PITTSBURGH CABLE TRANSIT

Technology, Concepts, &
Opportunities Analysis

Summer 2018

Doppelmayr®

PIONEERED BY THE ROCKEFELLER FOUNDATION
100 RESILIENT CITIES

Table of Contents

1 BACKGROUND & HISTORY

1.1 INTRODUCTION

Since 2014, Pittsburgh has been a member of the 100 Resilient Cities (100 RC) program that was started by the Rockefeller Foundation.

As a member, participating cities have the opportunity to engage with 100 RC's Platform Partners who have specialized expertise from the private, public, academic, and non-profit sector.

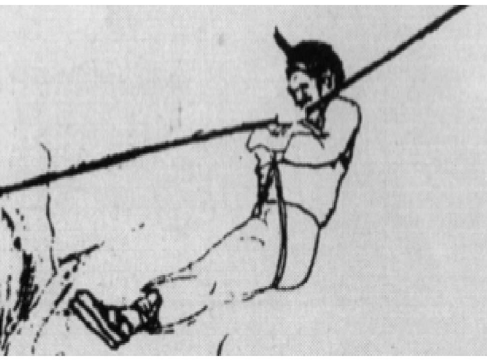
In July 2017, the City's resilience office submitted a service request to engage with Doppelmayr Garaventa Group, the world's largest manufacturer of ropeways, to deepen its understanding how cable transit systems can enhance public transportation in Pittsburgh.

In the past decade, cities around the world are now actively implementing ropeways to complement and enhance their existing bus and rail networks.

Cable car specialists conducted a workshop in Pittsburgh to educate City staff on cable transit technology in Spring 2018.

This Technology, Concepts, and Opportunity Analysis (TCO) is meant to capture the ideas expressed in the workshop and to provide readers with a concise summary of cable transit systems.

1.2 TECHNOLOGY HISTORY



Ropeways were used as early as 250BC.

Cable has been used extensively throughout human history for a variety of purposes. The technology has undergone continual upgrades and advancements which have led to improved travel speeds, safety, cost efficiency, capacity and comfort. The four major phases of cable can generally be grouped into the Vernacular, the Industrial, the Recreational and the Urban eras.

Vernacular:

One of the earliest depictions of cable was found in ancient cave drawings in China dating back to 250 BC. Ropeways were also used in Europe during the Middle Ages. These simple cable lines were typically used to traverse challenging topography and to transport materials.

With over 12mi of cable cars, La Paz has the world's largest urban gondola network.

Industrial:

With the invention of the steel cable in 1834, cable made huge technological improvements. The first monocable and bicable patents were filed in the mid-to-late 19th century. Soon after, the world began to see the first wave of modern cable transit systems. For instance, San Francisco's cable cars debuted in 1882 and remain one of the world's most famous and recognized examples of CPT.

Recreational:

With the invention of the electrified streetcar, cable transit was largely abandoned in North American cities. However, the rise of winter sport tourism activities such as skiing gave the technology another lease on life. As such, ropeways were quickly re-purposed for use in tourist and alpine resort destinations. The first chairlift in North America opened in 1936 in Sun Valley, Idaho.

London's first cable car, the Emirates Air Line, transports 1.5 million passengers per year.

Urban:

During the 1970s and 1980s, cable was studied and "re-discovered" by a few transportation engineers and scholars. They found that cable transit was an inexpensive and cost-efficient alternative to the self-propelled vehicle. The technology progressed immensely throughout this time period and to this date, continues to find and gain mainstream acceptance. At this time, over three dozen cable transit lines are now operational in cities.

1.3 DOPPELMAYR

As the world market leader in the ropeway engineering sector, Doppelmayr/ Garaventa Group is pleased to be a Platform Partner within the 100RC's program network.

Our scope of business includes ropeway systems for passenger transport, material transport systems, avalanche blasting lifts, rope-propelled systems for public transport, automatic transport systems and general utilization concepts for cross-seasonal applications.

Doppelmayr®

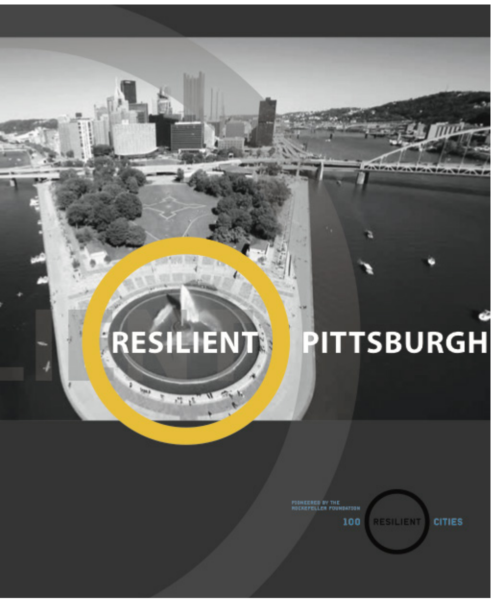
14,900 ropeway installations on six continents of the world have been supplied by Doppelmayr/Garaventa.

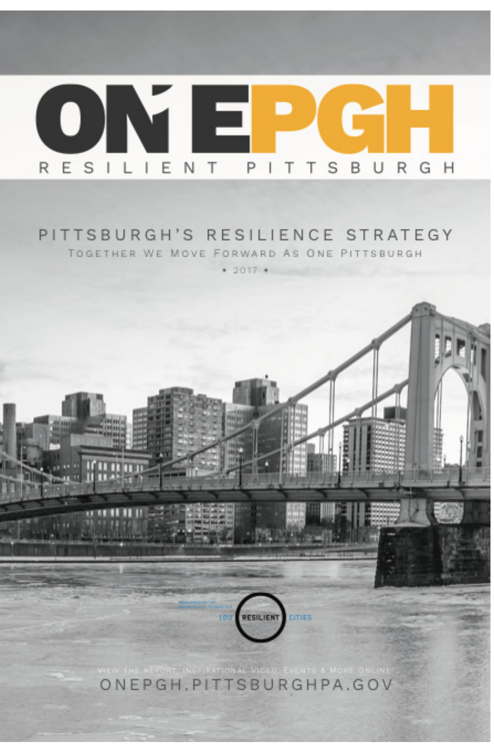
Doppelmayr/Garaventa is currently the world's largest ropeway manufacturer and has built over 14,900 cable-driven systems.

