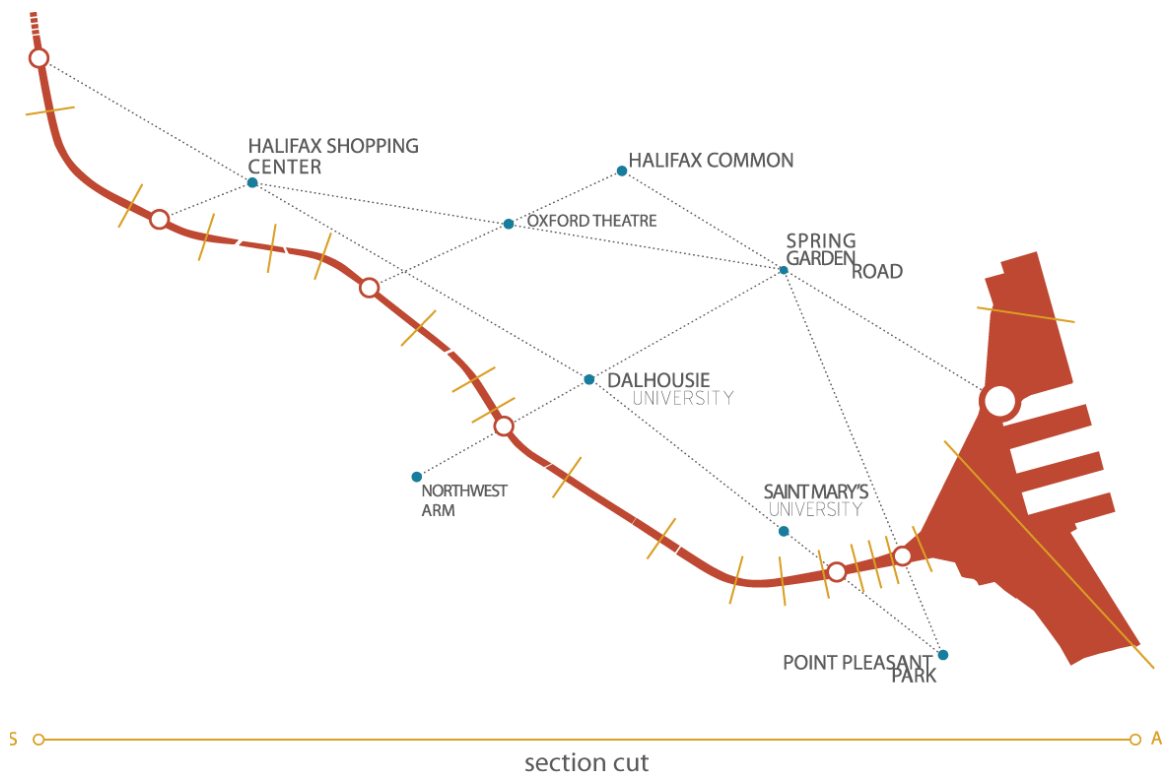
of its access to multiple venues of importance within the city. Thus framing the station within an environment where its design and services can actively sustain and promote a sense of place.¹⁴The

¹⁴ Transportation Research Board National Research Council, "The Role of Transit in Creating Livable Metropolitan Communities," 7.

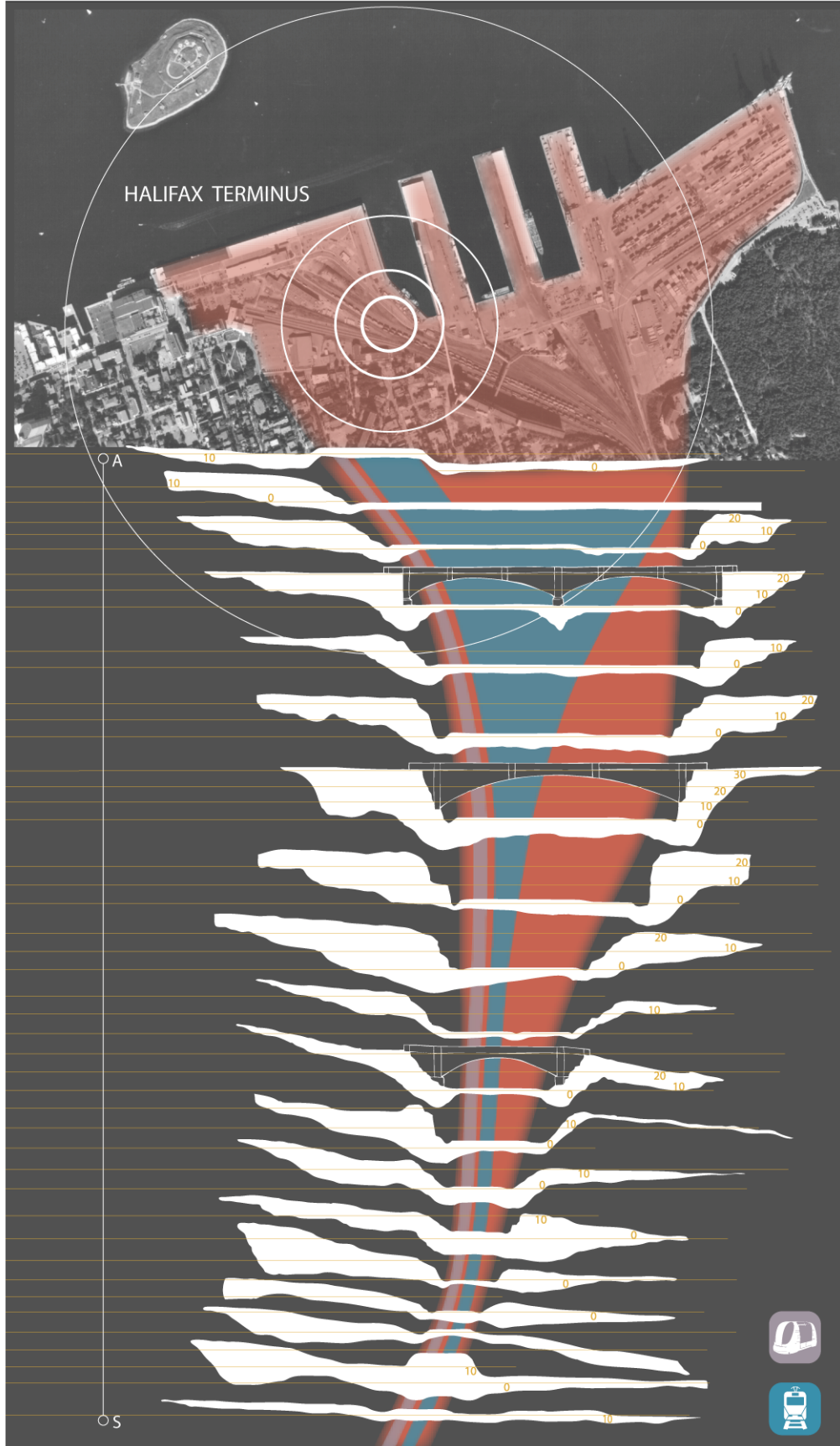


key to these projects is to re-envision infrastructure as part of the urban fabric of the city versus an adjunct isolated by its surroundings. In Halifax, this corridor has divided the urban fabric of the city and created a significant disconnect in the community between one side of the tracks and the other. By activating the rail corridor with public transit, the stations along the line will work towards knitting communities together and facilitating spaces for social and economic interchange.¹⁵

15 Shannon and Smets, *The Landscape of Contemporary Infrastructure*, 9.



Connectivity of the rail corridor to areas of interest within the city. Stations are considered as nodes from which activity radiates out to existing uses in the city. The yellow lines correspond to the section cuts on the following image.



Profile of underutilized rail corridor and its potential to accommodate new forms of transit.

Halifax, Nova Scotia

The Canadian Pacific Railroad began construction in 1912 on the rail corridor in Halifax. This corridor extends from the town of Bedford to the south end of the Halifax Peninsula. It was designed to shuttle freight from the port terminal and people from the city, and immigration center at Pier 21.¹⁶ Now, due to diminished rail traffic, this corridor is underused. Environmental engineers, Larry Hughes and Sandy Scott, first proposed using this corridor for a light rail transit line from the community of Sackville to the existing train station in Downtown Halifax. This proposal was ultimately unattainable due to costs being too high to develop a system that would only see feasible ridership levels at peak transit times. Thus, it proved cheaper to put more buses on the road at tighter intervals to accommodate peak traffic.¹⁷ Personal rapid transit is seen as an alternative to placing more public transit on already stressed infrastructure routes. Pioneered by Leslie Blake, it is an urban light transit system that runs on a computer guided track.¹⁸ As a flexible, electric alternative to public transit, personal rapid transit is part of a broader movement in land locked urban environments towards mobility-on-demand public transit networks.¹⁹

16 Pierre Taschereau, "South End Railway Cutting: Report No. 2 of the Area Studies Groups," *Halifax Field Naturalists News* 27 (1982): 2-23.

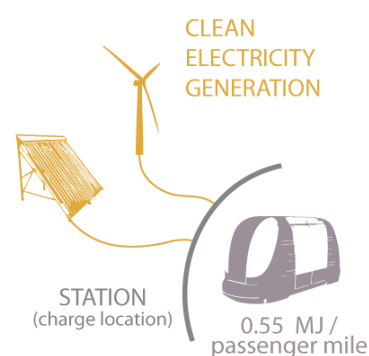
17 Larry Hughes and Sandy Scott. *A Proposal for an Urban Rapid Transit System for the Metro Region; Part 1: Halifax, Bedford, and Sackville* (Halifax: Whale Lake Research Institute, 1990), 1-40.

18 Terence Bendixson, *Instead of Cars* (London: Temple Smith, 1974), 200.

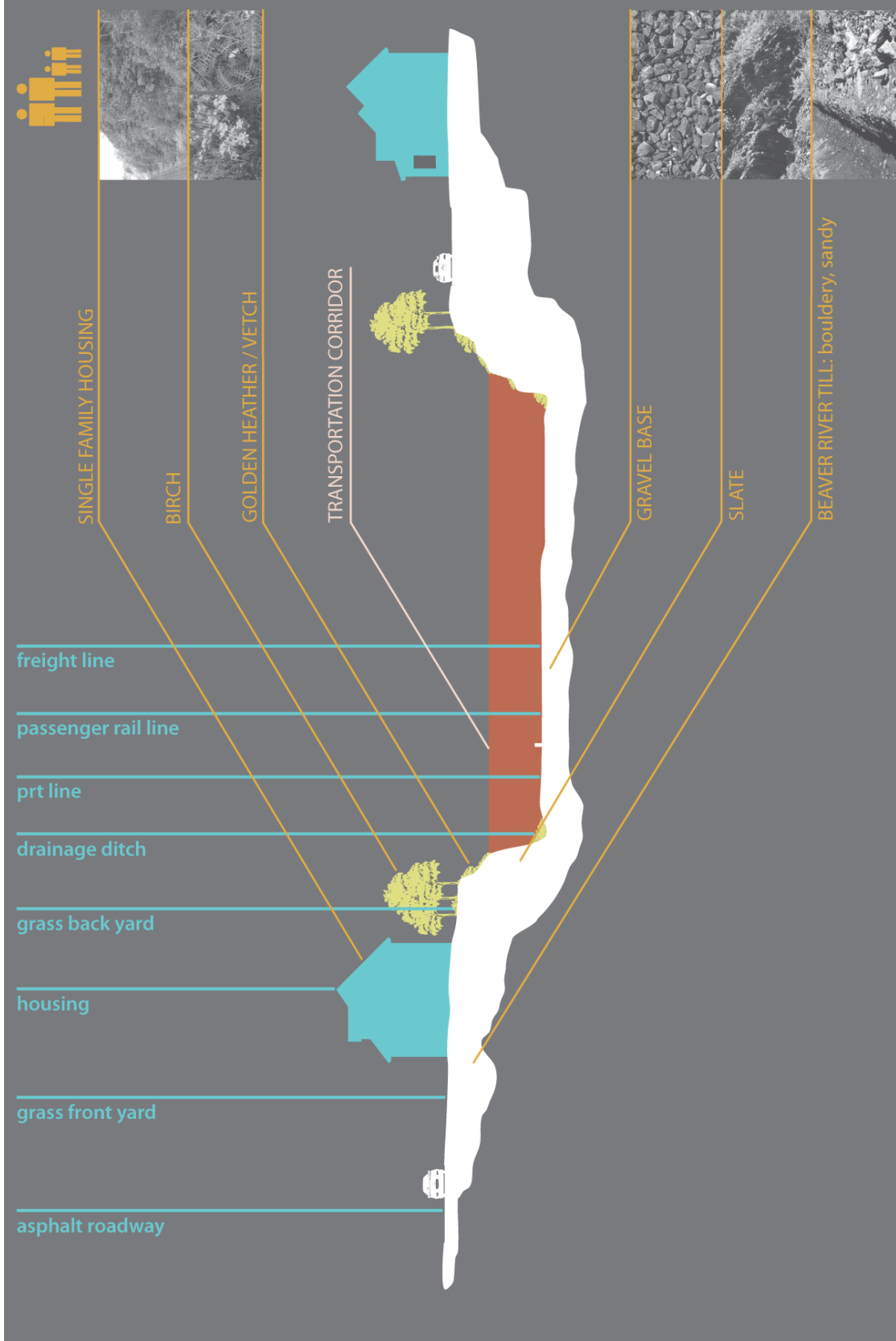
19 Martin Lowson, "A New Approach to Effective Sustainable



View of rail corridor from Tower Road bridge.



Electric 'prt' cars can be linked to renewable energy sources for power.



Typical sectional profile of the rail corridor in Halifax.

Mobility-on-Demand Transportation

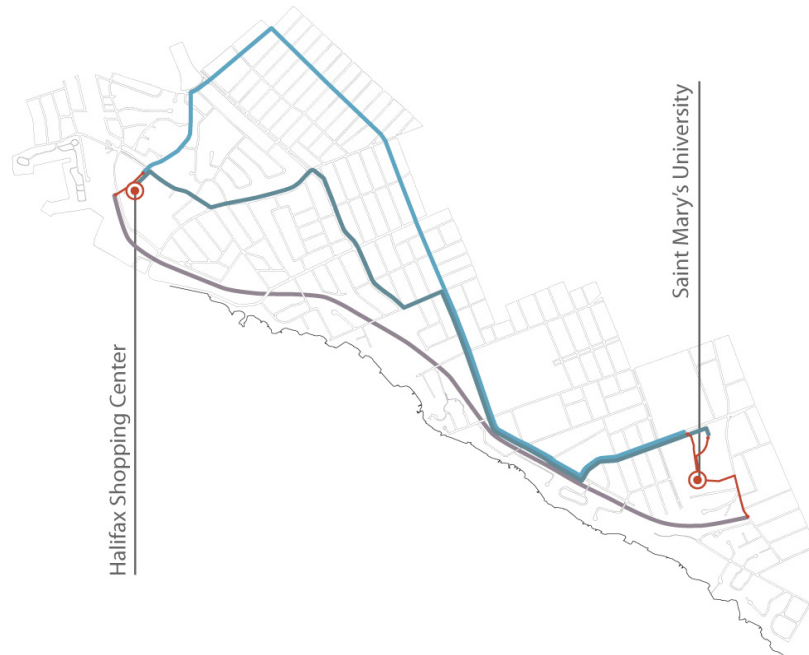
Mobility-on-demand systems have begun to emerge as potential solutions for reducing the stress placed on the road network of cities. These systems provide point to point travel that functions on a personal scale, but provides a high modal capacity.²⁰ Successful personal alternative urban transportation systems include the BIXI bike system, which has been introduced into nine cities worldwide and the Ultra 'prt' pod cars adopted at



Personal rapid transit 'pod car' Heathrow Airport. From Ultra Global, "Photos-Videos."

Urban Transport," Transportation Research Board (2003): 42.

20 Moshen Mostafavi and Gareth Doherty, *Ecological Urbanism* (Baden: Lars Müller Publishers, 2010), 392.



<p>PRT</p> <p>6 1/2 minutes</p> <p>4.2 km</p>	<p>6 people / trip</p> <p>24 hours / day</p>	<p>= 1296 people / day / pod car</p>
<p>Car</p> <p>10 minutes</p> <p>4.5 km</p>	<p>6 people / trip</p> <p>24 hours / day</p>	<p>= 6 people / day / car</p>
<p>Metro Transit Bus</p> <p>21 minutes</p> <p>4.8 km</p>	<p>36 people / trip</p> <p>18 hours / day</p>	<p>= 1620 people / day / bus</p>

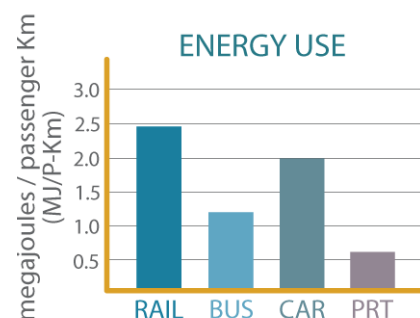
Advantages of 'prt' over the car and current public transit by bus.

Heathrow Airport in London, England as a method to move people to and from the terminal building to the various parking areas.

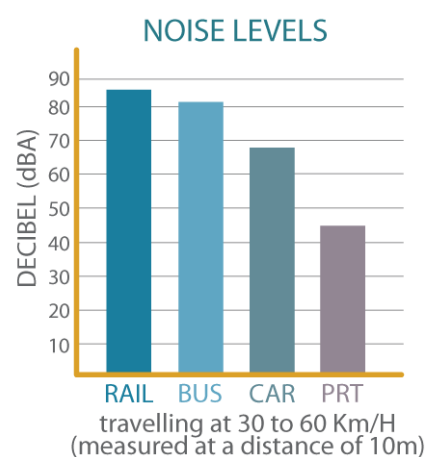
The advantages of these systems lie in their limited footprint on the urban environment and their ability to operate 24 hours a day, at the demand of the user or users.²¹ Unlike conventional mass transit networks, the mobility-on-demand system is at standby until a person activates a vehicle, the vehicle then allows the person to travel between destinations without having to make stops at undesired locations. This allows the system to use a minimal amount of energy during non peak hours, and by stopping only at requested stations, reduces unnecessary stopping and starting.²² This strategy helps the 'prt' system to consume much less energy than typical transit systems. Due to the fact that the rail cut runs through many residential neighbourhoods in Halifax, noise becomes a major concern. The pod cars are powered by an electric drive train and run on rubber tires, which reduces the noise levels generated in comparison to other forms of transit. Although the concept of mobility on demand systems is in its infancy, Terence Bendixson suggests that their potential is unlimited, as they are the only track based transportation system that posses the ability to be

²¹ William Mitchell, *Mobility on Demand: Future of Transportation in Cities* (Cambridge: MIT Media Laboratory, 2008), 7-8.

²² Lawson, Martin. "Service Effectiveness of PRT vs Collective-Corridor Transport," *Journal of Advanced Transportation* 37 (2003): 231-232.



Data provided by Ultra PRT, "Energy Efficiency."



Data provided by Ultra PRT, "Silent Vehicles."

integrated into cities without disrupting the usage patterns that already exist.²³

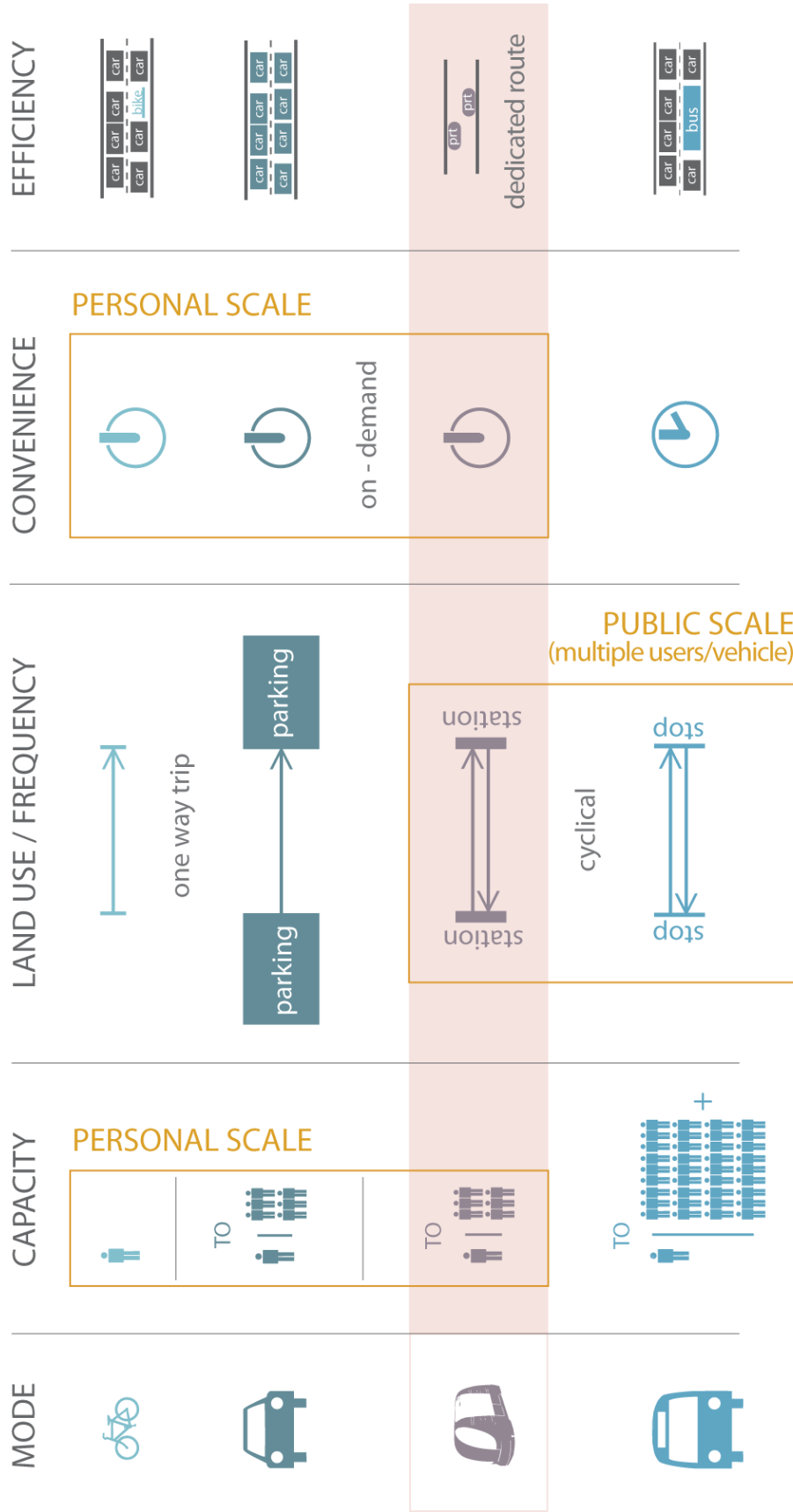
A primary driver for the use of a 'prt' system in Halifax versus a more conventional system such as 'light rail transit' is based on its association with the car. Car use and ownership is at its highest among the 45 year and older demographic, as well as among younger couples with children.²⁴ Thus to make an impact on traffic congestion levels, this becomes an important demographic to influence. Matthew Paterson suggests that this demographic group has associated the car with personal freedom, flexibility, and safety.²⁵ Therefore, a mass transit strategy will do little to sway their attitudes towards public transit. Martin Lowson recognizes that many of the qualities of the 'prt' system are similar to the qualities of car based transit. The personal scale, immediate access, non-stop travel and the ability to control who rides with you; may be able to sway some people who are attracted to the personal nature of the car to the use of public transit.²⁶ With an aging population it becomes critical to develop a system that caters to the cultural desires of a region, versus a common one size fits all solution.