Key Facts and Figures

- 801 million euros in sales revenues was posted by the Doppelmayr Group in the financial year 2016/2017
- 14,900 ropeway installations on six continents of the world have been supplied by Doppelmayr/Garaventa
- 40 countries worldwide have a subsidiary or agency representing the Group
- 95 countries around the globe have already been export destinations for the Group
- 2,720 employees — 1,398 of them in Austria alone, 384 of them in Switzerland work for the Doppelmayr/Garaventa Group worldwide
- 103 apprentices in Austria, 28 apprentices in Switzerland are currently undergoing training at Doppelmayr/Garaventa

1.4 RESILIENCY SUMMARY





Preliminary Resilience Assessment

In December 2014, Pittsburgh was selected as part of the second cohort of the 100 Resilient Cities program.

During its initial stages, stakeholders met and identified a number of challenges and opportunities in its Preliminary Resilience Assessment (PRA). Some of the key themes highlighted were:

1. Regional Fragmentation
2. Economic and Racial Inequity
3. Aging Infrastructure
4. Mobility and Transportation Challenges
5. Environmental Degradation
6. Lack of Affordable Housing
7. Food Insecurity
8. Extreme Weather Events
9. Infrastructure Failure
10. Hazardous Materials Incident
11. Landslide and Subsidence
12. Economic Collapse
13. Disease Outbreak and Pest Infestation

Resilience Strategy

After the PRA was completed, relevant stakeholders were able to build upon that document to create the Resilience Strategy (RS).

More than 600 Pittsburghers came together and contributed to the RS when it first began in June 2015.

The RS was designed to specifically align to the four "p"s of an existing framework. The four "p"s refer to:

1. People
2. Place
3. Planet
4. Performance

The RS recognizes the need for both governmental and nongovernmental entities to work closely and collaboratively to ensure that goals and objectives are achieved.

From a transportation perspective, stakeholders have acknowledged that the City's unique topography of rivers and hills have contributed to poor transit connectivity in some areas.

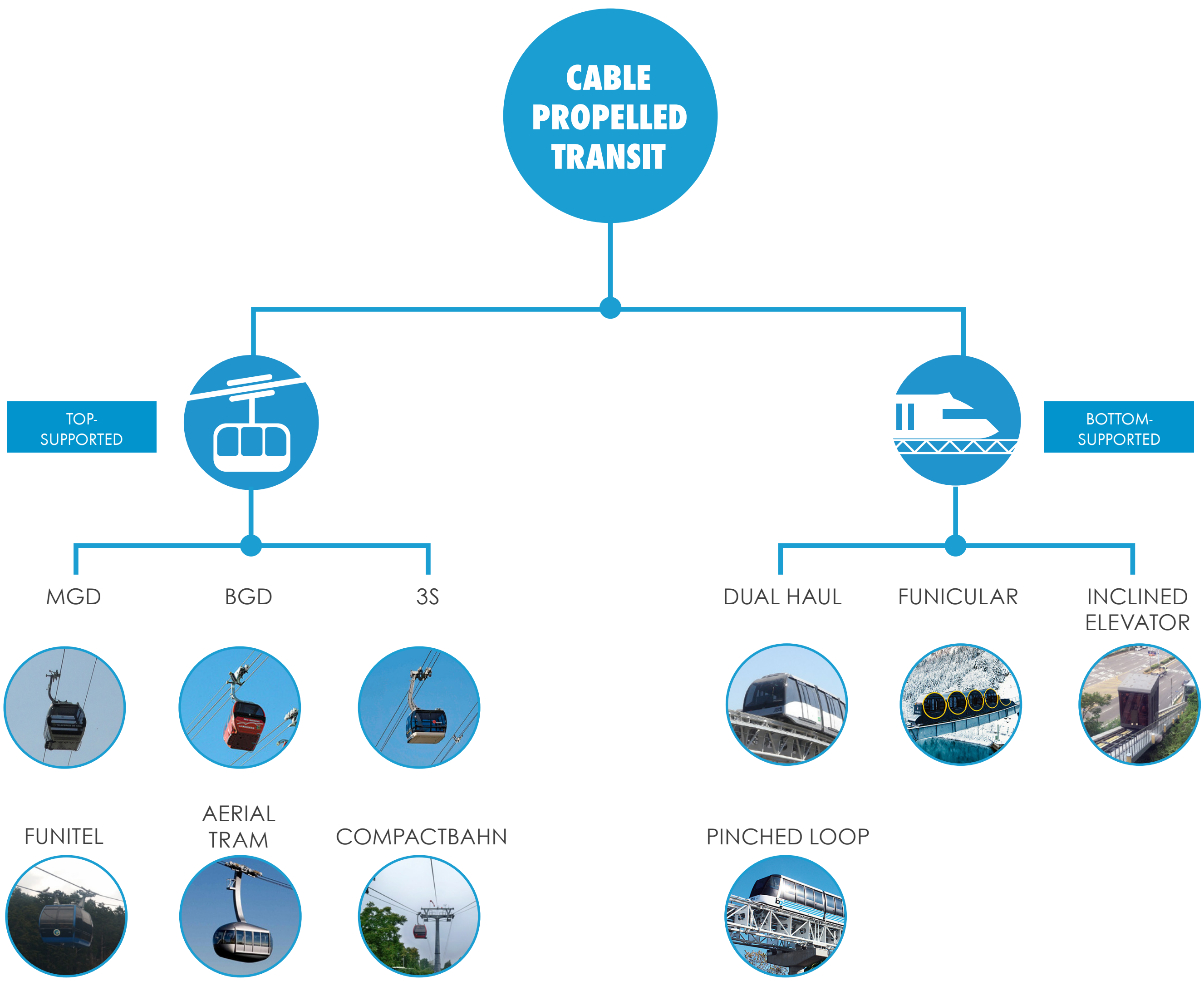
As a result, residents living in these transport deprived "pockets" are disconnected from the rest of the City. This problem is particularly exacerbated by the 25% of residents who do not own a personal vehicle.

While the City estimates that its existing physical infrastructure of roads can support a population two times its current size, leaders must make strategic decisions on how they can best revitalize aging infrastructure in addition to building new transit connections to improve non-automobile options.

2 CABLE TRANSIT INTRODUCTION

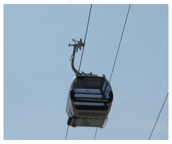
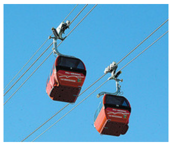
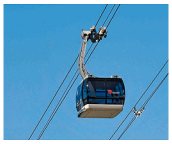
2.1 CABLE TRANSIT TYPES

Cable Propelled Transit (CPT) is a transportation technology where motorless vehicles are propelled by a steel cable. CPT systems can be top-supported and bottom-supported and consist of the following technologies.



2.2 TOP SUPPORTED TECHNOLOGIES

The table below provides a summary of the performance characteristics of the various aerial gondola technologies found in urban and recreational settings. It is important to note that the performance capabilities can vary dramatically based upon the cable car technology selected.

TECH	DESCRIPTION	MAXIMUM SPEED (MPH)	CAPACITY	MAX WIND SPEED OPERATIONS (MPH)	CAPITAL COST (RELATIVE)	GRIP
MGD 	The monocable gondola detachable (MGD) is the most common aerial gondola technology available. It utilizes one cable for both support and propulsion.	15.7	4,500	Up to 43	Low	Detachable
BGD 	The bicable gondola detachable (BGD) is similar to the MGD but with two cables - one cable for propulsion and one track cable for support.	16.8	4,000	Up to 43	Low-med	Detachable
3S 	The 3S gondola is currently the fastest and highest capacity gondola technology available. It has a detachable grip and three cables - two for support and one for propulsion.	19.1	6,000	62	High	Detachable
Funitel 	The funitel is a detachable grip system that looks like an aerial tram but acts like a gondola. The system utilizes one dual loop cable to carry short-armed cabins.	15.7	4,000 - 5,000	62	Med-High	Detachable
Aerial Tram 	The aerial tram is a large cabin, fixed grip system consisting of one or two vehicles. The traditional aerial tram has two vehicles fixed to the same cable loop, shuttling back and forth in tandem.	28	2,000	50	Med-High	Fixed
Compactbahn 	The Compactbahn uses two small cabins (up to 15 persons) which operate jigback formation but without the need for a counterweight/ hydraulic tensioning for the track cable (resulting in smaller station size and costs)	13.4	50 - 150	n/a	Low	Fixed

2.3 BOTTOM SUPPORTED TECHNOLOGIES

The table below provides a summary of the performance characteristics of the main bottom-supported cable technologies that may be appropriate for the Pittsburgh context.

TECH	DESCRIPTION	MAXIMUM SPEED (MPH)	CAPACITY	CAPITAL COST (RELATIVE)	GRIP
Funicular 	A funicular operates with one or two trains shuttling back and forth in tandem between two end terminals with one haul cable and drive machinery.	31	8,000	Med-High	Fixed
Cable Liner Dual Haul 	A Dual Haul Shuttle Cable Liner is designed with two trains that operate independently on separate tracks. Each cable line has its own haul cable and drive machinery which enhances redundancy and reliability.	30	5,000	Med-High	Fixed
Pinched Loop 	A Pinched Loop system uses several haul rope loops which adjoin and overlap one another at stations. This results in higher frequencies as three or more trains can operate simultaneously in a synchronized, circular flow of trains.	30	5,000	Med-High	Detachable
Inclined Elevators 	Inclined elevators operate with one or two vehicle which are each attached to a loop of cable. These are generally built for short distances and have standing room only.	9	3,000	Low	Fixed

2.4 COMPACTBAHN SOLUTIONS

Compactbahns (known commonly in German as "Kompaktbahn") are specialized low-capacity aerial lifts which provide a cost-effective and space spacing solution for topographically challenging last mile problems. We've taken time to describe these systems as they are not commonly known.

Compactbahns typically operate in a jigback formation where two cabins (8-15 passengers per cabin) travel back and forth from two end terminals in tandem.

Unlike aerial trams, compactbahns require less station space and can be built without a counterweight/hydraulic tensioning for the track cable (resulting in smaller station size and costs).

Systems can also be operated with one person, or fully automated/self service mode, helping reduce staff costs. Compactbahns may be an innovative and cost-effective solution for many of Pittsburgh's hilly terrain.

Polinka, Wroclaw, Poland

Polinka, Wroclaw, Poland

Faja dos Padres, Madeira, Portugal

Faja dos Padres, Madeira, Portugal

2.5 FUNICULARS & INCLINED ELEVATORS

Pittsburgh already has a significant experience implementing and operating inclined elevators and/or funiculars. The Duquesne Incline and Monongahela Incline were both inspired by cable transport systems seen in Europe when the initial waves of German settlers arrived in the region.

While the City only has two of these systems left which operate mostly for recreational transport, modern equivalents of the technology has been adapted for urban transport use in many cities throughout the world.

Its high speeds, and cost-efficiency can allow Pittsburghers to move easily along the city's topographical challenges.

Pfaffethal-Kirchberg Funicular features two cable systems which transports 7,200 passengers per hour.

Stoos Funicular is the world's steepest funicular in the world (110%/47.7 degree max incline).

Lugano-Citta Stazione Funicular carries more than 2.5 million passengers per year.

Mamariga Funicular connects passengers to urban districts located on hills with Bilbao's Metro system.

2.6 MAJOR BENEFITS

Cities worldwide are now recognizing how CPT systems can improve transit connectivity. Some of the technology's major benefits are included below.