23 Bendixson, *Instead of Cars*, 141.

24 Turcotte, "Dependence on cars in urban neighbourhoods," 28.

25 Mathew Paterson, "Car Culture and Global Environmental Politics," *Review of International Studies* 26 (2000): 264.

26 Lowson, "A New Approach to Effective Sustainable Urban Transport," 10.



PERSONAL SCALE

PUBLIC SCALE
(multiple users/vehicle)

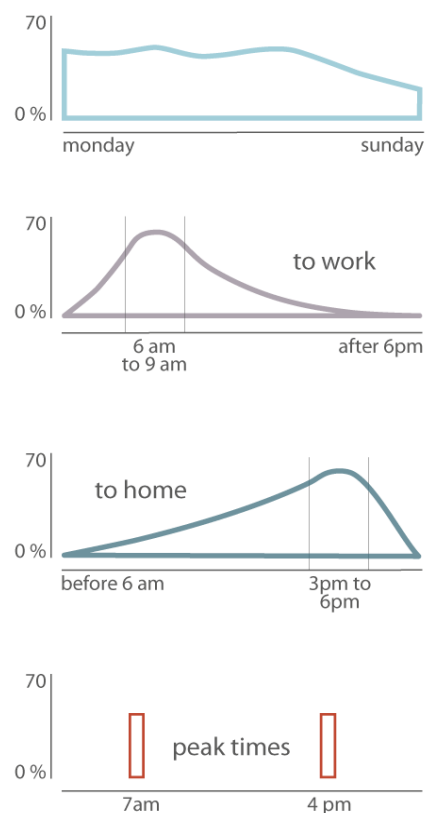
Advantages of 'prt' over the car and current public transit by bus.

CHAPTER 2: STATION ENVIRONMENT

Passenger Flow

A key aspect of any mobility-on-demand system is the location and design of its stations. Kenneth Griffin defines transit users as pedestrians, thus stressing the connection of stations to the pedestrian network. This connection at the pedestrian scale addresses three levels of engagement with the neighbourhood. The 'core' service area falls within a five minute walking radius of the station, the 'neighbourhood' is within a 15 minute walking radius and the 'support' area falls outside of this. By structuring development in this gradient, it will help to intensify land usage and create a structure for public space.²⁷ Unlike any other building type, Deborah Nevins suggests that the station belongs in this public realm. As the dynamics of social interaction are intensified by the flow of people within the station, outside the station, and by those coming to the station from various modes of transportation.²⁸

Therefore, as Brian Edwards describes, this public space needs to address its macro and micro impacts on the urban fabric of the city. At the macro scale, we see how the design of the station fits into or extends the urban fabric of the city. The impacts of the station at the micro level



Halifax Metro Transit weekly ridership data. From Metro Transit, "Annual Service Plan."

²⁷ Kenneth Griffin, *Building Type Basics for Transit Facilities* (Hoboken: John Wiley and Sons, 2004), 55.

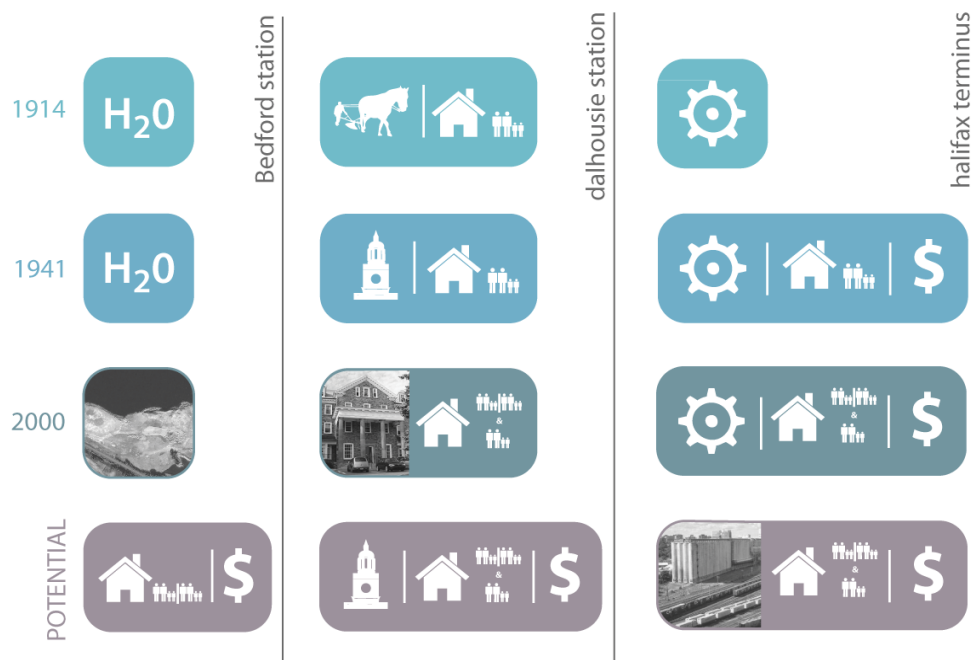
²⁸ Deborah Nevins, *Grand Central Terminal: City within the City*, (New York: Municipal Art Society, 1982), 14, 122-124.

occur over time and are exhibited by a subtle rearrangement of social life and activity patterns within the station neighbourhood.²⁹ Train station historian Alessia Ferrarini believes that the scale of the station must respond to the scale of the neighbourhood its serves.³⁰ By responding to this, each station will take on a character that is suited not only to the requirements of the transportation network, but the unique topographical and social environments of the neighbourhood around it. It is argued that designing for accessibility and place versus mobility, will allow these stations to become 'hearth' elements (the fire around which people assemble and interact socially) for the communities they serve.³¹ In doing so, it will allow the individual

29 Edwards, *The Modern Station*, 90

30 Alessia Ferrarini, *Railway Stations: From the Gare de l'Est to Penn Station* (Milan: Electa Architecture, 2004), 5.

31 Ethan Kent, "From Place to Place: Shifting the

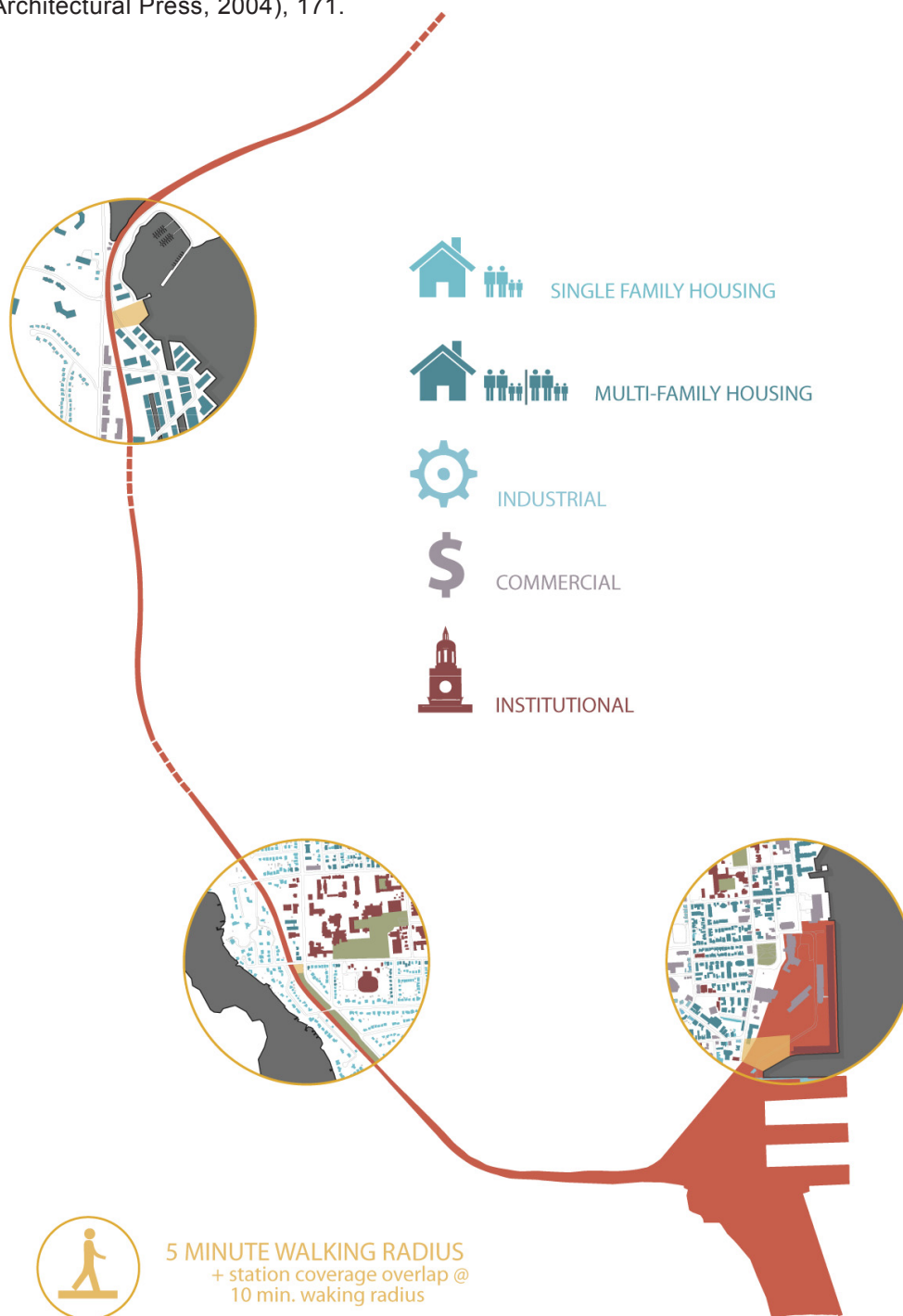


Site uses of the three proposed station locations since the creation of the rail corridor in 1914 to their potential uses after the creation of the 'prt' network.

to provide “character and color” to the space.³²

Transportation Paradigm with Placemaking,” www.pps.org/transportation/from-place-to-place-shifting-the-transportation-paradigm-with-placemaking/ (accessed 20/12/2011).

- 32 Jack Quinan. *Frank Lloyd Wright’s Martin House: Architecture as Portraiture* (New York: Princeton Architectural Press, 2004), 171.

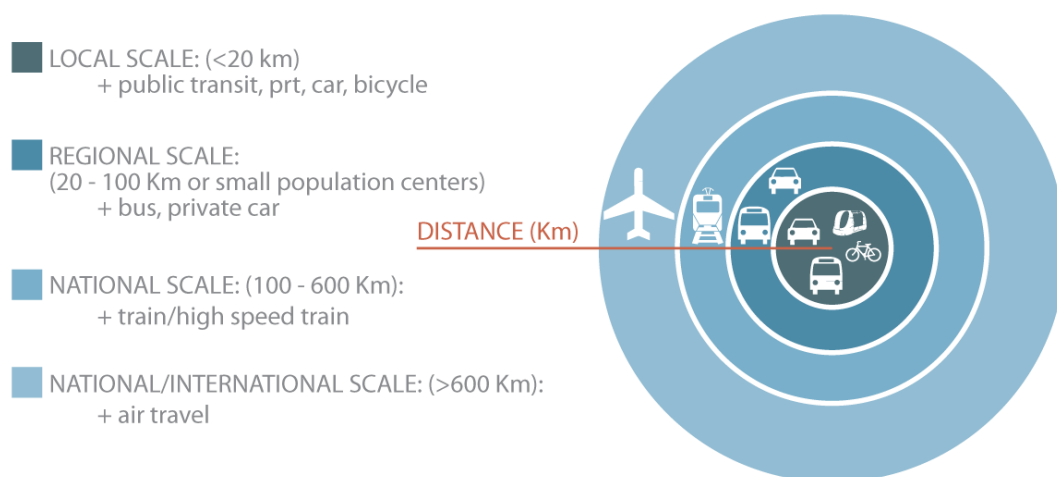


Neighbourhood characteristics of the three proposed station locations along the rail corridor.

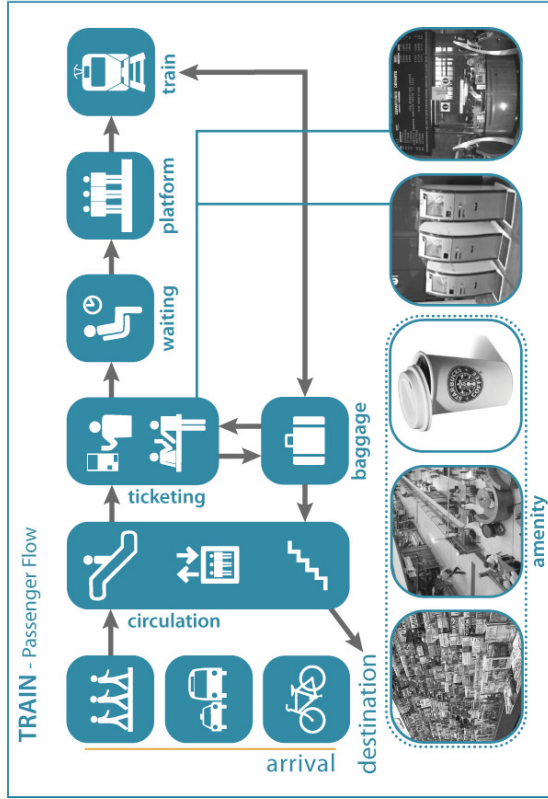
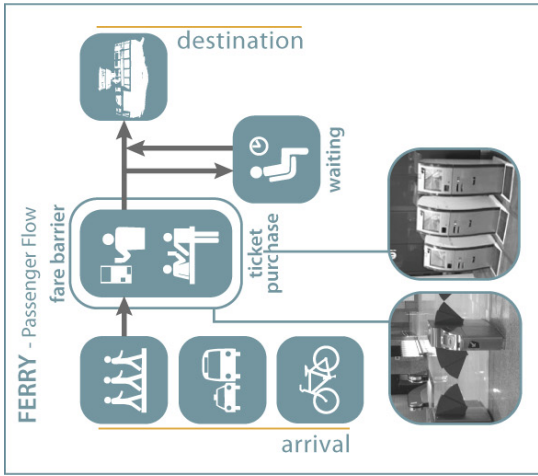
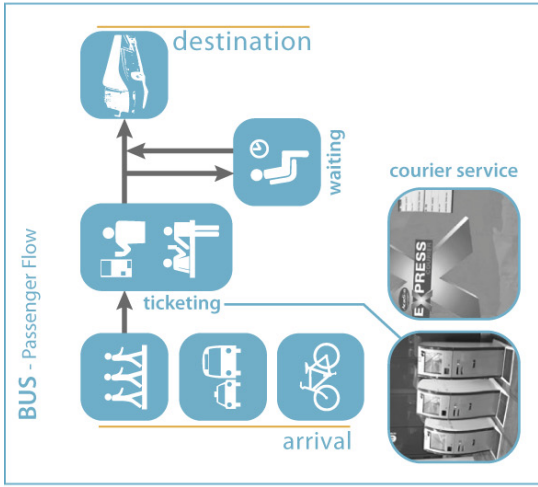
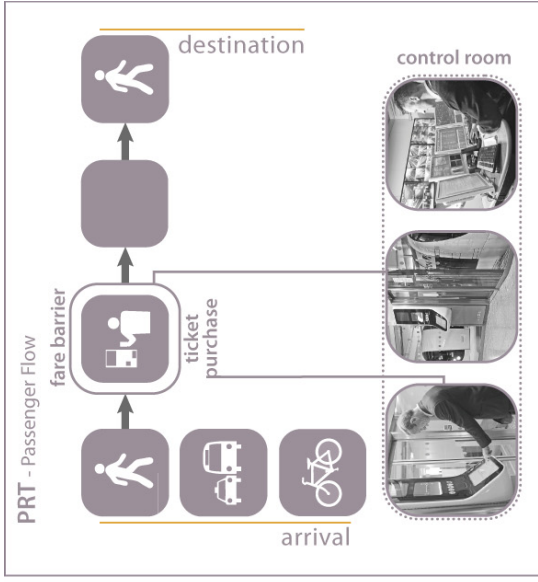
Station Network in Halifax

In an effort to better understand the relationship of the personal rapid transit network to the city of Halifax, this thesis will explore the designs of three stations. Each station will respond to a different set of contexts, scales, and level of amenity. This will allow for an exploration of one building typology in three different ways. These stations each have a different relationship with the city based on their location on the rail corridor. Frank Bruinsma describes how the mix of transportation modes at each station must balance with the mixture of uses in the station neighbourhood. Therefore, the more passengers per day using a node, the more varied the functional mix of uses to be provided. Starting from a balanced state allows the station to add value to the place as new activities or transportation links are added.³³ In order to reshape patterns of movement in the urban

³³ Frank Bruinsma, Eric Pels, Hugo Priemus, Piet Rietveld, and Bert van Wee, *Railway Development Impact on Urban Dynamics (Heidelberg: Physica-Verlag, 2007)*, 27.



Zoning transportation networks based on their service capabilities at efficient distances.

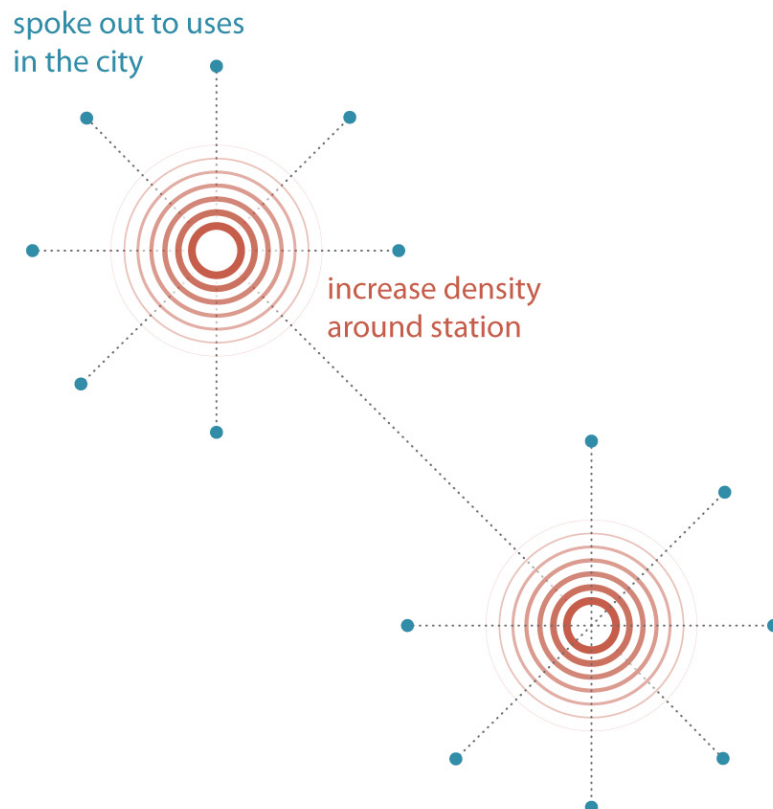


Common Elements



Typical flow of a passenger from arrival to departure for the transportation networks accommodated at the terminus station and required amenities.

environment these 'prt' stations need to be a part of a comprehensive transportation strategy that is based on the integration of multiple transportation networks. This integration will allow each station to have a larger passenger distribution array than is achievable by one network alone. The grouping of networks is based on the accessibility of the site, as well as the character of the neighbourhood. Locating a series of nodes along the urban rail corridor will allow for an efficient service area coverage that will extend beyond local service and accommodate transportation on a regional and national scale.



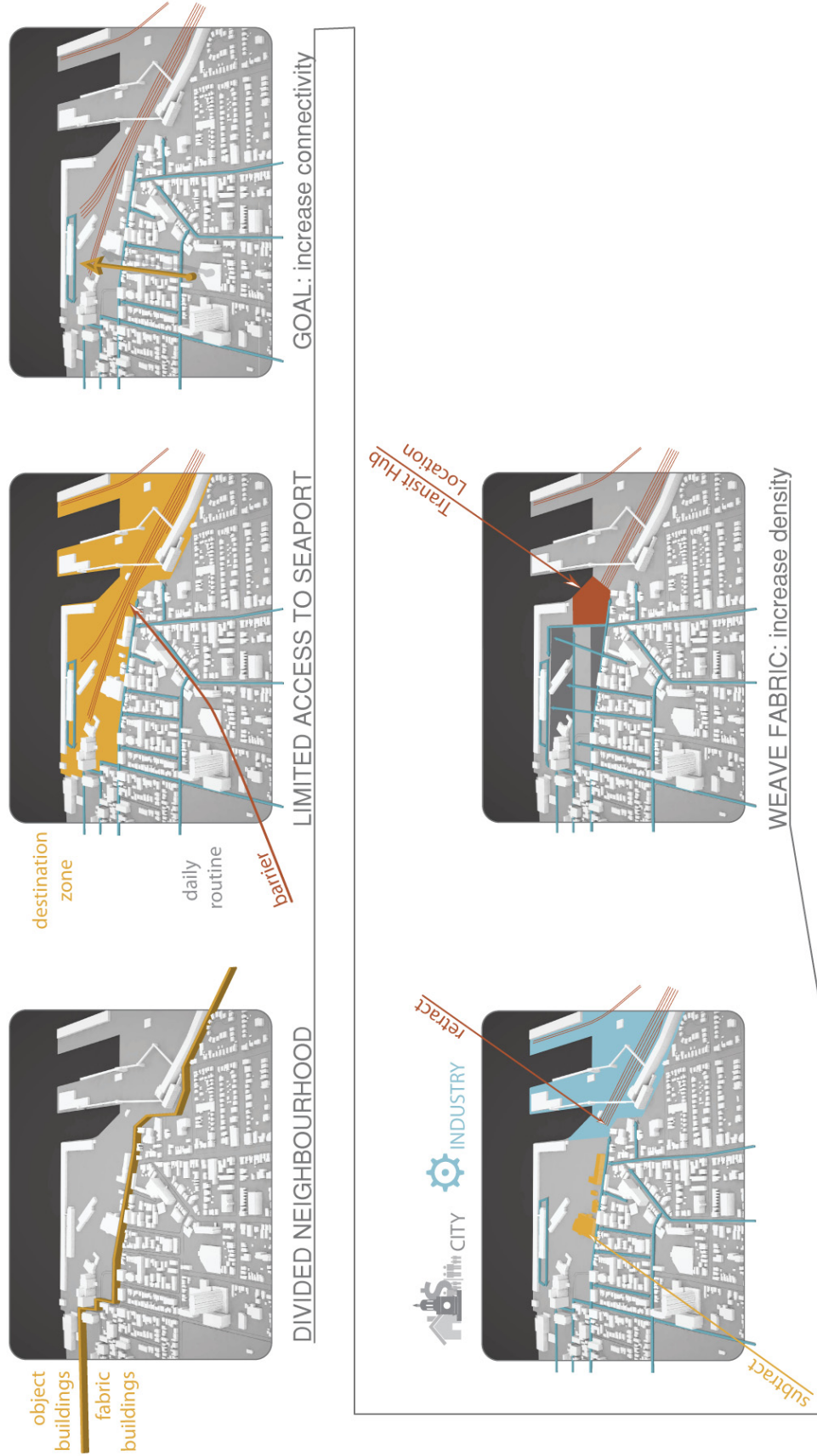
Stations will serve as transportation nodes that accommodate a large array of uses in the service area. They will also work towards facilitating a greater level of connectivity between existing uses in the city.

Terminus Station

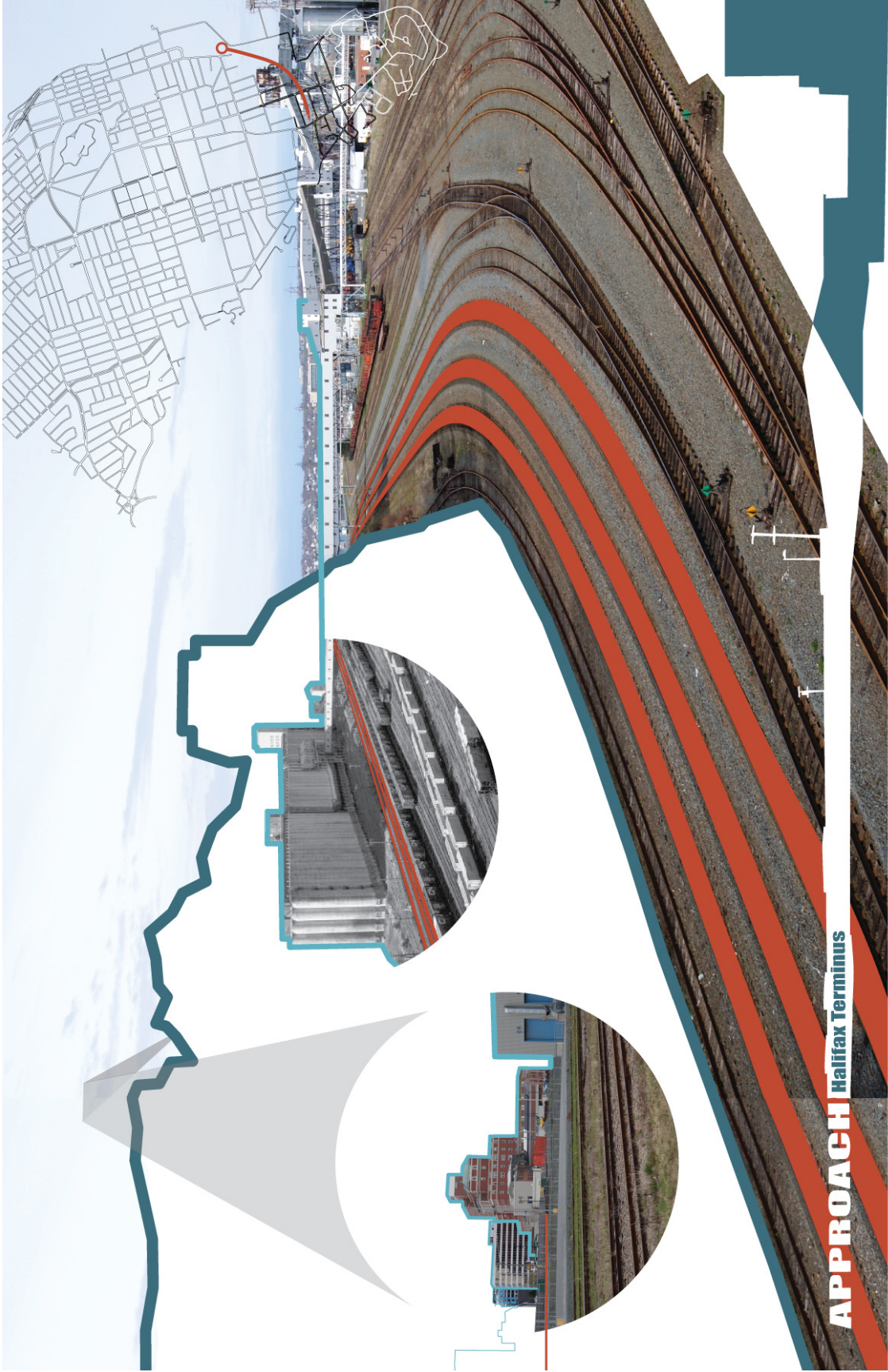
The first condition, the terminus, is a multimodal public transportation interchange located at the convergence of multiple transportation networks. This convergence point is located in the South end of the Halifax peninsula at the mouth of the rail corridor. Its station 'neighbourhood' serves a downtown population as well as a growing business and cultural district. This location places the station at the epicenter of industrial, cultural, and residential uses. This grouping of divergent landscapes allows the station to act as a gateway marking the edge of the city and the beginning of the transportation corridor. By its nature, the terminus station possesses a dual facade condition, where the front of the building belongs to the city and the rear belongs to industry and transportation.³⁴ This unique character is what provided the station its gateway status, as passenger arrival to this threshold, occurs as people proceed from the city to the transportation mode and vice versa. This element allows the architecture to play with the sense of expansion and contraction of space as one moves from the limitless space of the journey to the constricted space of the city.

The stations gateway location was determined by its proximity to existing transportation networks and the potential it has to significantly reshape the neighbourhood around the station. In its

34 Wolfgang Schivelbusch, *The Railway Journey: The Industrialization of Time and Space in the 19th Century* (Berkeley: University of California Press, 1986), 174-177.



Re-organization of the urban environment surrounding the terminus station.



APPROACH Halifax Terminus

Approaching the terminus station by train and 'prt' through the industrial landscape

current state the site of the proposed terminus is characterized by a lack of a consistent urban fabric. This fabric is fragmented by roadways and parking lots, as well as, being divided in two by the rail lines connection the Via rail station. These elements have created an area, where the activities generated on one side of the tracks have no relationship to the urban fabric of the city on the other side.³⁵ To establish a better connection between these divergent landscapes in the city, the transportation interchange retracts the clutter of infrastructure that has been a barrier to the growth of the area.

Infrastructure... can shift from being the primary engine of community degradation, to the driving force of community development.³⁶

By locating the station at the intersection of these landscapes, it forces the activities of each area to interact with the station. This interaction at the gateway to the new urban environment will set up a structure where social interaction animates the space.³⁷ The transportation interchange will function as a terminus to the southern end of the rail corridor, capping the existing rail lines and providing entry for the proposed 'prt' network. It's proximity to the harbor, at the inner edge of a pier, allows for the accommodation of ferry services. As well, an existing regional bus service (currently located at the existing train station) and a new metro transit bus interchange will be integrated

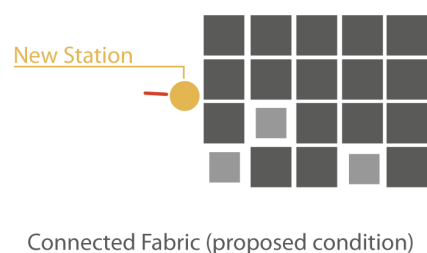
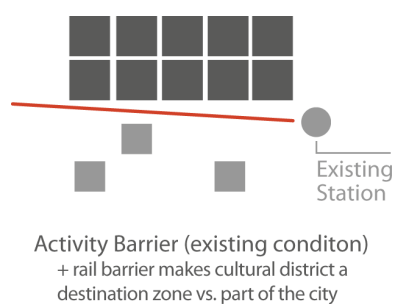


Diagram illustrating how pulling the tracks back will allow the fabric of the city to occupy the formerly cut off area of the Halifax Seaport.

³⁵ Tranick, *Finding Lost Space*, 2.

³⁶ Kent, "From Place to Place," 2.

³⁷ Shannon and Smets, *The Landscape of Contemporary Infrastructure*, 14.

into the proposed station. By integrating these networks, the station now has the capability to serve a local, regional, and national audience. This injection of a broad audience of users to the station neighbourhood will bring about a new urban form. This form will be characterized by the patterns of movement and use in the neighbourhood of the station.³⁸

To accommodate these networks at this location in the city, the rail lines were pulled back from the existing train station to the proposed gateway location. As a result of this move, the fabric of the city is allowed to penetrate into the formerly isolated cultural district. "The scale, dimension, and program of this station have the capacity to influence the surrounding structure of the city," adding to the experience of the neighbourhood.³⁹ By grouping these transportation networks, the station will have the passenger capacity to create a demand for amenities within the station neighbourhood, thus helping to reshape these patterns of movement in the urban environment.

In an effort to accommodate this demand, the station must provide a level of amenity that can support and engage a variety of users, as well as, the neighbourhood around it. The amenities provided at this station environment are designed to engage the transit user at a variety of levels. Thus, there will be a provision of easily accessible

³⁸ Tranick, *Finding Lost Space*, 70-98.

³⁹ Berlage Institute, *Brussels A Manifesto*, 168.

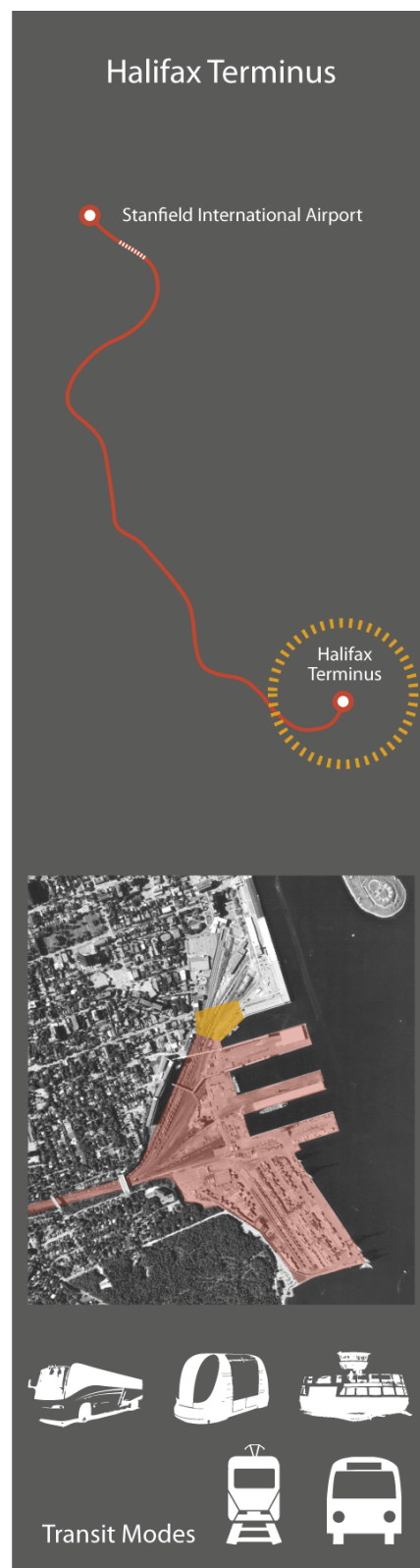


Diagram illustrating the various transit modes and their location in the corridor network.

shops, such as delis and newspaper stands, that will cater towards a quick interaction, where the average person will be moving through the station environment or switching between transportation modes at a rapid pace. Other uses will be catered towards those who are waiting for a bus or a train or residents of the station neighbourhood. These shops, such as formal restaurants and garment boutiques, are located further from the main paths of travel and accommodate people moving at a slower pace.

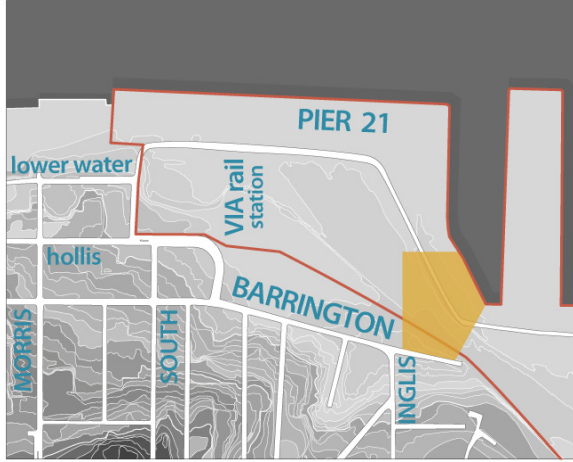
Great places are in fact defined by the ability to accomplish many things at once, often accomplishing many spontaneous, unplanned goals in the process.⁴⁰

In an effort to achieve this ideal the station

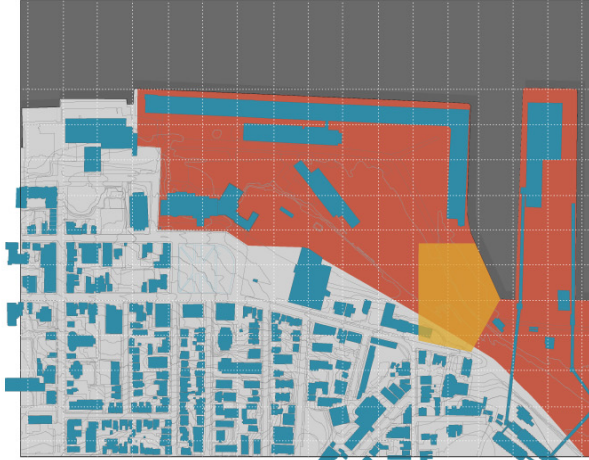
⁴⁰ Kent, "From Place to Place," 2.



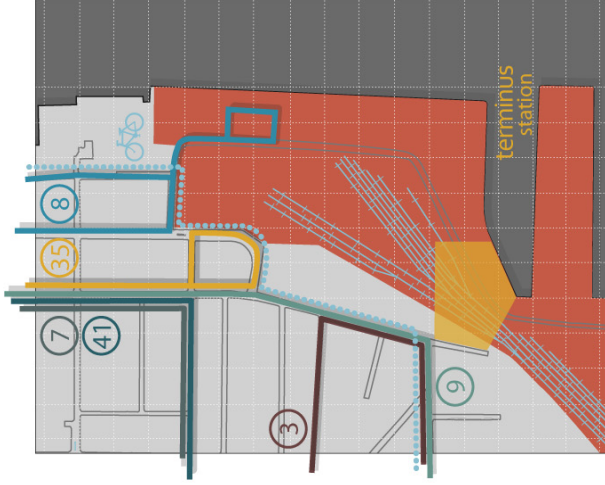
Illustrating the importance of connecting the terminus station to areas of importance in the city such as the boardwalk and Point Pleasant Park.



Topography



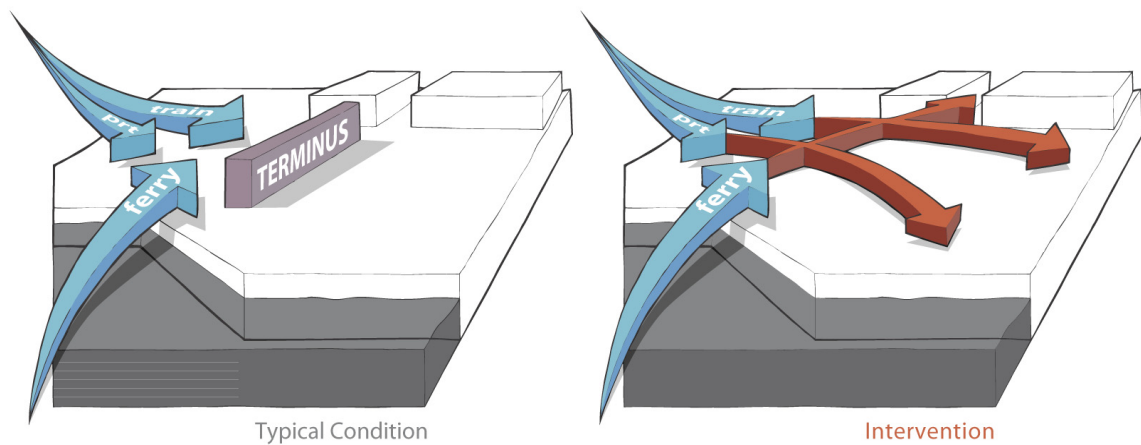
Built Form



Transit

Maps of the terminus station location in the South End of the Halifax peninsula. Highlighted in red is the potential development area. Highlighted in yellow is the proposed station location.

environment needs to capitalize on the resources already functioning well within the neighbourhood. For the Terminus station, it will be essential that it has a relationship with the boardwalk and downtown business district. It will also be critical to the success of the station to not turn its back on Point Pleasant Park or the industrial uses of the seaport, but to create an axial relationship with them. By focusing on creating a vibrant urban place within the greater city, the multimodal transit hub is positioned to set the tone for future development of the area. The void created by pulling the tracks back can now allow the activity of the city to feed into the emerging business and institutional area of the Halifax Seaport.

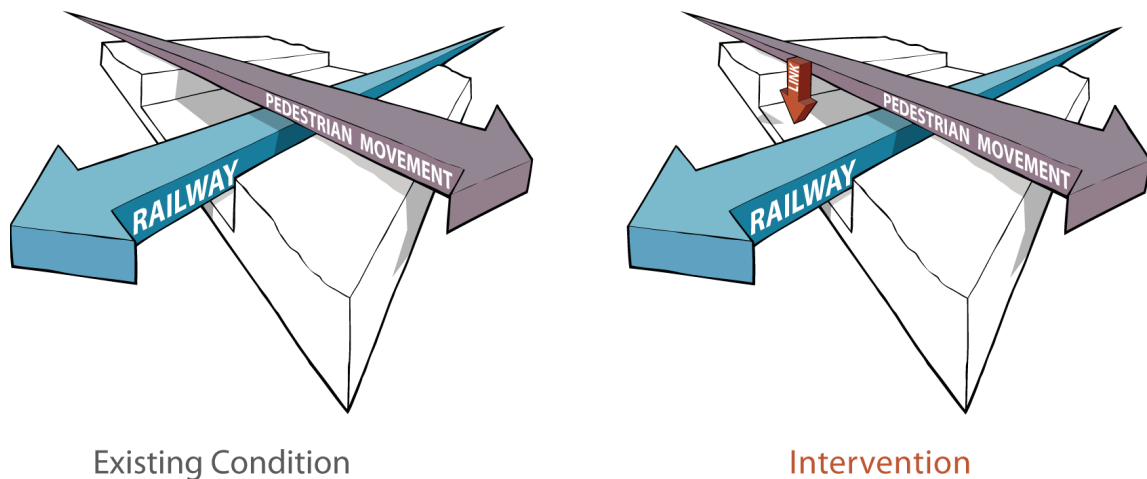


By allowing the movement generated by the various transportation networks to permeate the space of the city, it will become a generator of urban form.

Urban In-Line Station

The second study condition, is an in-line station that negotiates a change in elevation from the floor of the rail cut to the level of the city and provides access to the 'prt' network. The station that will be studied is located at the back edge of Dalhousie University in a predominately residential neighbourhood. This necessitates that it be "neighbourhood compatible." This statement is not about only addressing the "concerns of noise and safety," but how a transit stop at this location will "add value and preserve the character of the community."⁴¹ The station needs to provide a level of amenity that is consistent with the character of the neighbourhood, while opening up opportunities for growth. The scale of the design must not overpower the residential fabric that surrounds it,

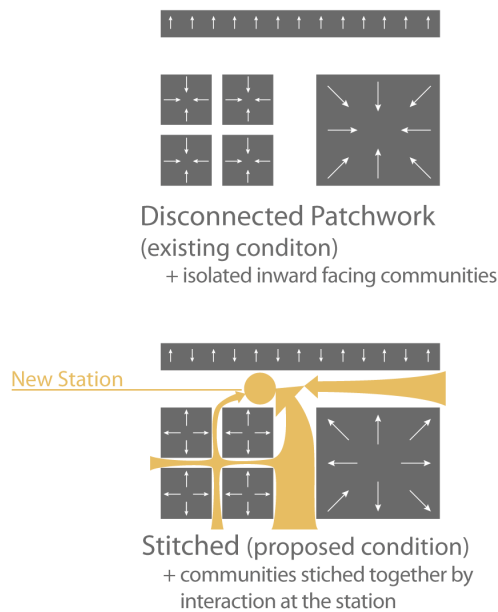
⁴¹ Gordon Douglas, "Rail Transit Identification and Neighbourhood Identity. Exploring the Potential for 'Community-Supportive Transit,'" *Journal of Urban Design* 15 (2010): 182.



The Dalhousie station is located within the rail cut. Thus, the key to the design is linking the movement at the level of the city to the transportation network by way of the station.

but also needs to create an icon for the station in the area. The Art Nouveau Metro entrances in Paris and the glass canopies of the Bilbao Metro system by Norman Foster are examples of infrastructure thresholds, that clearly belong to the station network, as well as, adding structure to the urban environment around them.⁴² The success of the 'PRT' network will be conditional upon the ability of the station to create these thresholds in a manner that adds value to the community as is, while also providing the framework for growth, as the neighbourhood diversifies to accommodate the demands of passengers using the transportation network. Therefore, this threshold is catered towards the students, workers, and neighbourhood residents who will be the primary user groups at this station.