1. INSTALLATION TIMES
Can be built in 1-2 years.

2. HIGH FREQUENCIES / NO SCHEDULES
Can arrive to pick up riders as quickly as every 8-12 seconds.

3. FULLY ACCESSIBLE
Provides 100% barrier free access.

4. HIGH RELIABILITY
Can function with reliability levels of greater than 99.5%.

5. LOW IMPACT ON GROUND
Travel above the ground and require towers and stations at specific intervals.

6. COST-EFFECTIVE
Can be built at 1/3 to 2/3 the cost of other fixed link transit.

7. HIGH SAFETY
Amongst the safest transport technologies in the world.

8. MEDIUM-HIGH CAPACITIES
Can transport up to 6,000 - 8,000 persons per hour per direction.

2.7 CABLE CAR SAFETY

Data collected from around the world demonstrates that cable cars are one of the safest forms of transportation.

Technological advancements in the ropeway industry combined with strict safety standards have resulted in nearly unmatched levels of passenger security. In addition, an overall culture of safety ensure that ropeways are designed and engineered with the utmost care and precision.

This high degree of safety is proven by empirical evidence found in countries with high usage rates of cable lifts.

> ***"A PERSON IS 3 TIMES MORE LIKELY TO SUFFER A FATALITY RIDING AN ELEVATOR THAN A SKI LIFT, AND MORE THAN 8 TIMES MORE LIKELY TO SUFFER A FATALITY RIDING IN A CAR THAN ON A SKI LIFT."***
>
> *- National Ski Areas Association*

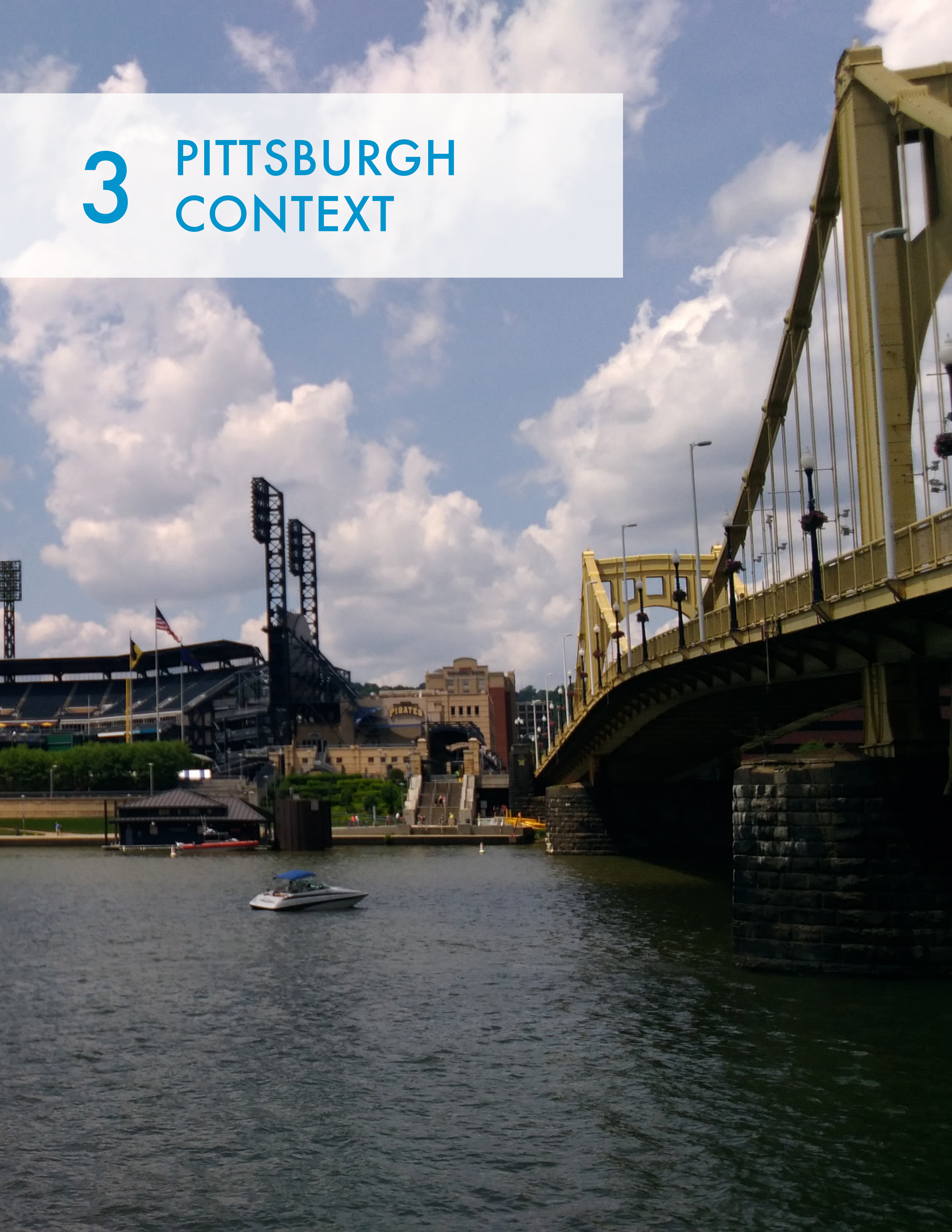
For instance, since the National Ski Areas Association (NSAA) started collecting passenger data in 1973, the US ski industry has transported 17.1 billion skiers and snowboarders. Between 1993 and 2018 — a span of more than 24 years — there has been zero fatalities stemming from lift malfunction.[Δ]

In North America, there is an estimated one passenger fatality for every 900 million ropeways passengers while there is one passenger fatality for every 31 million transit riders.[°]

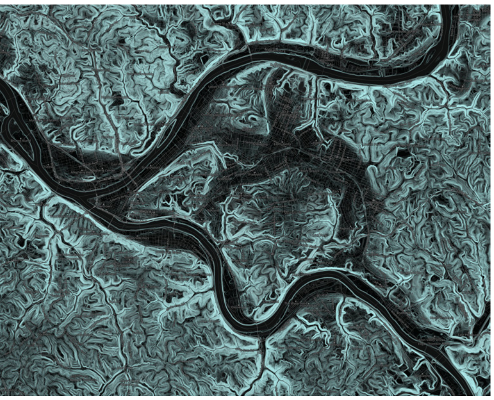
A similar trend of safety in occurs in Switzerland — home to the highest per capita use of cable cars. In this alpine country, ropeways are the safest form of transport.[†] Statistics demonstrate that lift passengers are three times less likely to be injured than in a tram, bus or train, and fifty times less likely to be injured than sitting in a car.