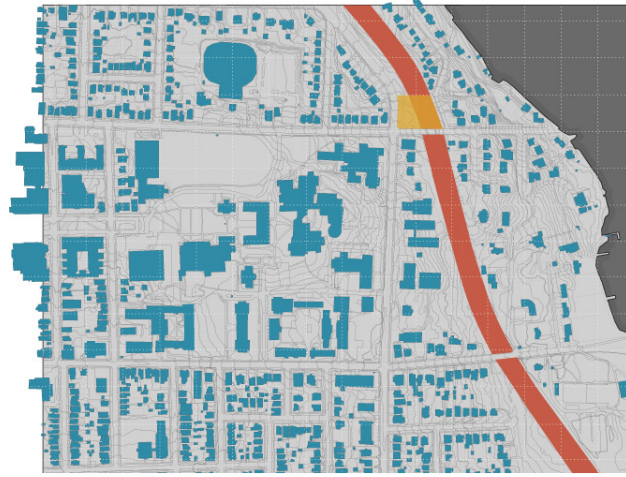
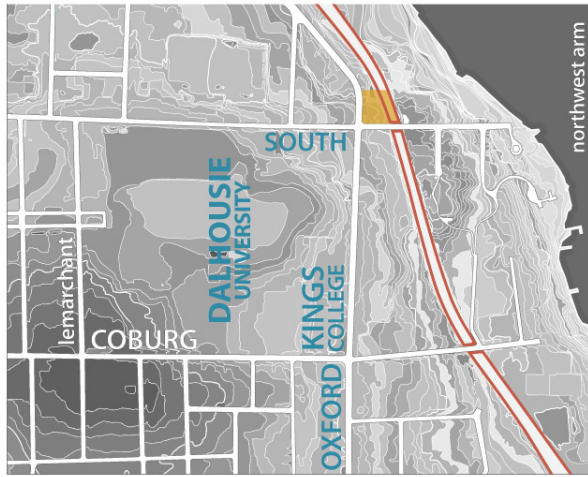
42 David Jenkins, *Catalogue Foster + Partners* (Munich: Prestel Verlag, 2008), 264.



The character of the neighbourhood can be strengthened by the integration of the station into the daily routine of its inhabitants and the accessibility it provides to the area.



Diagram illustrating the various transit modes and their location in the corridor network.



Topography

Built Form

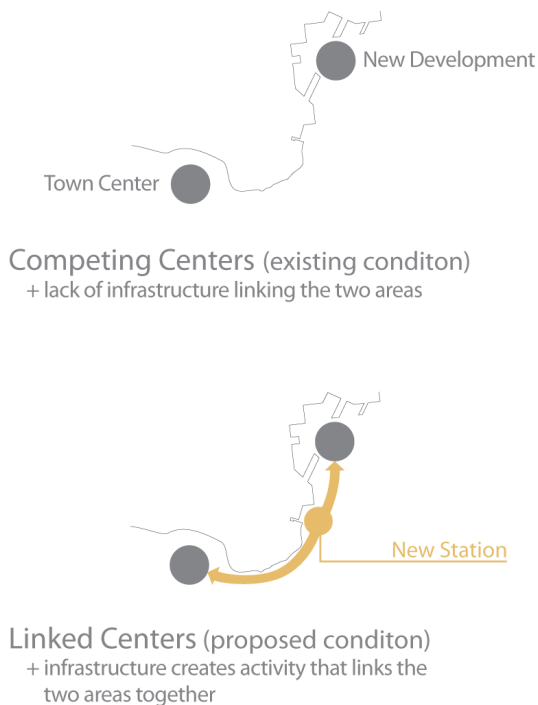
Transit

Maps of the Dalhousie Station location in Halifax. Highlighted in red is the rail corridor. Highlighted in yellow is the proposed station location.

Suburban Station

The third condition, an in-line station that is located in a suburban environment will serve the 'prt' network, as well as, a fast ferry service. This station will operate at a scale in between that of the terminus and the in-line urban station. Promoting community sociability will be key for this station in an area that is currently devoid of a common space for communal interaction. Gordon Douglas describes how the components of the station must capture the local identity if they are to gain community support and foster a sense of place within the neighbourhood.⁴³ The grouping of public transit will give more efficient access for

43 Douglas, "Rail Transit Identification and Neighbourhood Identiv." 177.



Locating the station between the emerging mixed use district and existing town center of Bedford will allow the station to act as a hinge. This hinge will provide a common space for both centers to share as part of a united community.

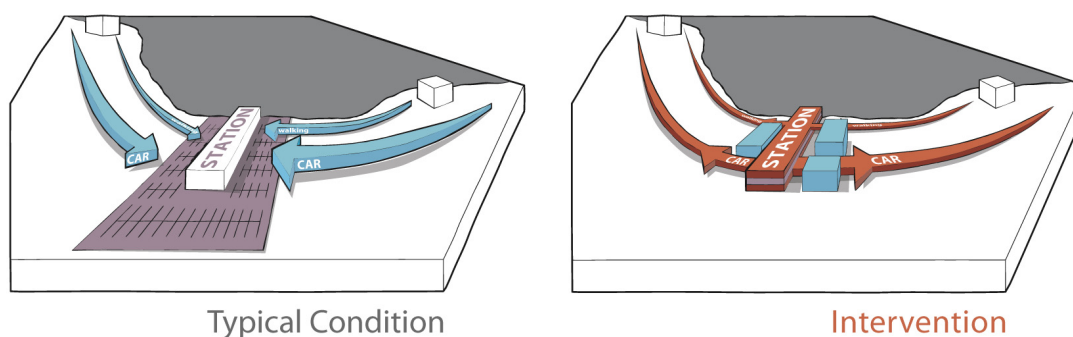


Diagram illustrating the various transit modes and their location in the corridor network.

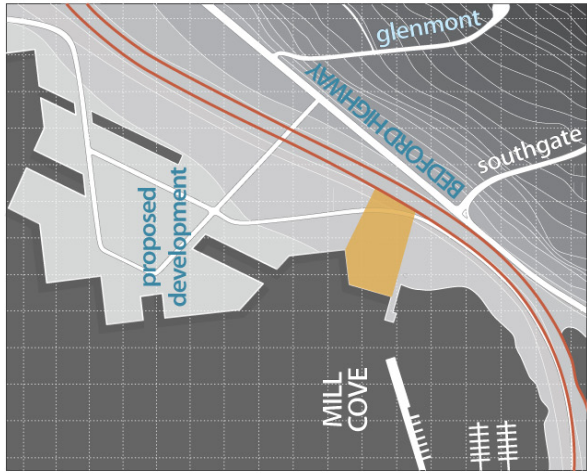
workers, neighbourhood residents, and shoppers to the peninsula. By increasing accessibility and providing spaces for social interaction the station will attempt to become an anchor between the community of Bedford and an emerging mixed use housing development being built at the edge of town.

In all three conditions improved accessibility created by transportation along the rail corridor creates a critical mass of demand for the development and intensification of land use. After time, this intensification and diversity of uses is what sustains and promotes the use of public transportation in the station neighbourhood.⁴⁴ By examining the relationship of the station to its community at three different scales of interaction, a clear diagram of the characteristics required to integrate into and add value to a community will be made that can be applied to other stations along this network as it grows. (see pg. 44)

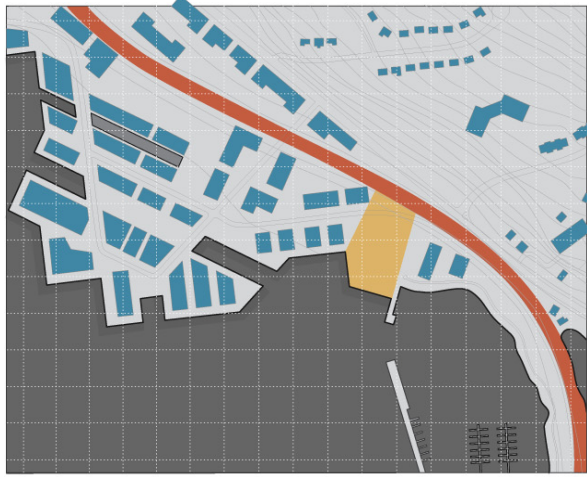
⁴⁴ Luca Bertolini and Tejo Spit. *Cities on Rails: The Development of Railway Station Areas* (London: E & FN Spon, 1998), 9.



In a suburban location commuters are often travelling to the station by car. By integrating parking into the design of the station, it will invite other uses to gather at the station, versus the typical suburban station as an island surrounded by parking.



Topography



Built Form



Transit

Maps of the Bedford Station location in Halifax. Highlighted in red is the rail corridor. Highlighted in yellow is the proposed station location.

Station Neighbourhood

Brian Edwards, Marcus Binney and David Pearce all suggest that developing station neighborhoods into nodes, leads to this intensification of land uses, as activity is drawn into the station environment to take advantage of the influx of people. This leads to an increased cultural well being for the community, as people engage in business and social interaction around the station.⁴⁵ The Naples rail network expansion in Italy demonstrated that the station neighbourhoods underwent spatial changes, which involved “land development and renewal, as well as, activity changes, including resident and job relocation.” These changes exhibited that activity would group around the urban rail stations.⁴⁶ Martha Thorne puts forward the notion that architects and planners need to capitalize on this social grouping by envisioning stations as a hub of a broader network of transportation strategies, thus capturing a functional mix of users in the station environment.⁴⁷

Community

This grouping of uses around the station, allow it to function as a ‘threshold,’ identified by Kelly Shannon as an infrastructure that negotiates a connection between the various competing forces,

45 Edwards, *The Modern Station*, 10-17.

Binney, Marcus and David Pearce. *Railway Architecture: Save Britain's Heritage* (London: Bloomsbury Books, 1979), 70.

46 Bruinsma et al., *Railway Development Impacts on Urban Dynamics*, 340.

47 Thorne, *Modern Trains and Splendid Stations*, 21.

but at the same time becomes a place within the city.⁴⁸ Wolfgang Schivelbusch describes how at this place, the idea of community is exhibited by the interaction of people and objects in the station environment. Thus, the station plays a central role in altering how the user communicates their thoughts and feelings.⁴⁹ These changes occur as the old conception of the rail corridor as a barrier to neighbourhood cohesion changes, to one of access and activity through the installation of a personal rapid transit network. It will be important for the station to possess the qualities and identification, as identified by Steven Parissien, within the urban environment that was formerly accomplished by institutions such as the church and the town hall.⁵⁰

As the stations along this network are conceived as interchange points of social significance, Alessia Ferrarini points out that they need to be innovative in the way they interact with the urban grid, creating a structure that is as important a public space as the town square.⁵¹ Stations such as Liège-Guillemins by Santiago Calatrava provide an example of how a structure can capture the spirit of the city, while reconnecting flows of movement between areas of the city formerly cut off by the rail road infrastructure.⁵² Along the

48 Shannon and Smets. *The Landscape of Contemporary Infrastructure*, 140.

49 Schivelbusch, *The Railway Journey*, 191.

50 Steven Parissien, *Station to Station* (London: Phaidon Press Limited, 1997), 77-80.

51 Ferrarini, *Railway Stations*, 58-162.

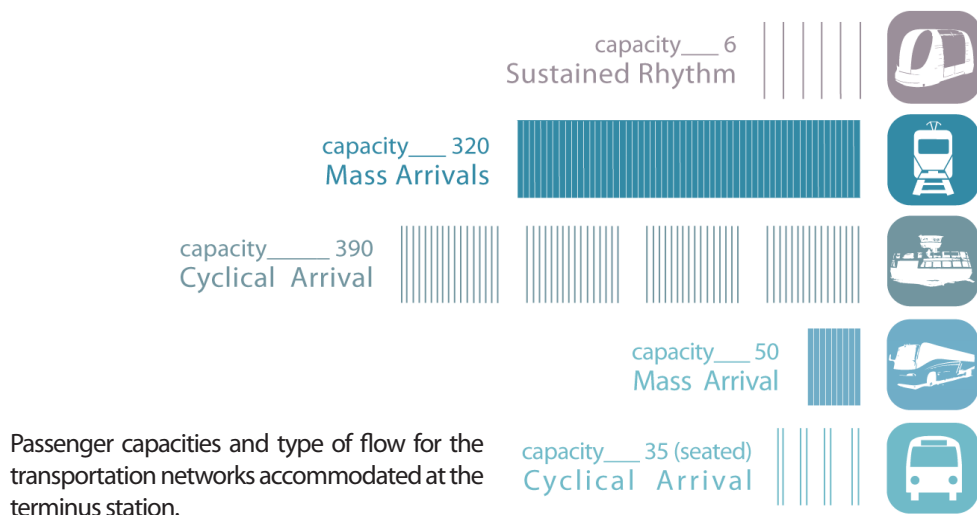
52 David Littlefield, "Antwerp Central and Liège-Guillemins, Belgium" *Architectural Design* 80 (2010): 107.

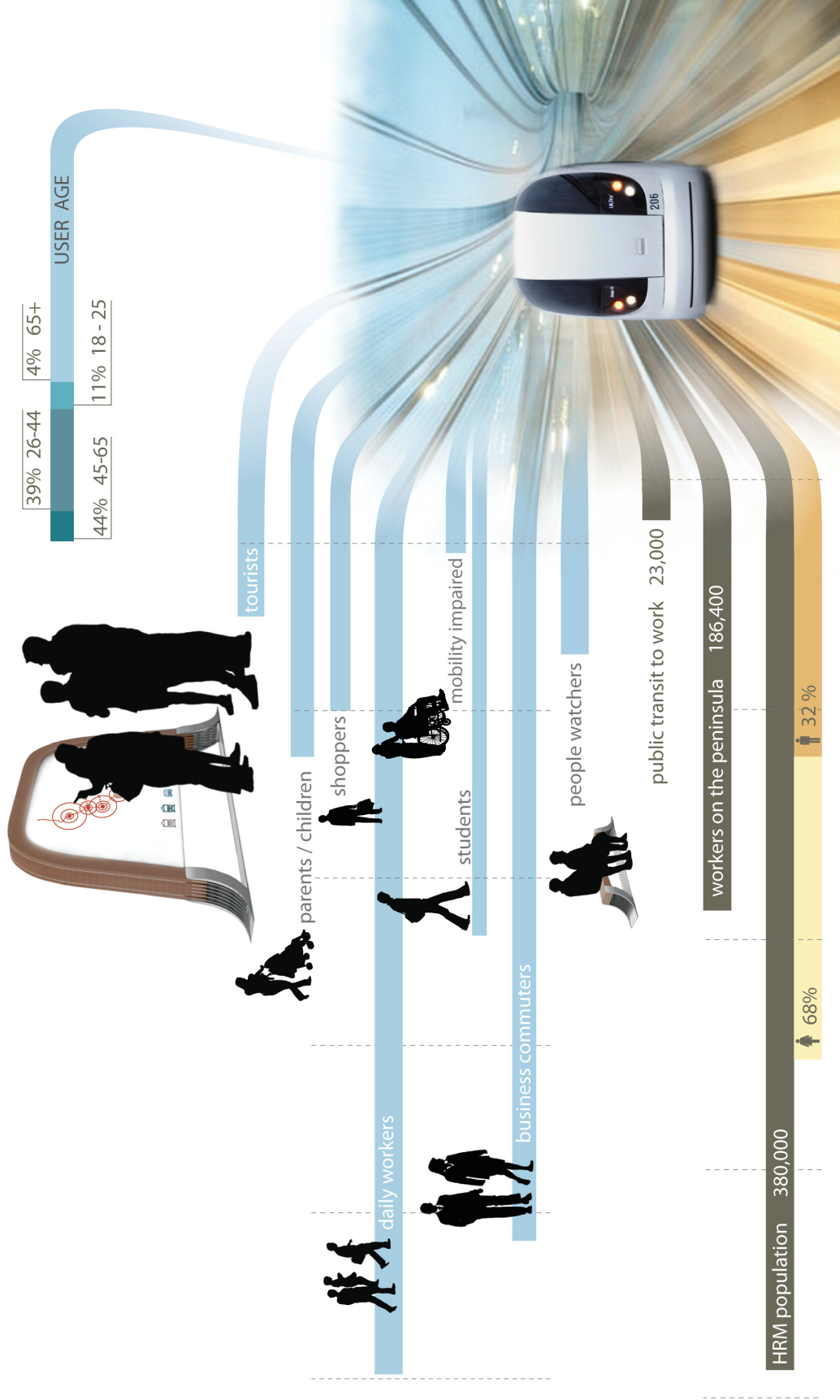
way we have somehow divorced ourselves from the transportation networks of the city. As the speed of transportation has increased over the last century, so has the detachment of the traveller with the landscape.⁵³ As this desire for quick connections grew, the station became a transitory place, through which people rapidly moved in and out. The decision to create a personal rapid transit network, with small scale vehicles was undertaken in an effort to reverse this trend and once again make the station a focal point for the community.

With mass transportation comes a cyclical mass of pedestrians, cabs, and buses as a constant flow of people pass through the station. This can have an isolating effect on the community, where neighbourhood residents avoid the station and its waves of movement.⁵⁴ Thus a small scale network, that provides a smaller more sustained stream of traffic, will provide the level of activity needed to sustain the station, without the huge masses

53 Schivelbusch, *The Railway Journey*, 33-34.

54 Ibid. 171-197.





Station user demographic. From Halifax Metro Transit, "Annual Service Plan"

of people that deter neighbourhood residents. This in union with the independence provided by the on-demand nature of the 'prt' system gives the community a sense of ownership over the choice of destinations, fellow travellers, and the time they wish to commute. By providing this personal aspect to public transportation, the station can better fulfill its obligations to the scale of the pedestrian, the community, and "the city as a whole."⁵⁵ Therefore, it is important for the network of stations developed for the personal rapid transit system to develop an identity that is unique to them, as well as each community they serve. Douglas Gordon explores this topic in depth, suggesting that identification with the community can create a supportive atmosphere that promotes use of the transit network.⁵⁶ Thus, the use of the public transportation network will be connected to the daily lives of its users, as well as the community that it serves.

Through re-envisioning our cities, transportation systems and economies around destinations, we will make feasible the more sustainable transportation modes of mass transit, walking and bicycling.⁵⁷

By achieving these standards of interaction with the community it is feasible to see the expansion of the 'prt' network to other under used transportation corridors, effectively creating a peninsula wide



Future public transportation map for Halifax, Nova Scotia, Canada.

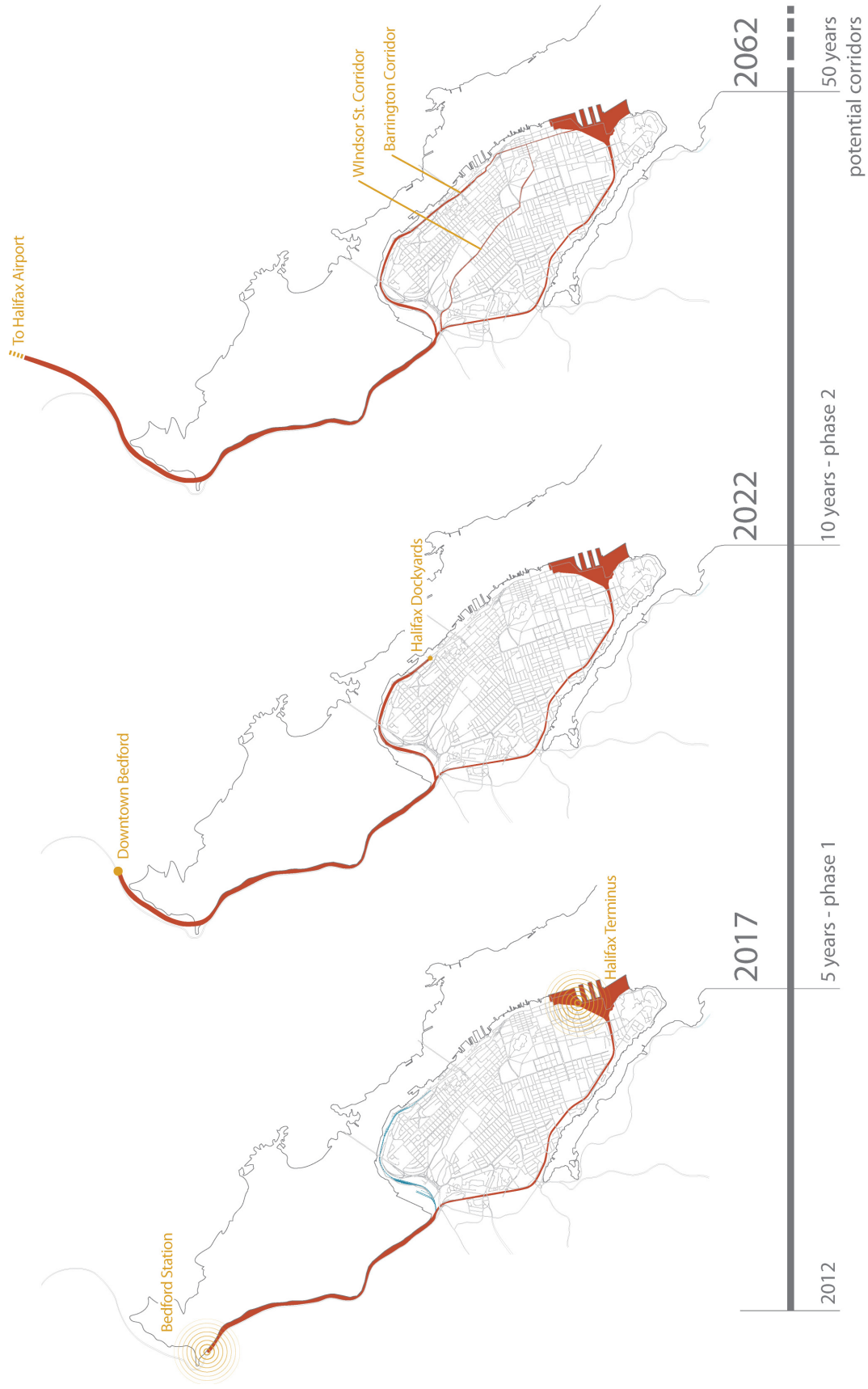
⁵⁵ Nevins, *Grand Central Terminal*, 122.

⁵⁶ Douglas, "Rail Transit Identification and Neighbourhood Identity," 191.

⁵⁷ Kent, "From Place to Place," 3.

network in the future. The “accessibility and exposure” created by thoughtful integration of a station into a community of need will help to foster business and social interaction.⁵⁸ This improved well being of the community will lead to growth and improvements in the urban structure of the city.

58 Transportation Research Board National Research Council. “The Role of Transit in Creating Liveable Metropolitan Communities,” 10.



Growth potential of the 'prt' network along underused corridors in the city of Halifax over the next fifty years.

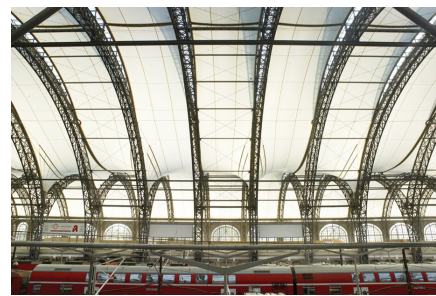
CHAPTER 3: STATION EXPERIENCE

Scale

Engaging the personal and the collective within the station environment becomes a critical piece of the infrastructure of the station. The threshold between these two scales of interaction provide the station with the “commotion and noise” that creates and sustains activity.⁵⁹ By studying stations of all different scales and locations in the world, it became clear how the manipulation of this variety of scales impacts the functioning of the station. The train sheds of stations such as Dresden, Waterloo, and Liège illustrated the importance of movement and light within the structural design of the station. Allowing light to propagate this sense of movement into the urban fabric of the city will provide a deeper engagement of the transit station with the community. At a more personal scale, this movement and light can be manipulated to provide comfort and direction within the station. Through these observations it was noted that the points of interaction between the station and its patrons often occurred with the items not designed by architects, such as furniture and service distribution equipment. This means that at a personal scale, the items providing comfort to the patron are often of a different design philosophy than that of the architecture. Brian Edwards describes how the “quality of furniture within the station is as important to the overall quality of the environment, as the architecture itself.”⁶⁰

⁵⁹ Schivelbusch, *The Railway Journey*, 191.

⁶⁰ Edwards, *The Modern Station*, 120.



Fabric Canopy - Dresden Hauptbahnhof.
From Niedenthal, *Stations in Germany*.



Articulated Canopy - Waterloo Station.
From Edwards, *The Modern Station*.



Vaulting Canopy - Liège Guillemins Station.
From Minutillo, “Liège-Guillemins TGV Railway Station.”



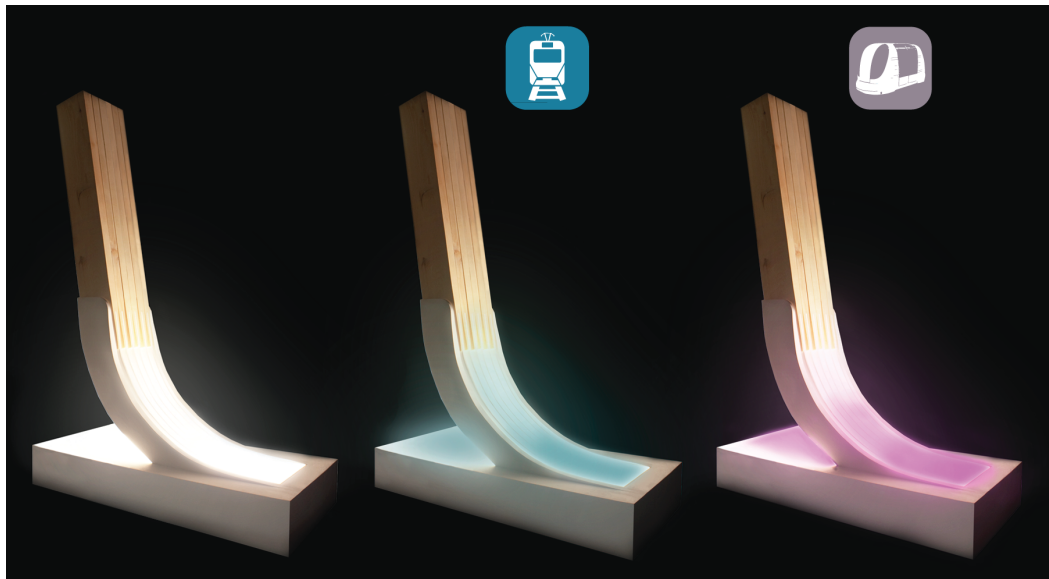
Station Services that do not coordinate with the character of the architecture.
From Uffelen, *Stations*.

Kit of Parts

As a method for approaching the overall design of the station, I started by examining the personal scale of components in the station and their relationship with the body. This exercise found its strength through a common language that was intended to provide a sense of clarity and identity for the transit network. By making these components a piece of the architecture package, it allows the design of the station to be read as a legible whole, which facilitates wayfinding through design, as opposed to signage.⁶¹

An important aspect of this common language is to achieve the sense of excitement and movement that is exhibited in the train sheds described above. The design of these components is derived from the idea of extruding the ground plane. By conceptually extruding the plane of the ground,

⁶¹ Jenkins, *Catalogue Foster and Partners*, 246.

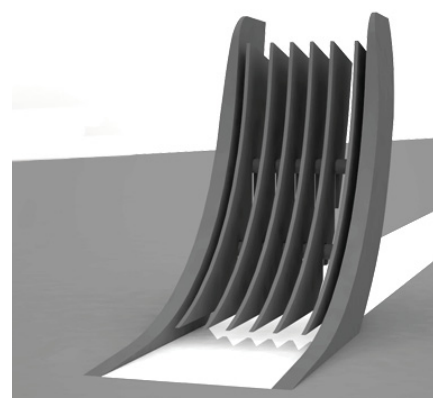
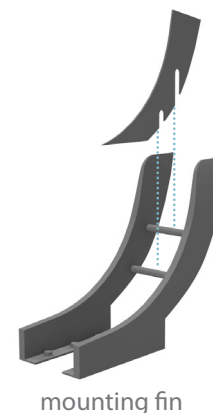


Detail of lighting characteristics of station components that highlight to users of the station where services are located and the arrival of transit vehicles.

it creates a feeling of uninterrupted movement, as the ground swells up and over the object. The area exposed beneath the object by the extrusion of the ground plane emits light that can be programmed to guide people to the transportation method of their choice or will light up, to signal the arrival of a transit vehicle. Giving the station users the ability to control this light, through interaction with the display, allows the community the flexibility to alter the character of their environment. The plaza and park space around the stations become a place where this same lighting system can be used to activate the space. Roger Tranick suggests that a space only becomes a “place” when it is imbued with a “contextual meaning derived from local content.”⁶² The local content in this case is the activity of the station, as transportation modes come and go and people flow through the space.

The design of these elements as a ‘kit’ allows for universal connections to be used across all of the products. This helped to refine the language, as well as, develop a product that could be made on a mass scale, which reduces overall cost. The saddle was designed with a hollow core so that services could be run through the leg to meet the demands of the component plugged into it. For elements such as the bench, where a station patron comes into close contact with the kit, the saddle could be connected to a heat source. Thus, hot water can be fed through tubing in the floor to the saddle. The water can then circulate through the tubes used to

62 Tranick, *Finding Lost Space*, 112.



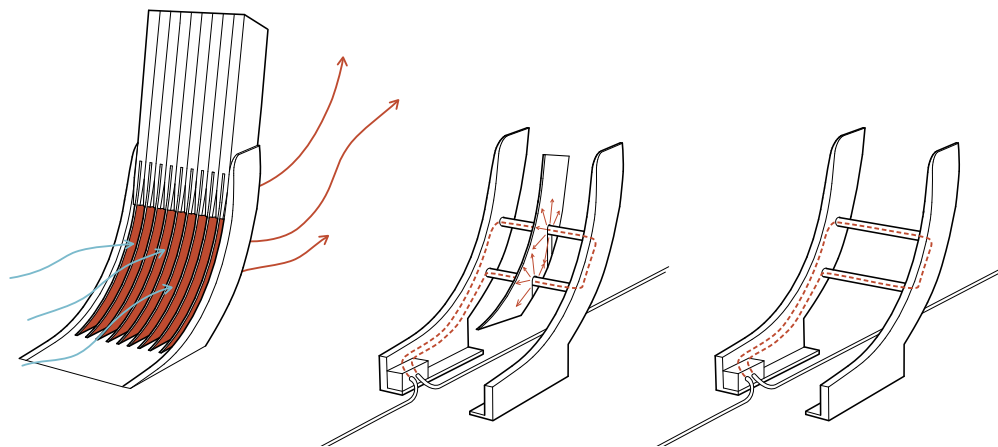
The 'kit' of parts can be used at stations along the network. This common component will help to create an identity for the stations

hold the fins in place transferring heat to the fins. As air passes between the fins it carries the heat through the space. This feature focuses on a detail that is scaled to the person, creating a microclimate around the person and object within the station. "Revealing a tactile ingredient in an otherwise ocular understanding of architecture."⁶³

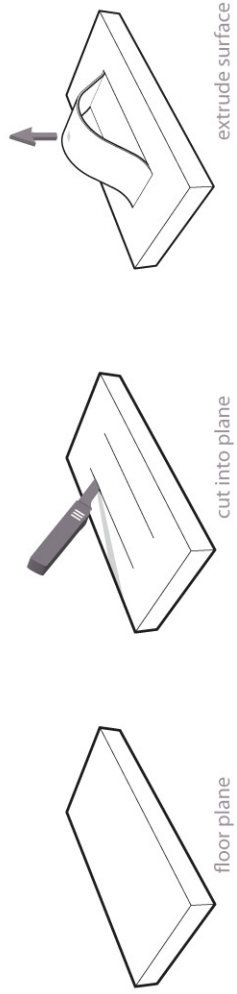
By using the 'kit of parts' to define an initial design strategy for the station, it created a language for how people and the city interact with the station. This helped to initiate a sense of place and provide a framework for how people interact with it. This sense of 'place' transforms the station into a hub of activity, where "news, gossip, and advice" are exchanged.⁶⁴

63 Juahani Pallasmaa, *The Eyes of the Skin: Architecture and the Senses* (Chichester: John Wiley and Sons Limited, 2005), 44.

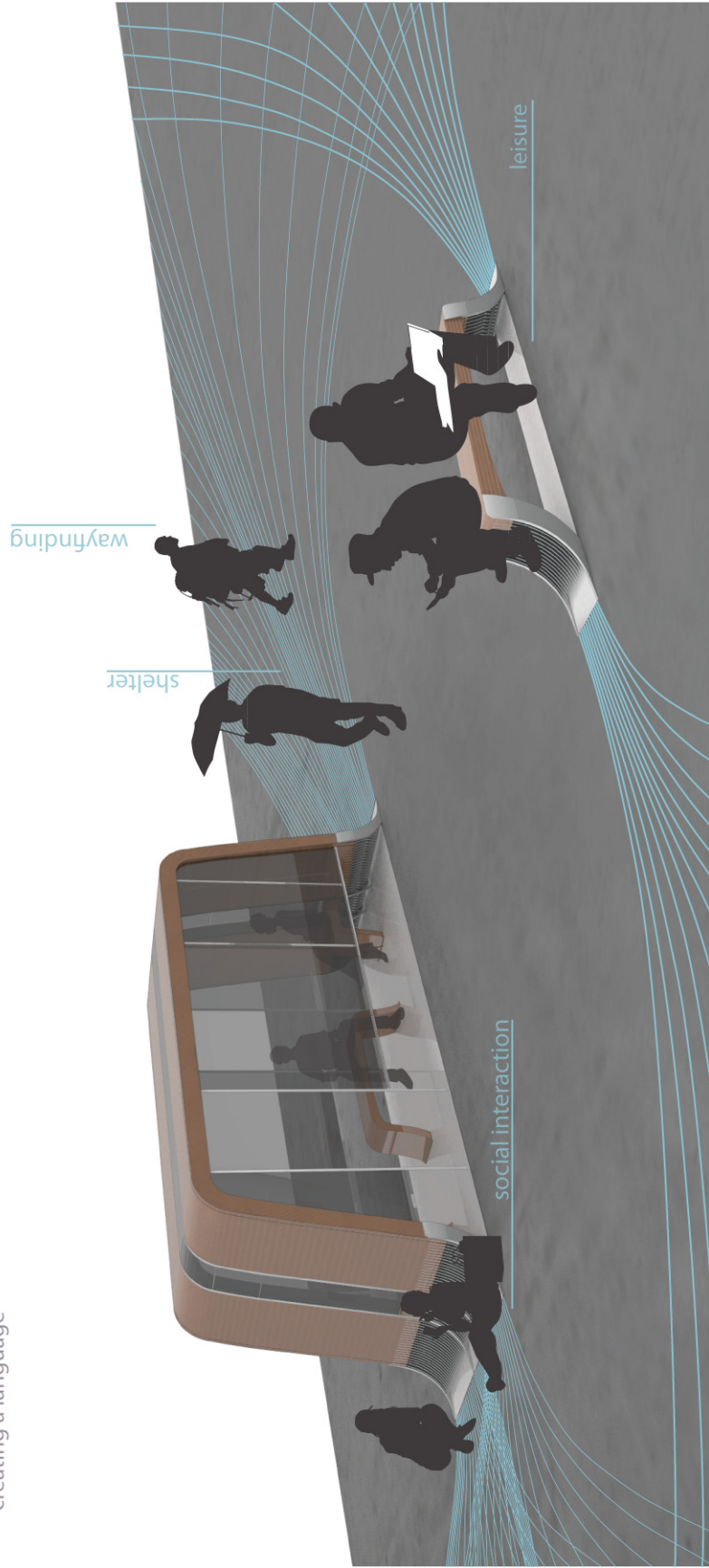
64 Jeffrey Richards and John M. MacKenzie. *The Railway Station: A Social History* (Oxford: Oxford University Press, 1986), 7.



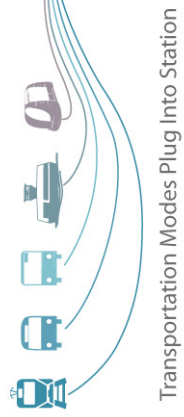
Creating heat sources around the area where people gather such as benches or information displays helps to scale the building to a more personal level.



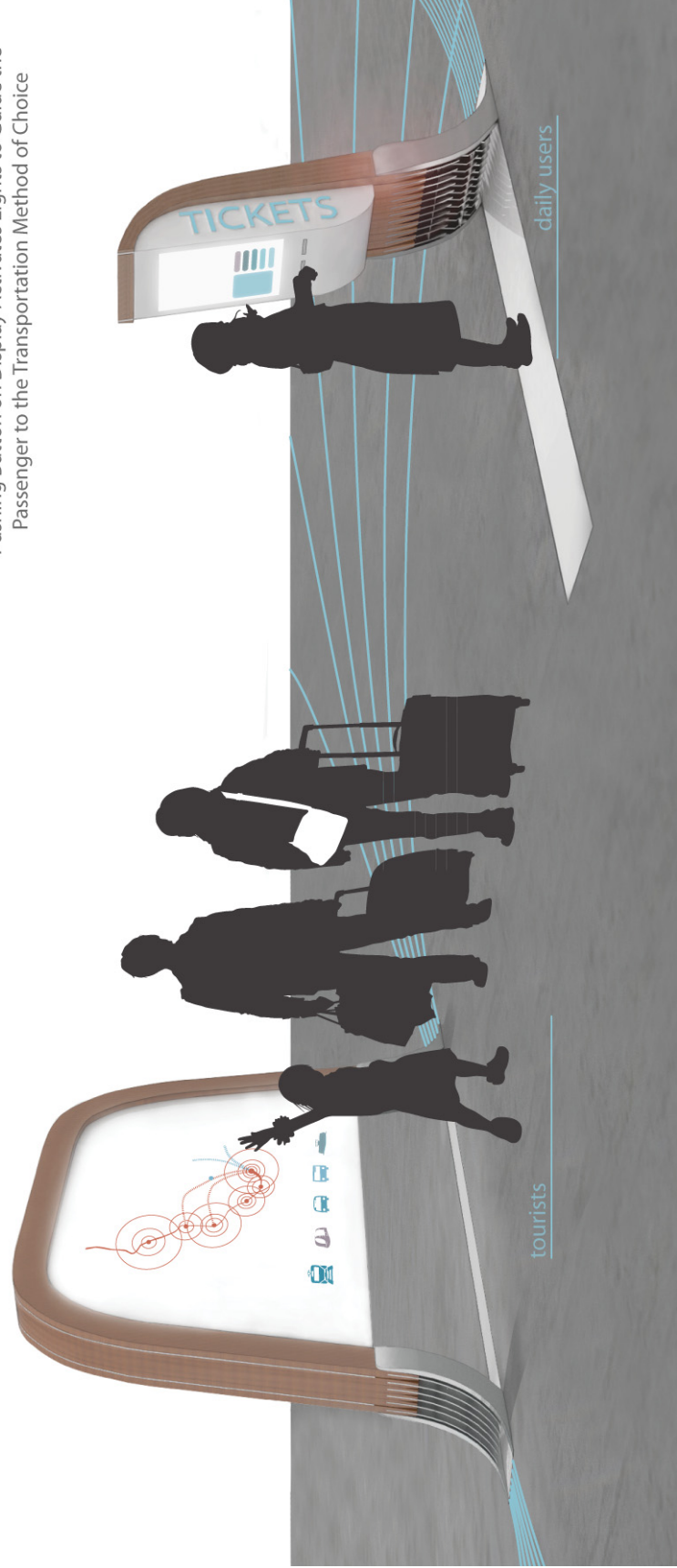
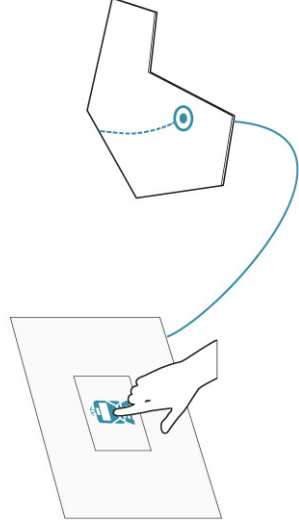
creating a language



Creating an architectural language of station components that accentuate movement and interact with passengers at a personal scale.



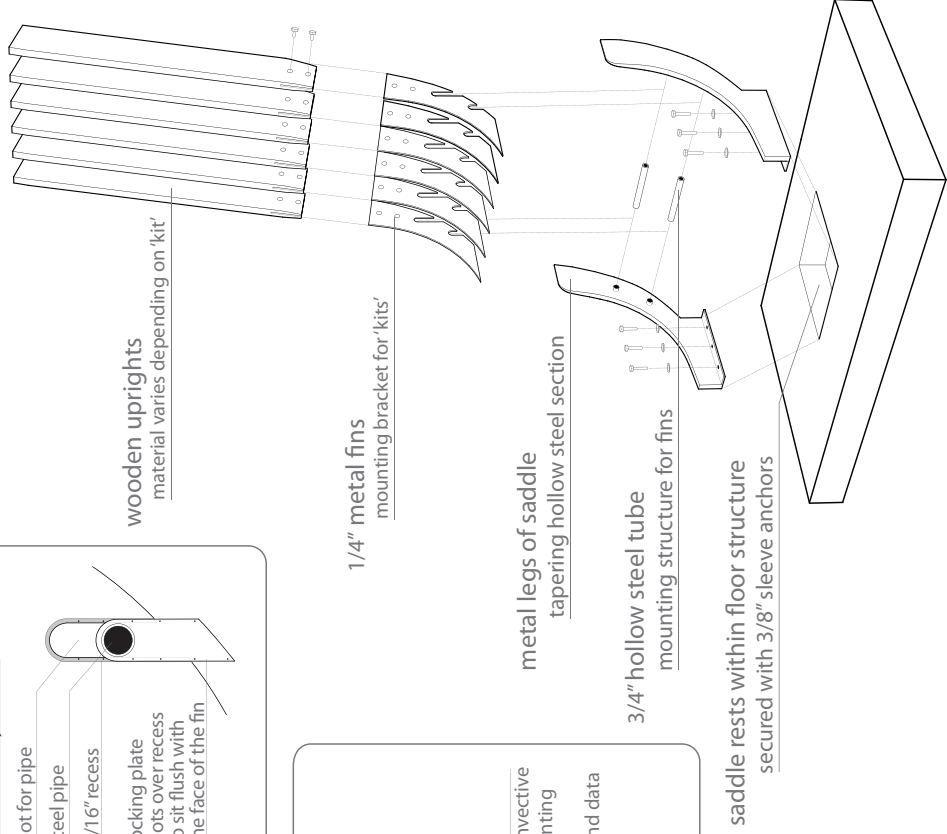
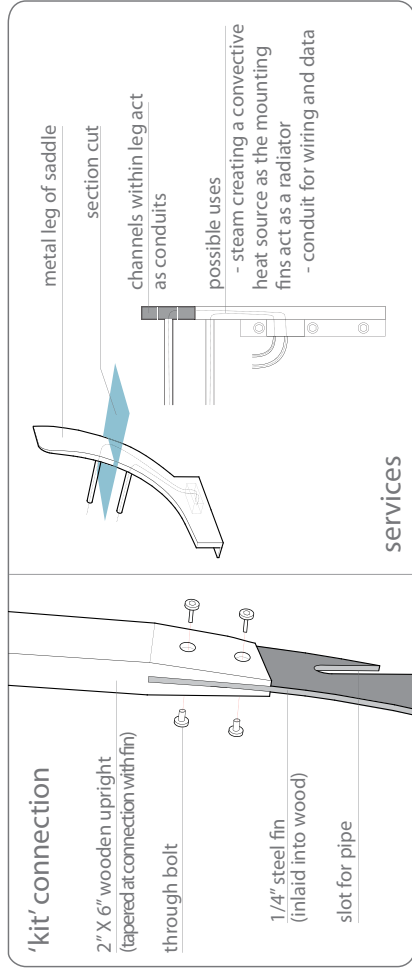
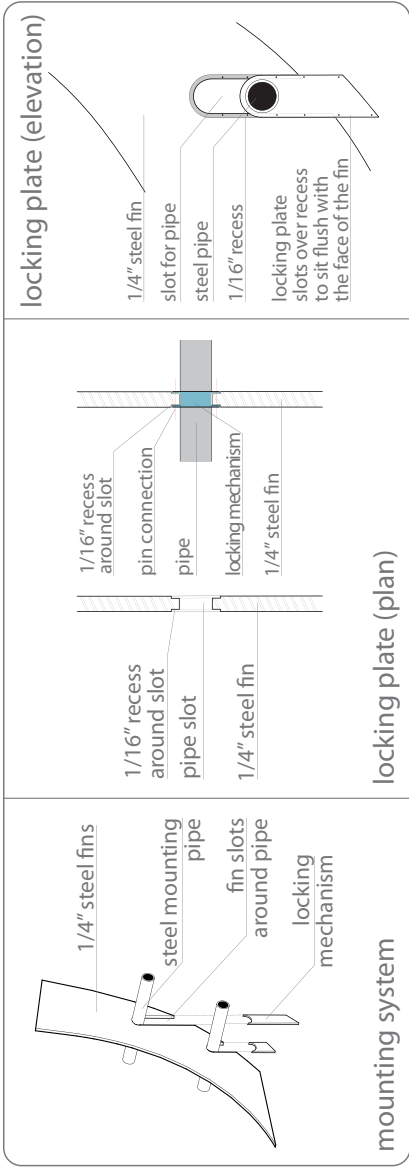
Activates Lights Inside and Outside of the Station to Signal Arrival and Departure