[Δ] NSAA Ski Lift Safety Fact Sheet (2017). Available at: https://bit.ly/2D2c80h
° Ropeways in North America - Impact Benefits and Outlook (2009). Available at: https://bit.ly/2xowvPa
† Seilbahnen Schweiz - Safety and Quality (2017) - Available at: https://bit.ly/2nEFjd1

3 PITTSBURGH CONTEXT



3.1 PUBLIC TRANSIT



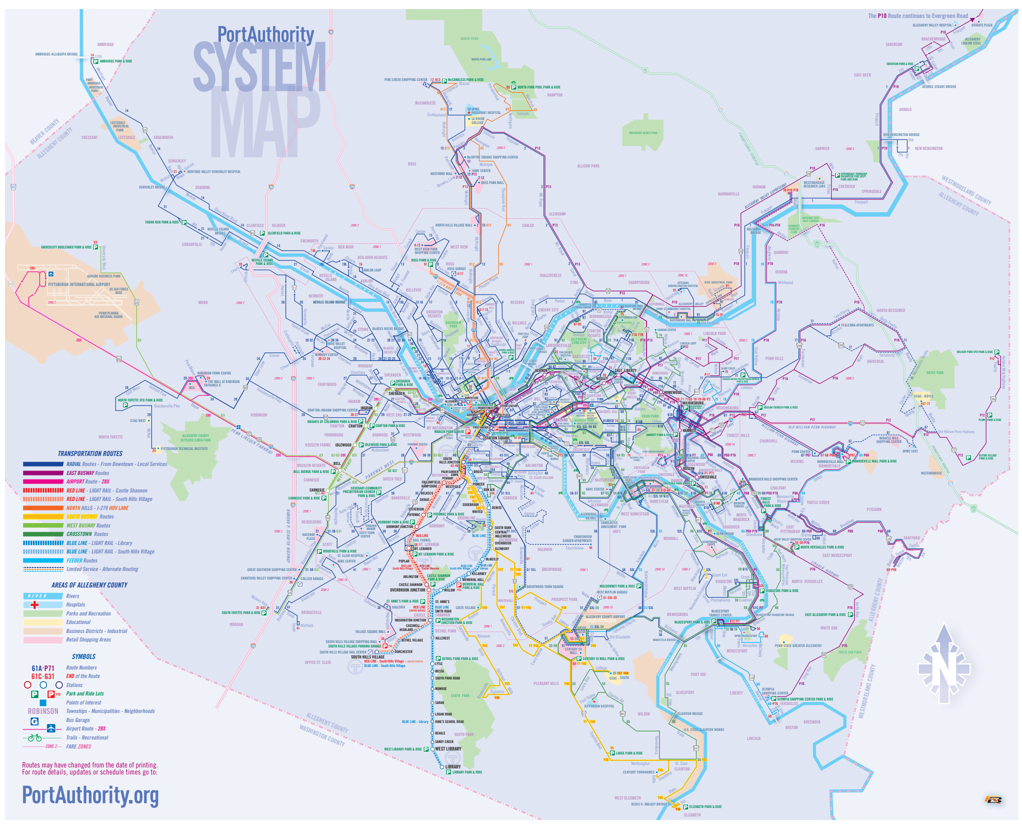
The unique topographical landscape of Pittsburgh is an ideal environment for maximizing the advantages of cable transport.

The Monongahela Incline, the USA's oldest operating funicular, still provides transportation to 1,000 commuters per day.

Public transit in Pittsburgh is the responsibility of the Port Authority of Allegheny County (also known as the Port Authority).

The Port Authority has a service area population of 1.4 million[Δ] and operates and owns a multi-modal network of transit systems which includes three light rail lines, two funiculars, 700 buses, and three bus rapid transit lines (South Busway, West Busway and East Busway).

Many of the City's transport routes are designed to follow existing rivers/ streams and terrain which has resulted in geographic "pockets" with poor transit connectivity.



System Map of all transit lines operated by the Port Authority

[Δ]Port Authority Performance Report (2016). Available at: https://bit.ly/2PvkTSE

3.2 FUTURE TRANSIT PLANS

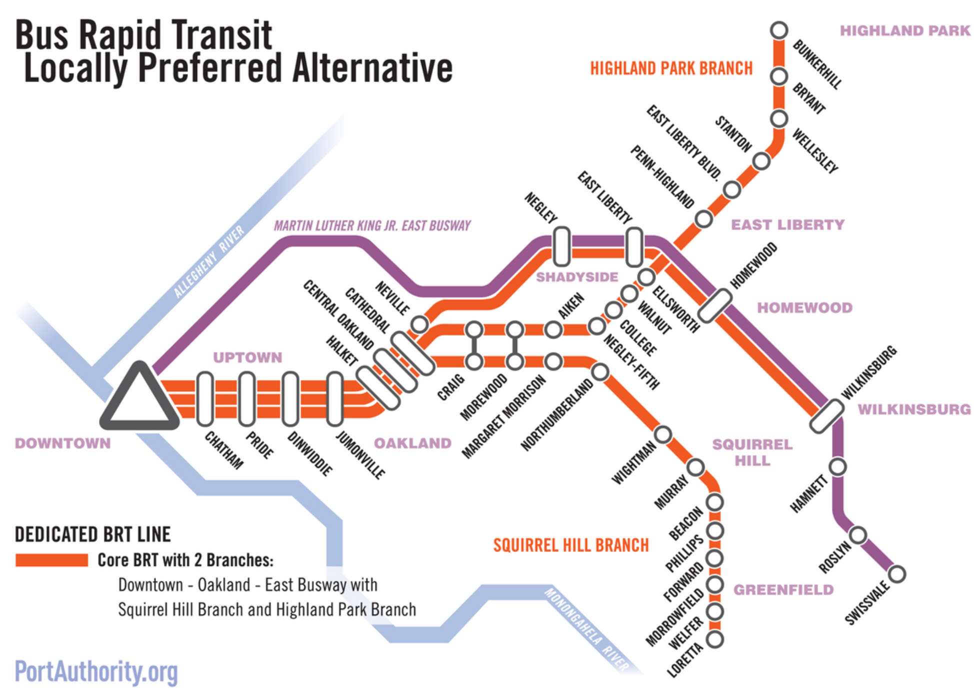
In 2011, the Port Authority began exploring the feasibility of constructing a bus rapid transit line linking downtown Pittsburgh and Oakland. The project is currently estimated to cost $195.5mm.[Δ]

Electric buses operating on a dedicated right of way will improve travel time between the Downtown and Oakland, with extensions to Squirrel Hill, Highland Park and Monongahela River Valley.

While the project did not receive federal funding, the Port Authority hopes to begin construction early next year and will proceed with local funding.

Cable systems can be built as complementary transit connections to any future rapid transit line.

While new developments are seeing cable transit systems functioning as trunk lines, most cable transit systems function best as feeders into other medium-to-high-capacity transit systems.



Downtown Pittsburgh to Oakland BRT Map

[Δ]Port Authority moves to final design for Pittsburgh-to-Oakland bus system (2018). Available at: https://bit.ly/2LjqSGL

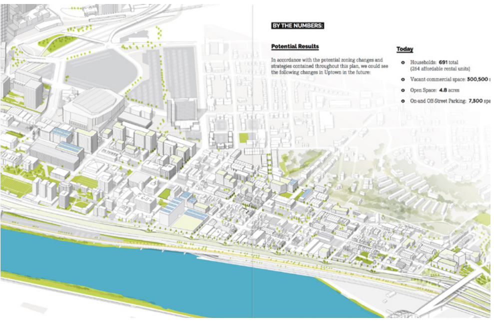
3.3 MAJOR DEVELOPMENTS

Further transit infrastructure may be necessary as the number of residents living in new units in downtown has risen from 4,400 in 2000 to 15,000 in 2017. ∆

Brownfield and greenfield redevelopment projects are ideal for cable transit as the developments can be planned around transit lines.

Typically, one of the challenges associated with cable transit in an urban area is "finding a vein" that will allow a cable transit system to be implemented cost-effectively. This challenge is mostly eliminated in greenfield and brownfield developments as the new development can be designed around the transit system.

Cable may be appropriate for some of major development projects that are being planned and implemented throughout Pittsburgh.



The Uptown Eco-Innovation District is also designed around Pittsburgh's p4 Initiative (i.e. people, planet, place, performance).

Uptown Eco-Innovation District

The Uptown EcoInnovation District, located in the communities of Uptown and West Oakland, is a community plan based on alternative planning methods which emphasize walkable, bikeable, and transit-oriented developments alongside placemaking initiatives that promote new and innovative businesses. The focus on non-automobile travel may provide opportunities to explore how cable transport can better enhance transit connections within the neighborhood.

Hazelwood Green is located just 15 minutes from downtown Pittsburgh.

Hazelwood Green (Almono)

At 178-acre in size, Hazelwood represents one of the largest undeveloped pieces of property in Pittsburgh. While this was a former brownfield site (home to a large steel mill), it will soon become a new community with innovative companies as its central platform. Located near a number of universities and industry, it is centrally located to function as an area where companies can conduct research, co-locate and grow. The Carnegie Mellon University's Manufacturing Futures Initiative and Advanced Robotics Manufacturing Institute acting as its anchor tenants. There are currently plans to begin construction of a public plaza in early 2019.§

∆ 28 projects worth $1 billion under construction (2017). Available at: https://bit.ly/2HJGcLY
§ Hazelwood Green's public space (2018). Available atL https://bit.ly/2NfwROG

More than nine high tech office buildings now occupy the Pittsburgh Technology Center site.

Pittsburgh Technology Center

Located alongside the Monongahela River in South Oakland, the Pittsburgh Technology Center is considered one of the forefront brownfield redevelopment projects in the City. As a former steel mill site, the area is now an office park with over 1,000 employees who work advanced academic and corporate technology research. Some upcoming plans for the district include the $25.5 million Elmhurst Innovation Center and $35 million Riviera office building.

Lawrenceville has been subject to gentrification.

Lawrenceville

Formerly an industrial area located 3 miles from downtown, Lawrenceville is now a hub for nightlife, live music, art and dining. Due to its affordable properties and historic homes, it has attracted many new young residents to the area.

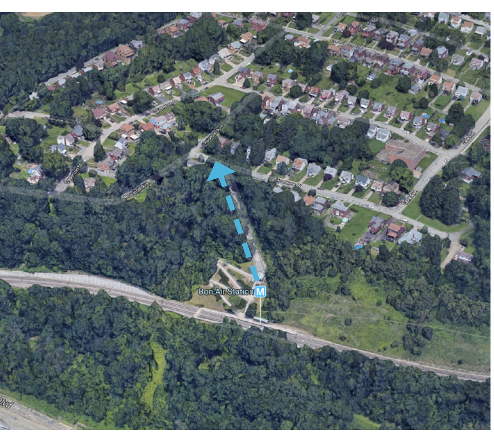
Lawrenceville has been ranked as one of the top hipster neighborhoods in the United States. One of its main thoroughfares, Butler Street, is a bustling road with trendy eateries, art galleries, antique shops and a historic movie theatre.

On site topographical challenges may create accessibility issues.