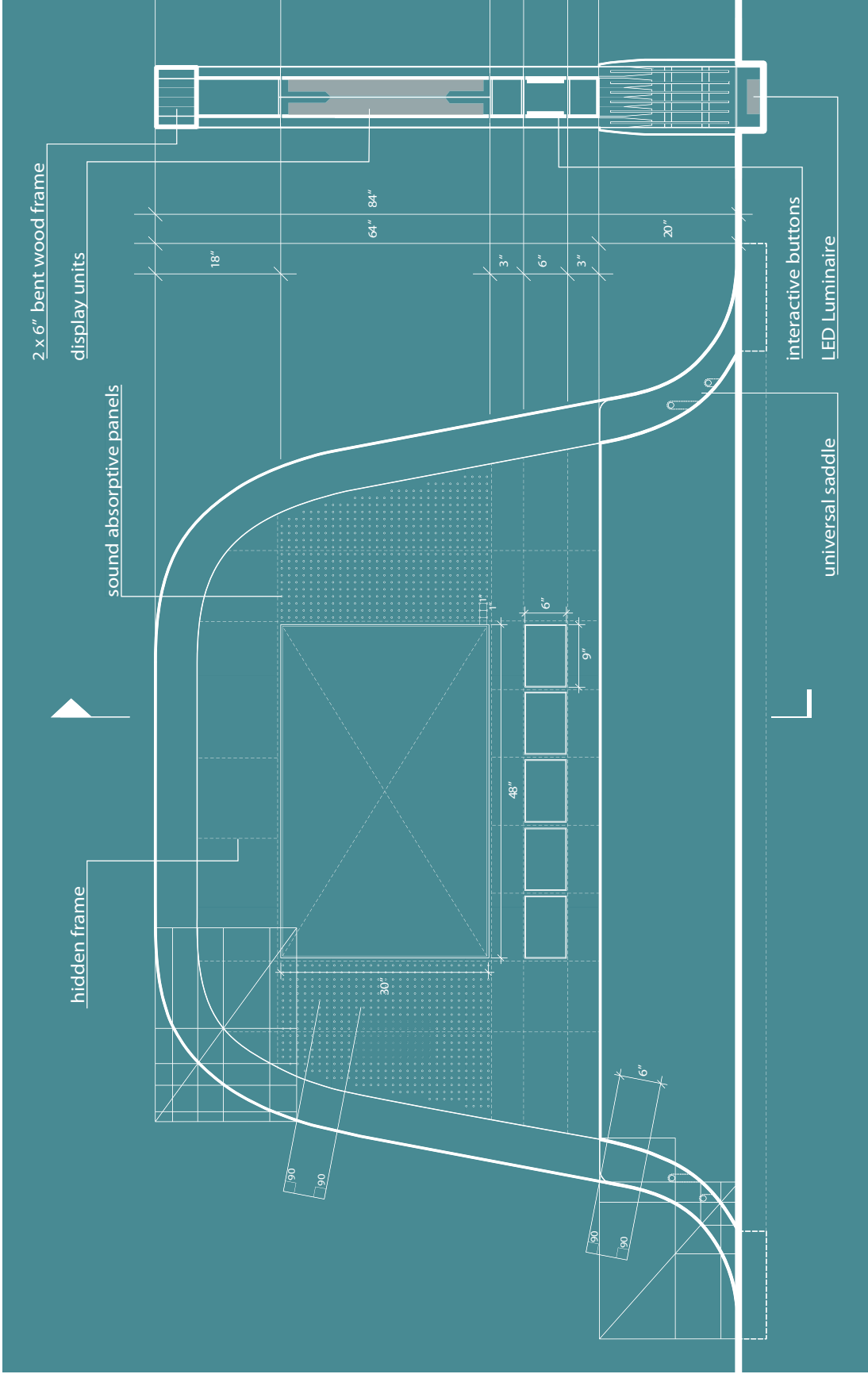
Using interactive elements to increase wayfinding and engage the larger community with the activity happening at the train station.



Creating a strong identity for the transportation network is an integral piece for its acceptance and use by the larger population.



Detail of the saddle assembly used to accomplish the flexibility of the 'kit of parts'.



Elevation and section of the interactive information display.

Scales of Development

Studying the typology of a transit station at three different scales will allow the designs to function as prototypes for the potential of a transit stop in that area, as well as, other areas along that line. To further this idea, each station will be explored at a different level of detail to provide a broad spectrum of design solutions that can be applied across all of the stations on the network.

The terminus station in Halifax will be explored at an urban level. This study will explore how the location and amenities of the station can contribute positively to the sense of place while acting as an anchor for growth. This growth will occur in area of the city that is being reclaimed from underused infrastructure that currently occupies the area. To foster this growth it will be key to design a transit station that is about more than just transportation services; therefore, creating an environment that encourages the community to appropriate the space by being an integral part of it.

For the Dalhousie Station the idea of threshold will be examined. The change in height from the elevation of the street to the elevation of the rail cut floor, highlights the importance of circulation. Exploring this sectional quality and layering of spaces will develop a rich set of ideas that can be used by other stations to improve wayfinding and access.

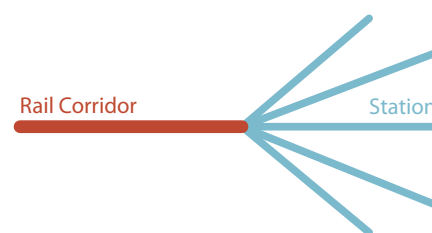
The final station, in a suburban environment will necessitate the incorporation of park and ride spaces for the transit user. In an effort to avoid having the station function as an island surrounded by parking, it will incorporate these spaces into a parking structure. The relationship between parking, the station, and the overall form of the building, will be an important part of this study. How this structure is clad and how you bring light into this space will be important detail qualities of the station. These details can then be exported to the other stations along the network.

The results from each one of these studies can be brought together to form a comprehensive overview of how to approach the design of stations for the 'prt' network along the rail corridor in Halifax, Nova Scotia.

Halifax Terminus

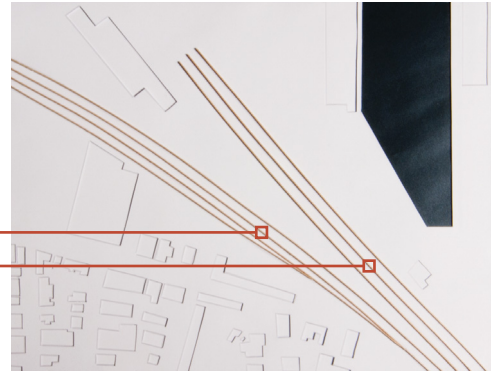
Locating the terminus station at the mouth of the rail cut and pulling the existing tracks in the Halifax Seaport area back to this point has opened up a significant amount of land for potential development. The layering of multiple transportation networks onto this location allows the terminus to achieve a scale that is large enough for it to guide development and provide a structure for future growth. Thus, the layout of the station area grew from a larger urban design exercise. This urban strategy first worked to improve connectivity between the Halifax Seaport and the South End neighbourhood adjacent to it. This was accomplished by bringing some existing streets that were previously cut off by the underused infrastructure through the site. The most significant connection involved bringing Inglis Street through to connect with Marginal Road. This provided the first east-west connection to the Seaport. Hollis Street was then brought through to connect into Inglis. These street connections improve access into the area by car, metro transit buses, and pedestrians. These moves have provided the structure for future development in the area as the neighbourhood around the station grows into the voids left by pulling the tracks back.

An analysis of the relationship between the mouth of the rail cut and major areas of importance in the city such as Barrington Street and the Boardwalk, suggested that the station was a node. From this

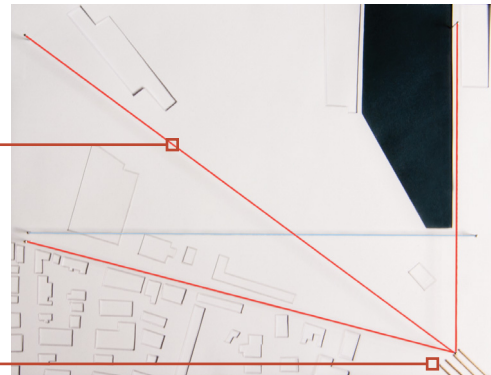


Relationship of the Halifax terminus to the rail corridor.

existing site barriers



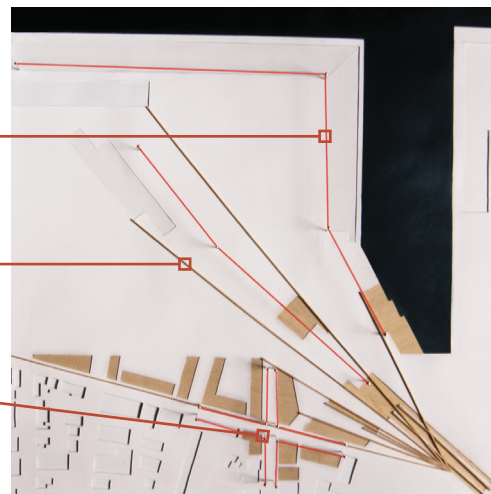
axial relationship of the mouth of the rail cut to significant locations in the city. (ie. Boardwalk, Barrington Street)



tracks pulled back



radiating out from node



locating buildings in relation to existing building on the site

orienting buildings on the radial grid to create connections with things outside the station environment

new street corner

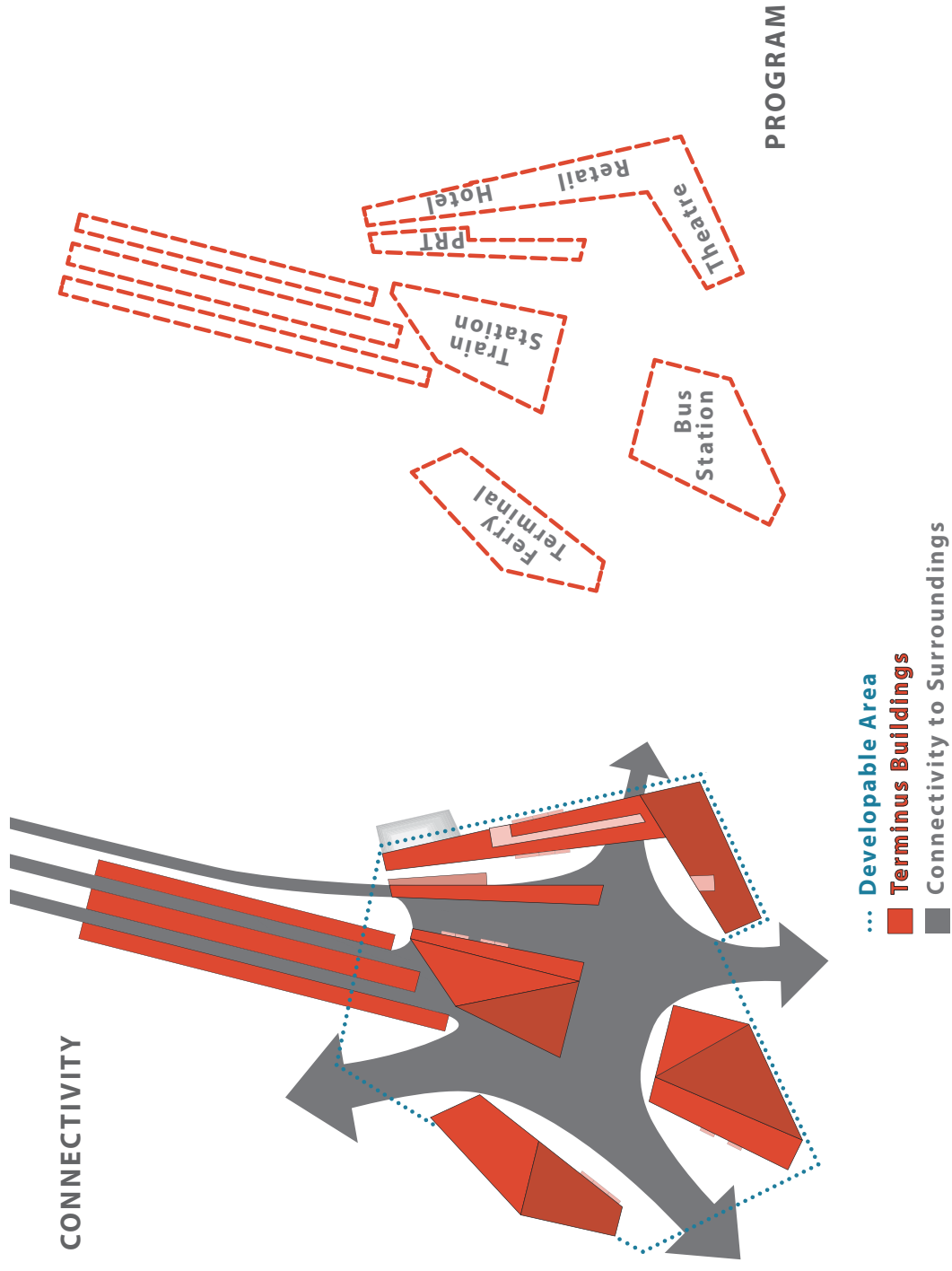
Urban design concept models of the Halifax Terminus Station and surrounding neighbourhood. (paper and basswood)

node, activity would radiate out into the station 'neighbourhood.' Therefore, the station becomes the anchor from which activity originates. As a response to this, the multimodal station was broken down from a mega structure incorporating all of the transportation networks into a set of buildings for each transportation network. These buildings were then arranged around a central plaza. The idea is that the plaza would function as this anchor for activity, where events could be held throughout the year. This generates activity for the larger neighbourhood as people come into and out of the station along paths linked to other activities in the city. In order to provide a framework for this plaza to be successful beyond a pathway to another transportation network, each building has commercial activities integrated into them, that open out onto the plaza. The north-west corner of the development is bounded by a mixed use building containing retail shops, office space, a hotel and conference center, as well as a small theatre. This building being integrated into the scheme allows for a constant gathering of people in the environment of the terminus. Thus, creating a level of demand that will be necessary for the shops and services to succeed when the plaza is not being used for larger events.

The layout of the buildings follows the notion that the activity generated within the plaza should radiate out into the station neighbourhood. Therefore, this layout makes visual and physical connections with its surroundings. The train and bus station are



The boundaries of the site were determined by their relationship to prominent features in the station neighbourhood.



The various stations were separated into individual buildings to create an urban plaza that anchors the station area. The location of the buildings allow for multiple connections to be made between the plaza and the station neighbourhood.

oriented along the axis of the old rail lines into the Seaport area. The ferry terminal becomes a piece of the old pier warehouses as it snakes out and down towards the boardwalk. The mixed use building along with some proposed housing makes a new street corner where Barrington and Inglis Streets meet at the edge of the station. These connections are structured so that the station becomes a piece of the existing urban fabric while reorienting and reorganizing space to add value to the community it serves.

After these connections were made, it was noted that there needed to be something that strengthened the idea of the station as a gateway to the city. The solution to this was to pull the edge of Cornwallis Park from its existing location all the way down to Inglis Street, which crosses in front of the station. This open space in combination with the proposed housing helped to structure an appropriate sense of arrival into the station environment. A pedestrian now has a direct route from Barrington Street through the park to the station environment. The park space also provided an appropriate location from which to place underground parking in an inconspicuous manner.

It is believed that this grouping of activities around the plaza will create a new urban quarter for the South End community. This area will be an identifiable place for assembly and social exchange, while also functioning at a more personal scale with the commercial activities and office space



Site plan for the Halifax Terminus and surrounding neighbourhood.

created. As an anchor it also opens out to the larger city, creating connections with things within the city that are functioning well and providing the necessary structure to support further growth within the community.

The design of the buildings evolved from the initial idea about station furniture, which involved a manipulation of the ground plane; to an alternative typography of faceted planes, that respond to the geometry of the site plan and surrounding features of the neighbourhood. The mixed use building illustrates this evolution clearly, as seen when approaching the station environment by the 'prt' system. The building emerges from the ground and snakes around the corner on top of a layer of retail. The design of this building facilitates multiple elements that strengthen the urban design strategy. At the tail end of the building, is the lobby for the hotel. Wrapped in glass on two sides, it is an airy space that works towards drawing people in, and to the very end of the station environment. The hotel also accommodates a conference space in the lower level, that is opened up to the city through an amphitheatre. The amphitheatre acts as an end cap to Barrington street and is an amenity offered to the neighbourhood for events or as a hang out space for neighbourhood residents.

Access to the hotel floors is accommodated by a service core that rises above the sloping plane of the roof and connects back into the building through hallways wrapped in glass. This vertical element



View from the 'prt' pod car on approach to the Halifax Terminus station area. The hotel and amphitheatre are located at the centre of the image.

was reflective of the service core in the Westin Hotel, located in the station neighbourhood; as well as, the towers supporting the conveyor belts for the for the grain elevators in the industrial zone at the rear of the station.

As the mixed use building snakes around at the intersection of Barrington and Inglis Streets, it forms a strong urban corner, with retail on the bottom floor and office space above. Adjacent to this corner condition is a port cochère, which provides quick access to the station plaza for pedestrians approaching from the west. The building culminates at the entrance to the station plaza from Cornwallis park. Here a glass wall forms the head of the snake, overlooking the plaza and waterfront. This wall forms the backdrop to a small black box style theatre. Locating the theatre here will anchor activity, along with the hotel at both ends of the mixed use building. This functions to frame the station plaza with a variety of user groups whose sole purpose is not just for transit. The theatre also has the potential to animate the plaza with color and movement, as performances become showcases that extend beyond the walls of the theatre and engage people walking through the station environment. This elevated space, along with landscaping and the hard wall of the adjacent bus station, help set up a threshold that functions as the gateway into the new station environment.

The station buildings themselves follow a similar formula, of a service bar with an adjacent shed

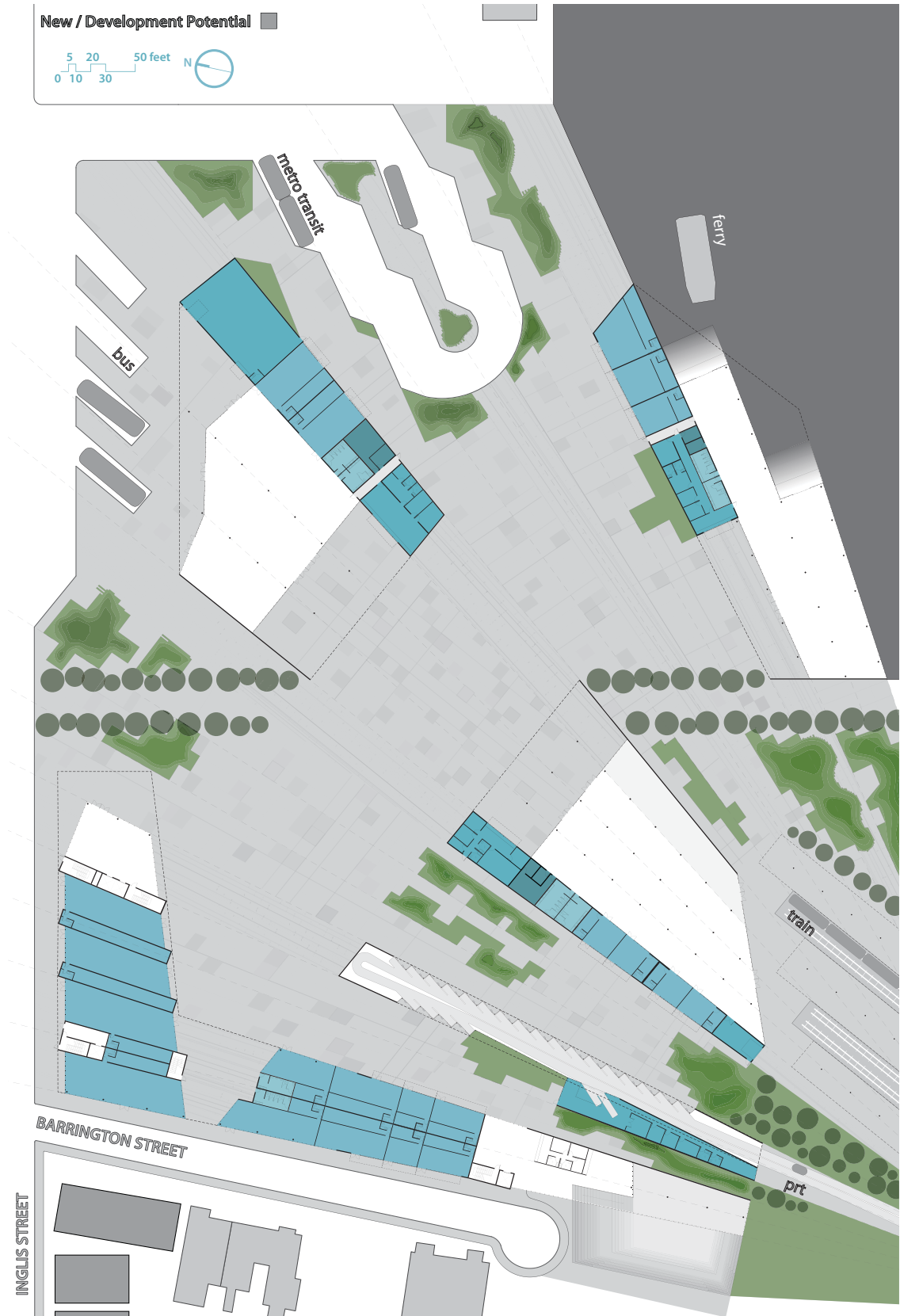


Approaching the Halifax Terminus station area from Cornwallis Park.

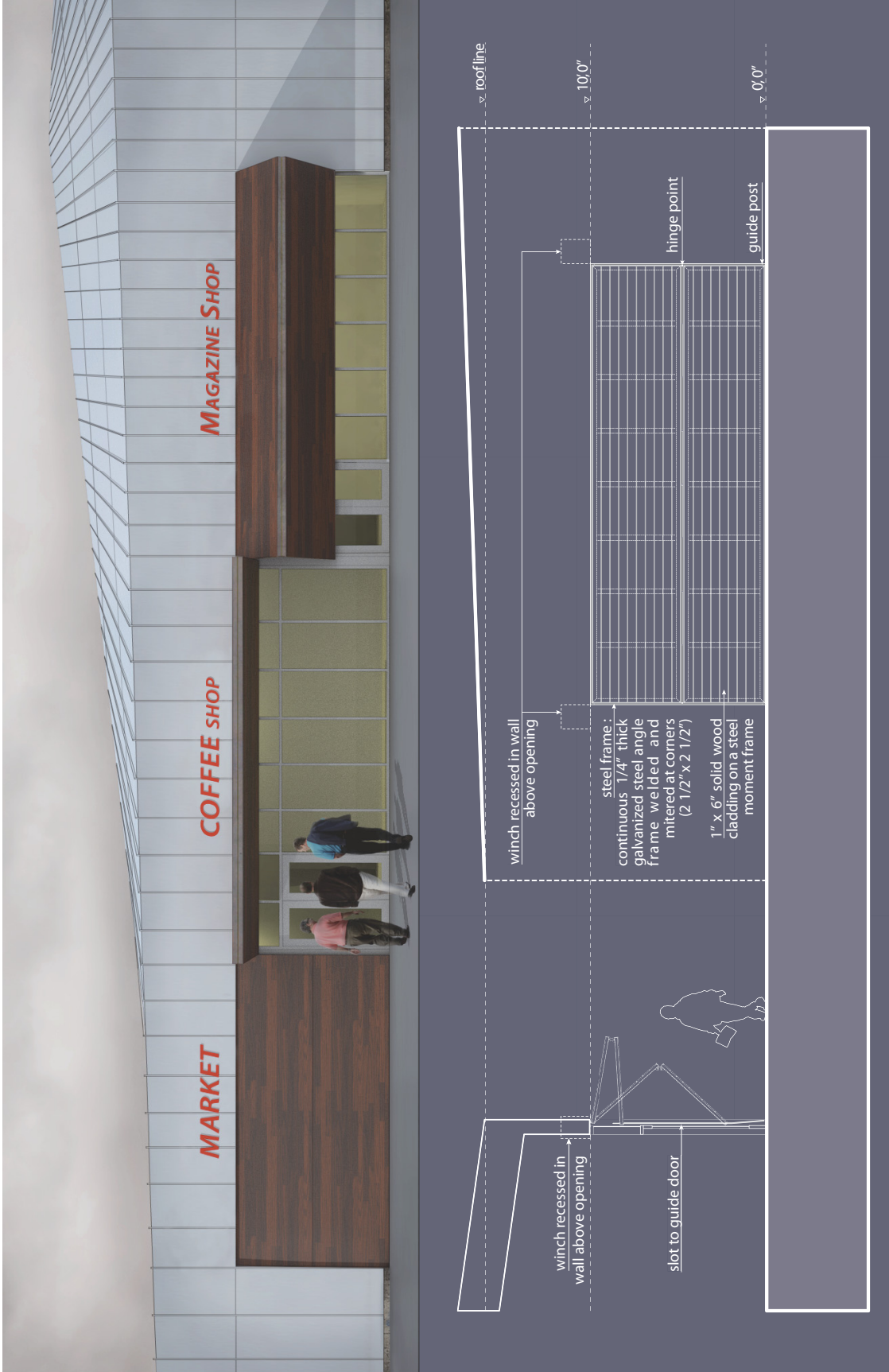
space for waiting and circulation. The entrance into each building is underneath a large overhanging canopy, which provides a sheltered space to purchase tickets and wait for other passengers to arrive. Once a passenger purchases their ticket, they can enter into the shed space, where things such as public washrooms are located in the service bar. Each station also contains commercial space, which can be accessed from inside and outside the station.

Wood clad awnings are used to accentuate the entrances to the commercial spaces on the exterior of the station. As they open and close, they animate the facades of the station buildings, based on the hours of operation of each commercial enterprise. The use of wood to clad the steel structure of the awning, provides warmth in contrast to the standing seam steel facade treatment of the station buildings.

Each station building is differentiated from one another by the transportation method it is accommodating. The Acadian bus network that currently acts as the regional bus service for Halifax, also has a parcel delivery service. Therefore, a storage and sorting area for this service is provided at the rear of the bus station, next to the bus stalls. The ferry terminal has a large overhanging roof on the back side to cover a set of floating docks, which rise and descend with the tide. The train station has three covered platforms, which service four sets of tracks. The canopies extend for the full length of a



Floor plans for the individual stations at the Halifax Terminus location. Highlighted in blue is the service bar for each building. Within this bar are the public washrooms, commercial space, and station services.



Detail view of the wood clad awning located at all commercial locations.

typical commuter train, to provide shelter for those getting onto and off of the train.

The 'prt' station building is of a much different scale than these other station buildings. It is designed to accommodate 20 parked pod cars at one time. Due to the fact that it is an on demand service, the building does not need to provide a waiting area. A passenger simply approaches a parked vehicle, selects and pays for the service at the touch screen display, and enters the vehicle, to be taken to the destination of their choice. The terminus location makes it an ideal point to locate the control center for the 'prt' network. At this location, a team supervises the proper functioning of the pod cars along the rail corridor network. Service bays are provided so that repairs can be undertaken on the vehicles when necessary.

The urban design strategies explored at this station location provide insight for how the typology of the station can be packaged to provide a level of amenity that fosters the growth of a community, similar to what was once achieved during the early years of railway construction in Canada. The combination of users for the purpose of transit, with those for other activities is an essential ingredient to create a vibrant social space. The interchange between these groups at all hours of the day is what will lead this station plaza to become a dynamic piece of the urban fabric of Halifax.



View of the Halifax Terminus station area at night from an approaching ferry.



1:1000 site model of the Halifax Terminus station neighbourhood. The areas modeled in white are existing, the areas modeled in wood highlight the potential development area created by pulling the tracks back to the new station location. The buildings modeled in wood are the proposed terminus station and adjacent mixed use housing.



Aerial view of the Halifax Terminus Station environment.



View of the Halifax Terminus station environment from the waterfront.



View from the northern approach to the Halifax Terminus station neighbourhood. (site model 1:1000)

Dalhousie Station

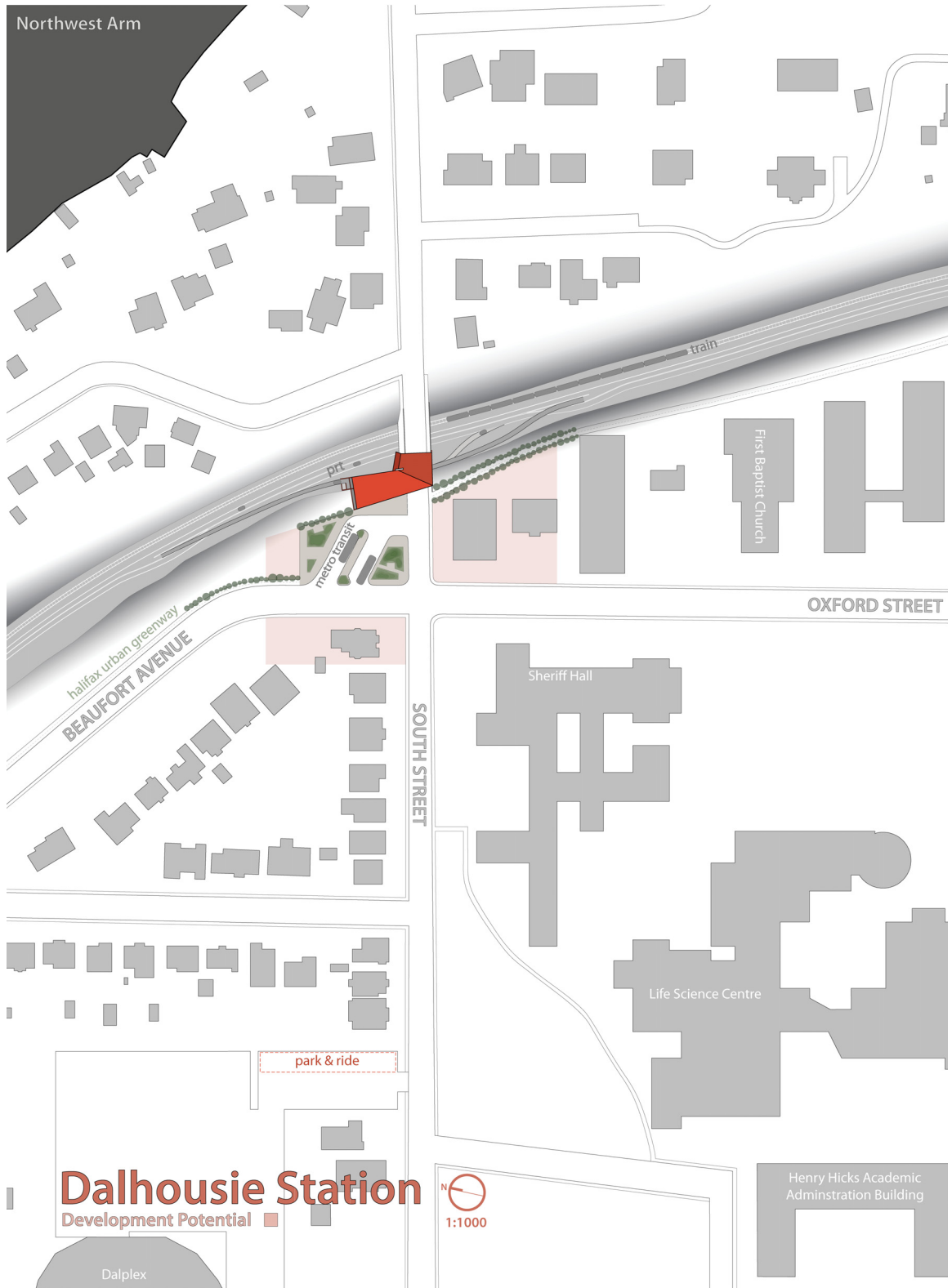
The Dalhousie Station is the smallest of the three stations being studied. What makes it unique is that it negotiates a change in grade, that means the passengers enter the building on a different level than where they board the transportation network. This adds a vertical dimension to the study of the station typology. The scale of the 'prt' cars is what makes a station within the rail cut possible, as it allows for the platforms going in opposite directions to be stacked on top of one another. Thus, leaving the rail cut open for the free passage of the 'prt' cars not stopping at this station and the existing rail line for the train network.

To accommodate this, the building is pulled back from the street to the edge of the rail cut wall. This move opens up space in front of the station to accommodate a metro transit bus depot. This allows for the north-south 'prt' network to be connected into an east-west bus network, creating a larger network of public transportation services. In an effort to avoid the station becoming purely about transit; little pocket parks are integrated to create zones for social interaction and gathering. These pocket parks are linked to the greater Halifax Urban Greenway Project, which is looking to create an active transportation corridor along the edge of the rail cut. This linkage will help to bring pedestrians and cyclists to the area to use the station.

As the station asserts its presence within the



Relationship of the Dalhousie Station to the rail corridor.



Site plan for the Dalhousie Station and surrounding neighbourhood.



Above: floor plan of the Dalhousie Station in relation to the surrounding city. Below: view of the station as a person approaches from Dalhousie University (South Street).

community, it will spur growth and redevelopment of the buildings adjacent to the station to take advantage of the influx of people and activity to the area. The station also replaces the decaying concrete bridge over the rail cut with a new steel structure. The new steel bridge helps to lighten the appearance of the station while becoming a new threshold as one approaches the station from the neighbourhood on the west side of the rail cut. Using the roof and walls to wrap these spaces of transition from one area to the next will provide an identity to the station. This identity will be key towards attracting community interest and positioning the station within their everyday lives.

The design of the station has a conceptual relationship to the terminus stations, but is shaped to meet the constraints of its local environment. The overhanging roof in this situation is used to create a threshold at the moment one passes from the land to the bridge over the rail cut, creating a constant remainder of the relationship between the city and the rail cut below. The roof is brought down and underneath the bridge at this point to reinforce the threshold; as well as, impart the sense that the station is holding the bridge up from the tracks below. This element of hanging from the roof plane is also employed when approaching the station from the south side. From this view, the exterior extends down and under the bottom platform and back up to the roof plane. The 'prt' platforms are held within this hoop.



View of the north face of the Dalhousie Station, where the roof plane comes down to wrap the bridge and hold it up from the tracks below.
(1/8" = 1'0" sectional model)

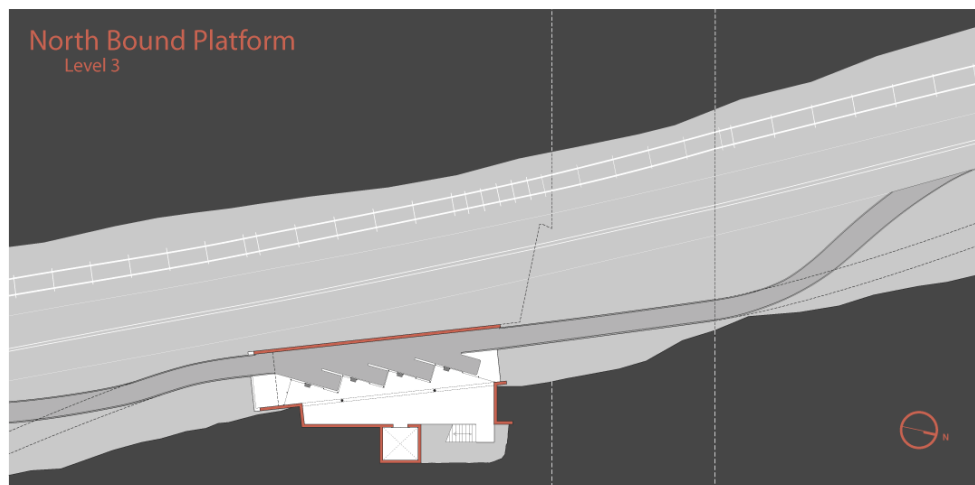
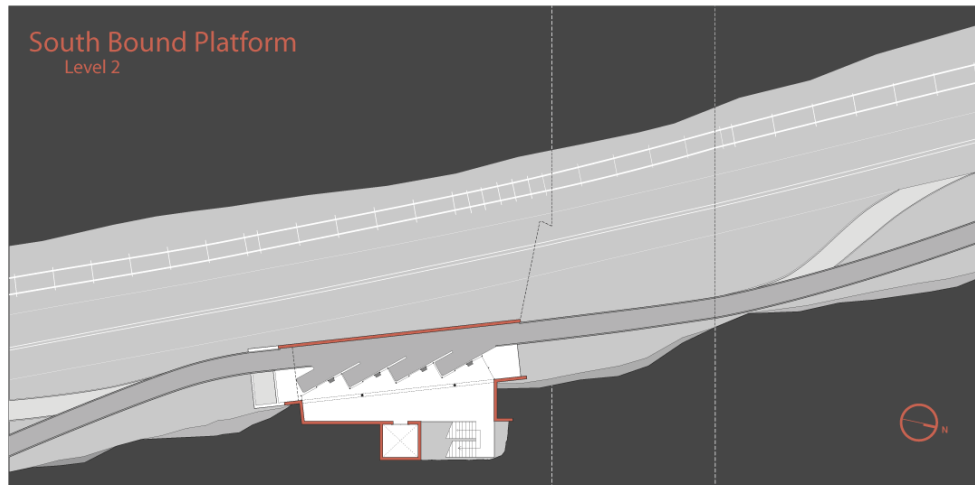


Southern view of the 'prt' platforms being hung within the hoop extending down from the roof plane.

The interior wall of this hoop is cut open to create a threshold between the circulation space of the station and the platform area, where the waiting pod cars are parked. Bridges from the platform level take the pod cars back down to the floor of the rail cut, where they merge into the continuous traffic lanes. The circulation space of the station is cut into the slate walls of the rail cut. This creates a unique atmosphere as one descends down the stairs of the station and experiences the raw face of the rail cut wall before entering into the pristine environment of the pod car. As at the terminus station, the on demand nature of 'prt' network reduces the amount of services needed to be provided at the station. The main level simply provides room for a coffee/newspaper stand setup, which is catered towards students and professors who want to grab a quick coffee and something to read on their walk to work from the station.



The primary user group for the station will be students and staff of Dalhousie University. They will exit the station and proceed uphill to the Dalhousie campus located in the upper left corner of the model. (site model 1:1000)



Floor plans of the Dalhousie Station. Level 1 provides access to the platform levels, as well as, providing space for a small cafe and seating area. Level 2 provides access to the 'prt' pod cars heading south towards the Terminus Station. Level 3 provides access to the 'prt' pod cars heading north towards the Bedford Station.

The entrance to the station is created by cutting a piece of the main facade wall and pushing it into the station to create a slot for the doors to be placed. This provides a sheltered threshold from which one can enter the station. Highlighting this move with color and text, helps to identify the station while also facilitating wayfinding. The end walls of the station are left open to provide views along the rail cut, as well as, to bring daylight into the space before one descends to the platform levels.

The idea of using the roof plane as a threshold at the terminus station was further explored here, for its potential to become a portal between different environments. These environments include the relationship of the city to the rail cut, the raw character of the passenger circulation zone to the pristine and modern world of the 'prt' system and entry into the station from outside. These elements provide an identity for the station and structure it in a manner that allows it to become a piece of the identity of the neighbouring community.



View of the Dalhousie Station from South Street, highlighting the recessed entry wall and the threshold between the city and the rail cut. (1/8"=1'0" sectional model)



Aerial view of the Dalhousie Station from the south side. (1/8" = 1'0" sectional model)



Sectional model of the Dalhousie Station, highlighting the multiple platform levels and 'prt' pod car vehicle access and parking. (1/8" = 1'0")



Aerial view of the Dalhousie Station and its location in the surrounding neighbourhood. (site model 1:1000)

Bedford Station

The Bedford Station has a different character in the neighbourhood than the Terminus or the urban in-line station at Dalhousie University. The difference in its character comes from how people arrive at the station. Unlike its urban counterparts, which will serve a predominantly pedestrian user group, the Bedford Station will see many of its users arrive by personal car. Therefore the station must not only respond to an emerging mixed use district in search of an identity, but also a more transitory nature brought on by the necessity of park and ride spaces for cars.

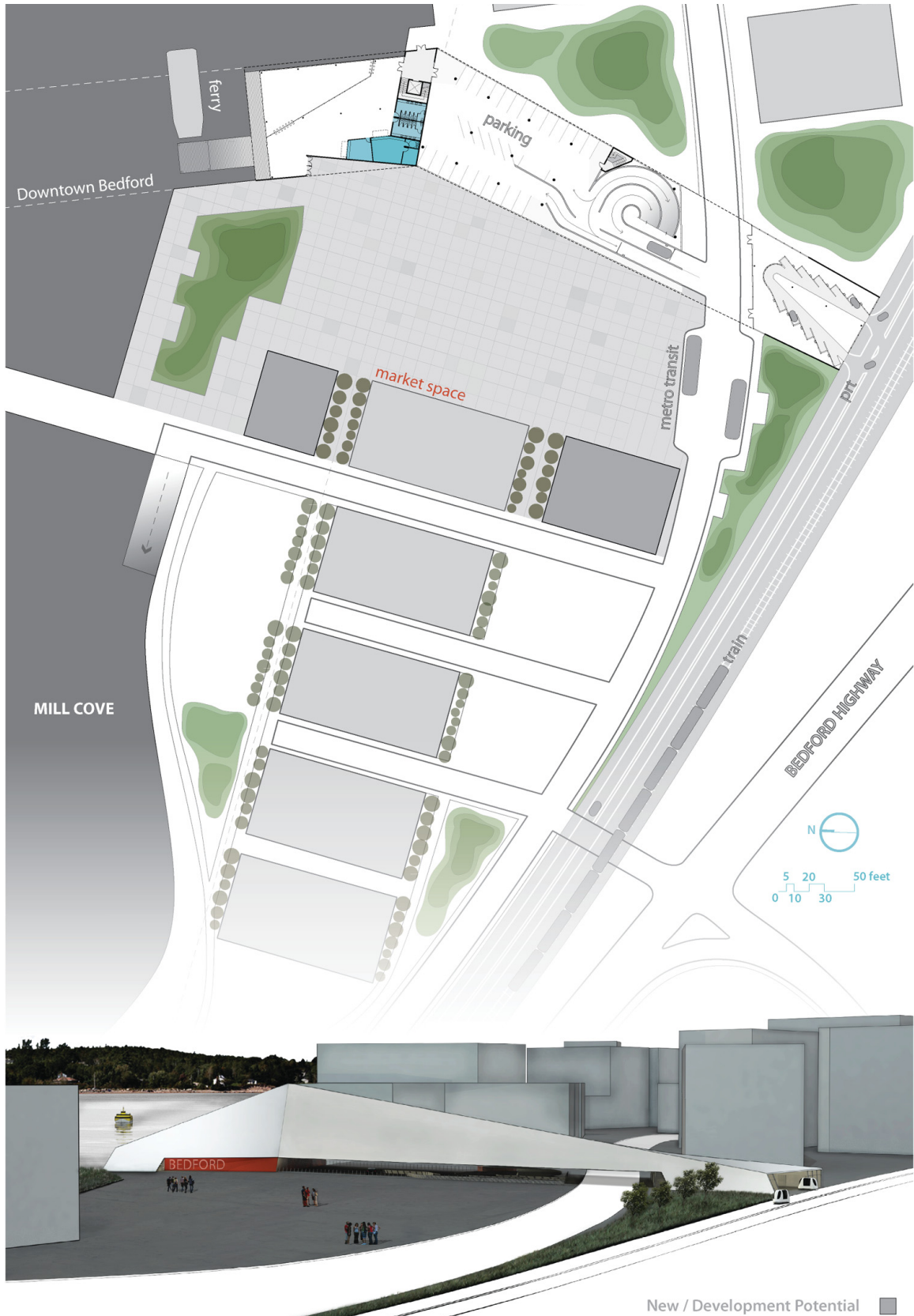
The station is positioned at the edge of the site, up against the boundary of the new mixed use development, so that a market space can be created in front of the station. This market space will be a mediating zone between the old portion of Bedford and the newly constructed. This junction will create an area of social significance that is framed by the facade of the station on one side and mixed use buildings on the opposite side. In an effort to keep this space pedestrian friendly and avoid the station becoming an island within a sea of parking, it has been designed to accommodate a parking garage within the centre of its form. This garage is accessed by the road that links the old and the new areas of town through the station. By having the road pass through the station form, it creates a threshold between the 'old' and 'new' parts of Bedford. This threshold condition is an



Relationship of the Bedford Station to the rail corridor.