Lower Hill District

The Lower Hill District is part of the “Hill District”, a historically African-American community. After the Pittsburgh Civic Arena was demolished in 2012, there are now plans to redevelop the area. Up to 1,200 residential units and 1 million square feet of retail/entertainment space has been proposed to revitalize the site. Footpaths, public plazas and green space will help connect the new redeveloped area with the Hill District. The sloping topography of the site may offer opportunities to implement cable transport systems.

3.4 MAJOR CHALLENGES



Some of the major transportation-related challenges faced by Pittsburgh are listed below.

1. STEEP ROADS

2. LANDSCAPE DIVIDES CITY INTO "POCKETS"

3. 25% OF RESIDENTS DON'T OWN CARS

4. AVERAGE RESIDENT SPENDS 42% OF INCOME ON HOUSING AND TRANSPORTATION.

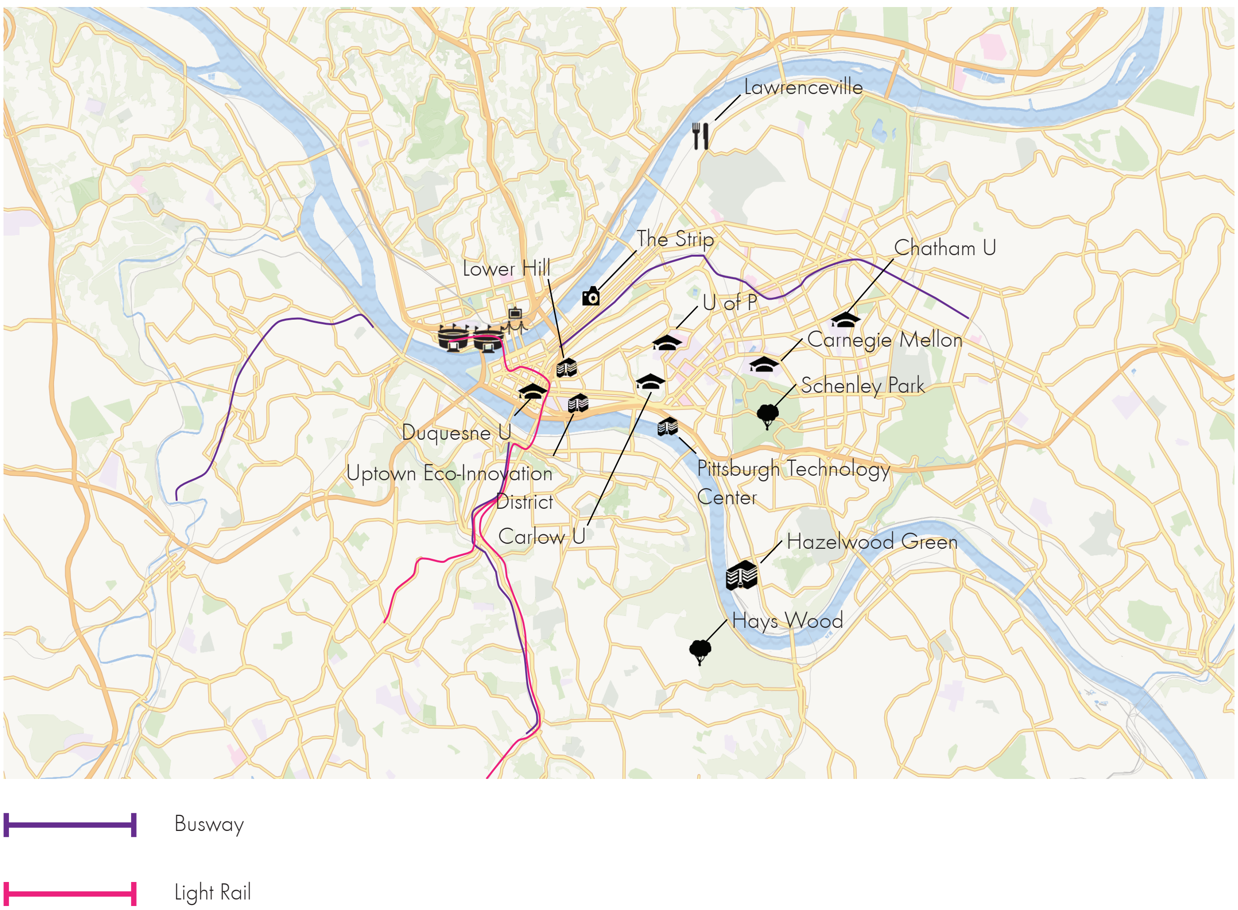
5. TRANSPORT CONSTRAINED BY RIVERS AND HILLS

6. RAPID TRANSIT STATIONS LOCATED FAR FROM RESIDENTIAL COMMUNITIES

7. ERA OF CONSTRAINED PUBLIC FINANCING

3.5 MAJOR ACTIVITY NODES

The map below highlights some of the major activity modes in the Pittsburgh area. Creating better transport linkages between and throughout these districts can reduce travel times and improve convenience for those without a car.



4 CABLE TRANSIT OPPORTUNITIES

4.1 PITTSBURGH CABLE TRANSIT OPPORTUNITIES

Within most urban environments there typically exists just a handful of opportunities (or fewer) that can be leveraged to implement an effective cable transit system. In some cities, such opportunities number from few to none.

Not so with Pittsburgh.

Given the Steel City's "carved up" topography characterized by hills, valleys, ravines, rivers, bridges and stairs; there is perhaps no major city in America with as many potential applications as Pittsburgh. From minor, small-scale connectors that would service the areas immediately adjacent existing transit nodes all the way up to major trunk lines capable of moving tens-of-thousands of people per day, Pittsburgh is uniquely positioned to capitalize on its beautifully unique land form by marrying it to the benefits that can be provided by cable transit technologies.

The writers of this report have developed six different cable car concepts that are believed to be prime opportunities to implement cable transit systems in the Pittsburgh context. These concepts should neither be seen to be prescriptive nor all-encompassing. Instead, readers of this report should use these concepts to better understand what benefits a cable transit system can bring to their city and use that information to envision and design cable transit systems of their own.