Site plan for the Bedford Station and surrounding neighbourhood.



Above: floor plan of the Bedford Station and surrounding neighbourhood. Below: view of the station as one approaches the station neighbourhood southbound from the Bedford Highway.

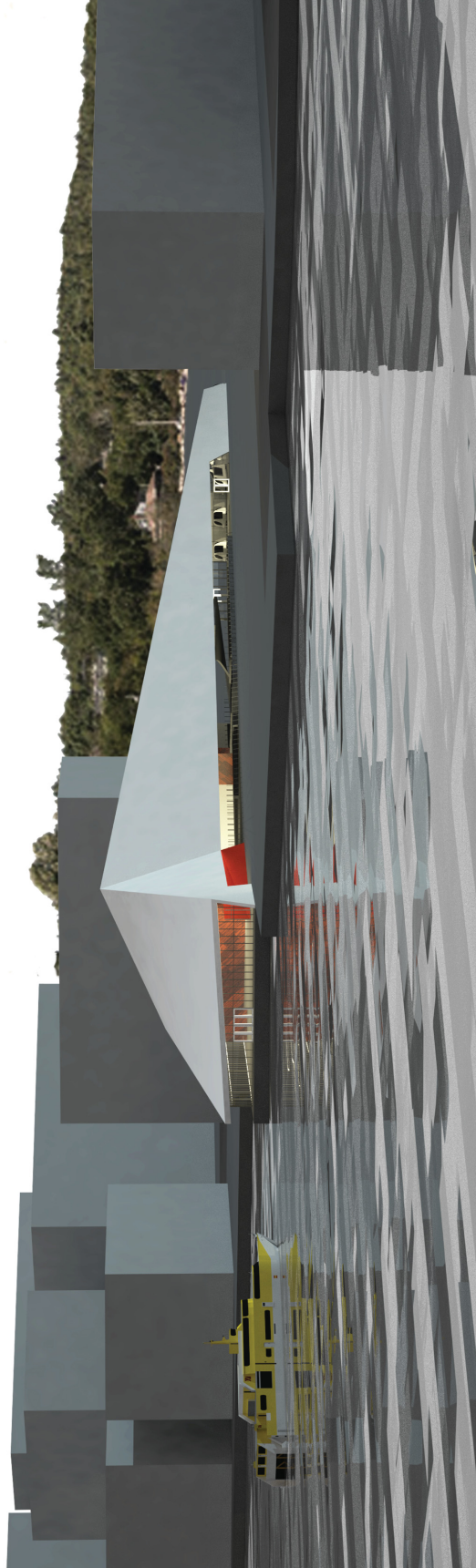
extension of the examples set forth by the Terminus and Dalhousie stations.

The 'prt' network is located at the end of the building closest to the rail corridor, while ferry access is provided at the end closest to the water. Metro Transit Bus links will be provided along the road that passes through the building. These services allow for passengers to be brought to the station by metro transit bus. Then provided access to the Halifax Peninsula from land or water, creating a significant area of coverage by public transit.

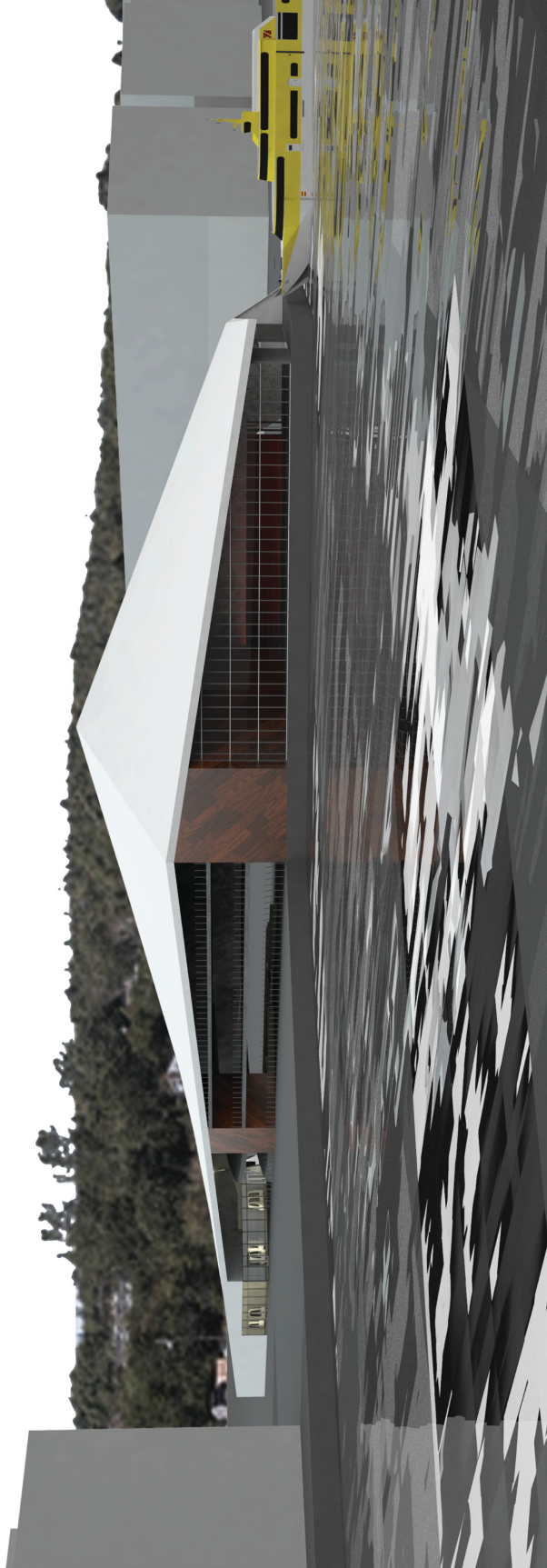
The monolithic form of the building is designed to create a strong identity for the station within the community. This identity is further strengthened through the provision of social spaces such as the market space, which the community can use to grow their own sense of identity in a suburban area outside the influence of the Halifax peninsula.

The design of the station was created through a reaction to site influences. Starting with a wedge shaped building that sloped upwards from the rail corridor towards the Bedford basin, it was bent in the center so that it responded to the old town center of Bedford. This bend also helps to frame the market space in front of the station. Thus, the faceted inclined shape was derived from the forces acting on the form as it was bent.

The facade on the east side was opened up to create views to the basin, as well as to match the character of the mixed use buildings on this side.



View of how Bedford Station addresses the existing town centre of Bedford from across Mill Cove.



Approaching the Bedford Station by ferry from the Bedford Basin.

The western facade, facing the market space, was left monolithic to help frame the urban environment that unfolded in front of it. As at the Dalhousie Station, color and text were used to highlight the entry into the station, which was created by pushing a piece of the wall back.

The amenities associated with the station are located at the ferry end of the station, due to the fact that passengers are required to wait for the ferry to arrive. Thus, space is provided for a small cafe, as well as, public washrooms. A loft level may be added in the future, based on the level of demand for more amenities within the station. The 'prt' portion of the station provides on demand access for ten pod cars at a time.

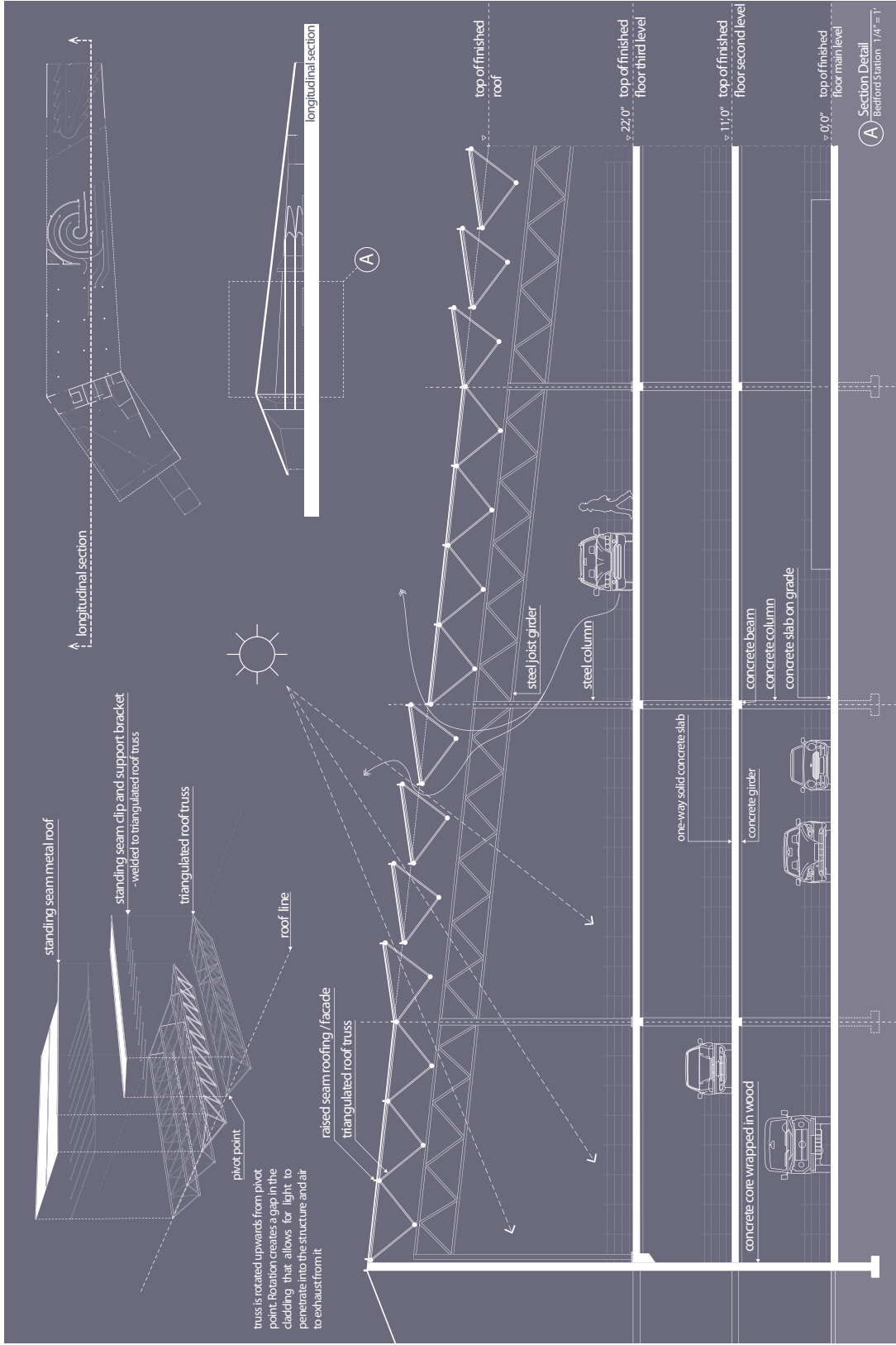
In studying the typology of the station it has become clear that each building tends to have a significant roof surface area. This surface area has the potential to be manipulated to further add to the utility and experience of the stations. One option for this space is to integrate solar panels into the cladding system. The energy generated from the solar panels could be used to help reduce the



Aerial view of the Bedford Station, highlighting the surface area of the roof. (site model 1:1000)

electricity load needed to charge the 'prt' cars at each station. In this instance it would be important for the panels to seamlessly fit within the profile of the roof, so as to not intrude on the form of the building. Another issue facing the stations is how to get as much natural light into the space as possible, despite having such large roof areas. The Bedford Station became a good candidate for such a prototype because of the need to have light penetrate the parking garage and to exhaust car fumes.

A triangulated roof truss system provided one possible solution to this question. This type of roof truss is constructed out of steel tubes, which allow for it to be twisted and still retain its strength through its triangulated webbing. Therefore, the truss can be manufactured so that it mounts even with the other trusses at its end points, while through the center it is twisted upwards. This rotation lifts and separates this section of the roof cladding from the plane of the roof, allowing light to enter and fumes to be exhausted. The facade and roof cladding of the stations is a standing seam steel roof system. This allows this opening to occur at the seam between panels, providing a clean slot that is continuous with the cladding system as a whole. For the Bedford station this opening is simply screened in, as it is located above the parking garage, but as a prototype it could be further developed to be a fully enclosed system, that could be used to provide light into the interior space of stations such as that at the Halifax Terminus.



Structural detail drawing for the roof of the Bedford Station. The triangulated roof trusses are twisted upwards along the back of the station to allow light to penetrate the monolithic facade, as well as, allowing for fumes from the cars to be exhausted.



1:1000 site model of the Bedford Station neighbourhood. The areas modeled in white are existing, the areas modeled in wood highlight the potential development area and the location of the rail corridor.

CHAPTER 4: CONCLUSION

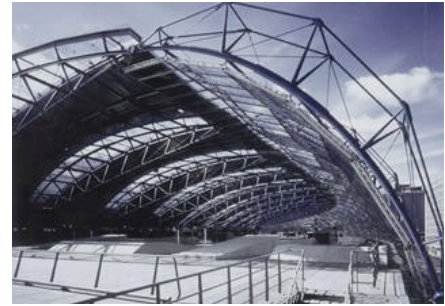
As a network that ties communities together, with stations that foster their growth, the development of a 'personal' rapid transit system in Halifax, Nova Scotia, has the potential to significantly shape the 'communal' urban fabric of the city. Located at the intersection of multiple layers of passages and landscapes, the station and its network weave together interactions that allow a new urban structure to take root. The study of the station typology in three different contexts has allowed for the development of a rich set of prototypical conditions that can be used by architects to develop the stations along this network. The completed network of stations will help to alleviate the stress of traffic on the streets that serve the Halifax Peninsula, as the overall transportation network is rearranged around them. These nodes may then provide order and a regional coherence to the complex matrix of systems that comprise the city.

APPENDIX: PRECEDENTS

London Waterloo Station

Nicholas Grimshaw & Partners

Waterloo International Station in London, England was built to accommodate the new Eurostar line from the center of London to the center of Paris. The Eurostar line became a case study for the competitive use of rail for trips between 100 and 600 kilometres. This helped to initiate the concept of transportation based on the distance a mode could efficiently cover versus another transportation method. The efficiency of the Eurostar necessitated a station that could accommodate 3200 passengers at a time. Understanding how these flows of people could effect the comfort and calmness of a passenger while trying to navigate the station was a critical factor in the design. The architects' attempted to solve this issue by manipulating the rhythm of the structure and providing ample natural light; to help disoriented passengers find a sense of direction. Thus, the building structure essentially acted as a background screen that provided cues to the passengers about how to navigate efficiently.⁶⁵



London Waterloo Station, UK.
From Edwards, *The Modern Station*

⁶⁵ Edwards, *The Modern Station*, 131-132.

Dresden Hauptbahnhof

Foster & Partners

Natural light became the critical element for Foster and Partners in their redevelopment of a 19th century train station in Dresden, Germany. The use of natural light creates a comfortable and airy environment. This ambience works towards making the station a 'place' that someone can spend time in, versus a transitory space that people quickly pass through. The clarity of spaces and ease of travel within the station is a result of the lighting strategies used by the architects.

The integration of multiple modes of transportation and retail into the station creates an environment that generates activity in the urban fabric of the city. By pulling the original tracks back, the architects created a flexible space within the station that can be used as a market or zone for cultural events by the community. The flexibility of this design allows the station to evolve and adapt as its role in the community grows with the public transportation network.⁶⁶



Dresden Hauptbahnhof. From Niedenthal, *Stations in Germany*

66 Niedenthal, *Stations in Germany*, 30-33.

Liège-Guillemins Station

Santiago Calatrava

The Liège-Guillemins Station in Belgium was conceived in the 90s as a catalyst for urban development. This development would be linked with the creation of a high speed transportation network along the underutilized rail corridor through the city. Calatrava used the design of the station to define a new modern image for a former industrial city. He achieved this through a structural system that spans over all of the tracks, eliminating barriers that restrict movement. This provided passengers with a clear line of site to the transportation method of their choice, as well as, an increased sense of safety on the platform. By having no façade, the urban environment is drawn into and through the structure. Thus, heightening the sense of lateral routes through the space and increasing wayfinding.⁶⁷

⁶⁷ Josephine Minutillo, "Liège-Guillemins TGV Railway Station: Liège, Belgium," *Architectural Record* 198 (2010): 87-91

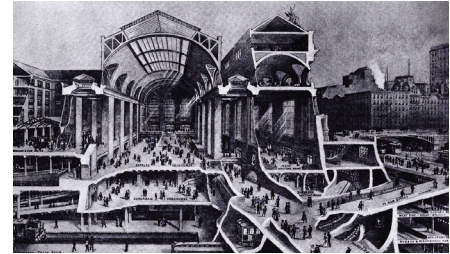


Liège-Guillemins Station.
From Minutillo, "Liège-Guillemins
TGV Railway Station."

Grand Central Terminal

Reed & Stem / Warren & Wetmore

The dynamics of social interaction were exploited within Grand Central Station to a degree that had not been witnessed in any other station buildings up until that time. Believing that people were the embodiment of the urban form of the city, the architects' gave form to their movements. Thus passenger circulation networks created spaces and within these areas arose the ideal of what civic architecture was. In order to sustain this definition, the architecture needed to interact with the city on multiple scales and through multiple venues. By wrapping the ground floor of the building with retail, it allowed the station to serve passengers, as well as, the city. Capturing this activity within a structure that witnesses the constant flow of users as they cycle to and from their destinations allows the station to become part of the lives of its passengers and the city. Therefore, the station can begin to be considered the hearth for the community it serves.⁶⁸



Grand Central Terminal.
From Nevins, *Grand Central Terminal*

68 Nevins, *Grand Central Terminal*

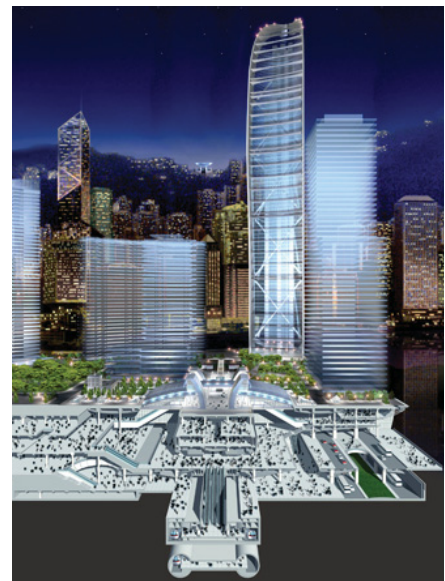
Kowloon Station

Terry Farrell and Partners

The Kowloon Station was conceived as a transportation node within a new development outside of Hong Kong. Each transportation node is provided with a dedicated set of services particular to that network at their point of entry, while communal services between the networks are arranged along the perimeter of the concourse. This integration of shared services helps to alleviate passenger confusion due to duplicated services. Thus, helping passengers to navigate through the station more efficiently.

The salient characteristics of this station are the pedestrian scale of its entry structure and its ability to pull natural light deep into the below grade areas of the station. The natural light and ample size of the concourse allow commuters to easily identify the direction of travel they need to take to the various networks, without feeling rushed by the crowd around them.⁶⁹

69 Thorne, *Modern Trains and Splendid Stations*, 68.



Kowloon Station. From Thorne, *Modern Trains and Splendid Stations*

Nordpark Cable Railway

Zaha Hadid

The Nordpark Cable Railway in Innsbruck, Austria, demonstrates how a small scale station, like that at the Dalhousie location, can dramatically interact with its context. Each station along this network is unique, creating an identifiable element in the community, while being derived from a similar language. Zaha manipulates the common language of the canopies to match specific elements within the station neighbourhood.⁷⁰ As suggested by Roger Tranick, this manipulation of context helps to create a sense of 'place'.⁷¹ The flowing nature of the canopies construction helps to draw activity to and through the structure, highlighting the interplay of movement with transportation.

70 Joann Gonchar, "Zaha Hadid redefines 'contextual' with four sinuous stations for Innsbruck's Nordpark Cable Railway," *Architectural Record* 196 (2008): 187-193.

71 Tranick, *Finding Lost Space*, 112.



Nordpark Cable Railway. From Gonchar, "Zaha Hadid redefines 'contextual' with four sinuous stations for Innsbruck's Nordpark Cable Railway."

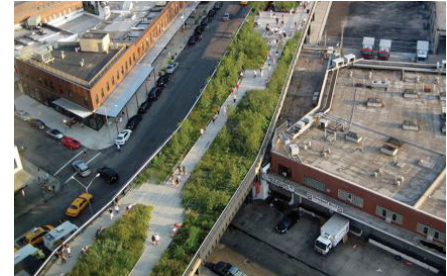
The High Line

Diller Scofidio + Renfro

The High Line is an elevated linear park that traverses above the streets on the west side of Manhattan Island. It was constructed on the steel bed of a disused rail corridor that serviced a former industrial district. Instead of tearing down the abandoned structure, the community convinced the government to save it and transform it into a public amenity. As much of the structure had already been overgrown with vegetation, it presented itself as an ideal space for a park. By recognizing the potential of the corridor, and bringing activity to it, the High Line has transformed the area and spurred on real estate development in its immediate neighbourhood.

The identification and restoration of a disused rail corridor is significant to the argument proposed by this thesis. It provides a clear frame of reference for the potential of corridors like these to be reused and their potential to revitalize the neighbourhood around them. At a smaller scale, the design of the High Line landscaping demonstrates how historical elements and their abstraction can be used to create paths and plantings. The park space in front of the terminus station possesses a similar industrial nature to that of the high line, thus capturing the movement and structure of the historical area in the redevelopment will give it greater depth.⁷²

⁷² Friends of the High Line et al., *Designing the High Line*, 4-152.



The High Line. From Friends of the High Line, *Designing the High Line*.

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