The concepts that follow include:

1. <u>Community-Scale Cable Cars</u> — the use of funiculars, inclines & compactbahns to connect neighborhood level activities to isolated local transit nodes.
2. <u>Recreational & Institutional Circulators</u> — the use of multi-section cable car systems such as MGD and 3S systems to move people throughout spaces such as green spaces, resorts, university campuses, and airports.
3. <u>Re-Connectors</u> — the use of right-sized gondola or aerial tram technologies (whether or not they are multi-section), to reconnect isolated communities to the wider urban fabric and transit network.
4. <u>Brownfield Cable Cars</u> — the use of cable cars within still-in-the-planning-stages brownfield development sites so as to eliminate some of the challenges inherent in using cable cars within an urban environment.
5. <u>Temporary "Test-Drive" Systems</u> — the use of slim-profile aerial gondola systems to service a temporary need or event with a plan to sell-off or re-purpose the technology in a different location.
6. <u>Grand Trunk Cable Cars</u> — the use of multi-section aerial gondola systems such as MGD and 3S to create primary and secondary trunk public transit lines within an urban context.

4.2 COMMUNITY-SCALE CABLE CARS

For all public transit trips, walking is an important part of the first- and last-mile problem. As such, creating more pedestrian friendly environments is critical in encouraging a shift away from car-centric developments. However, Pittsburgh's pedestrian network is often frustrated by difficult topography and manmade infrastructure obstructions (i.e. highway and rail lines). This often makes walking inconvenient and uncomfortable.

While the City is home to over 700 public staircases (many of which are located in Southside Slopes, Polish Hill, Greenfield, Marshall-Shadeland, California-Kirkbridge, Perry South and Fineview), a high number are in poor condition, require maintenance and are poorly signed.

For highly frequented staircases, Community-Scale Cable Cars could be built to improve walking conditions and to enhance accessibility for an aging population. A potential application for funiculars is to implement systems to connect residents living on top of steep hills to rapid transit lines located in the valley.

Stairs

Incline (Funicular)

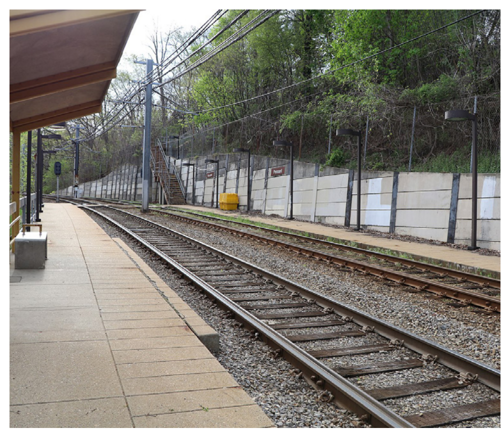
Compactbahn

Many light rail stations are located in areas of hilly terrain (see below). As such, access to the station from nearby residential areas remains challenging.

Strategically built inclined elevators connected to stations may facilitate and ease accessibility for all passengers.

Bon Air Station

Pennant Station



Boggs Station

Points to consider when designing a Community-Scale Cable Car:

1. Systems such as these can typically be built for a few million dollars and maintained for a few hundred thousand dollars per year.
2. Systems such as these tend to be most effective when there is a clear natural topographical challenge no greater than 1,600 feet (500 meters) in distance.
3. Compactbahns will typically have a lower capital cost than a funicular or incline due to the lack of guideway. This lack of a guideway, however, dictates that a compactbahn must travel between two stations in a completely straight configuration. Funiculars and inclines have a much greater capacity for non-straight alignments.
4. Community-Scale Cable Cars—when located in highly-trafficked tourist destinations—have a tendency to be extremely profitable.

Community-Scale Cable Cars consist of both top-supported and bottom-supported transport systems where vehicles are propelled by a steel cable. Examples in the above photos include systems built in Quebec City (left), Switzerland (top right) and La Paz (bottom right).

4.3 RECREATION & INSTITUTIONAL CIRCULATORS

A wide variety of both top-supported and bottom-supported cable cars are utilized in Institutional and Recreational areas for amusement and/or transportation purposes. These systems tend to operate within "walled gardens" linking various attractors within the holdings of a single landowner.

Examples of this concept include (but are not necessarily limited to):

Las Vegas City Center Tram

This three-station elevated automated people mover connects three different MGM properties on the Las Vegas strip.

Pearson Int'l Airport Link Train

This dual-haul three station people mover connects two airport terminals with a satellite parking facility. It operates 365 days a year, 24 hours a day with an over 99% reliability rating.

Garden Show Cable Cars

Systems such as those built for the Rostock, Munich and Koblenz garden shows circulate people above the park grounds while charging a fare for each ride. Applications such as these have been shown to be very profitable while blending transportation and amusement into a single unified attraction.

Disney Skyliner

A new multi-section, multi-station gondola system that knits together many different attractions at Disney's flagship theme park in Orlando, Florida.

Kolmården Wildlife Park

A wide number of specialty turns and stations allows visitors to the Kolmarden zoo in Sweden to view the zoo's animals from above while enjoying a leisurely ride throughout the parklands.

University of Wrocław

A compactbahn installation in Poland that connects two university campus districts separated by a river.

Re-Purposing This Concept Within Pittsburgh – Schenley Park

Schenley Park is a large 420 acre greenspace located near the Carnegie Mellon University and University of Pittsburgh. Due to its size and popularity with residents and visitors, there may be opportunities to better improve transportation to and within the park.

Many aerial gondolas have been built in large parks to facilitate movement and enhance recreation for residents.

Doppelmayr built a temporary gondola for the 2005 Federal Garden Show (i.e. horticultural festival) in Munich, Germany's Riemer Park. The large 210ha greenspace was connected by a 1.6 mile aerial gondola which served 1.6 million guests in just 6 months.

Points to consider when designing a Recreational & Institutional Circulator:

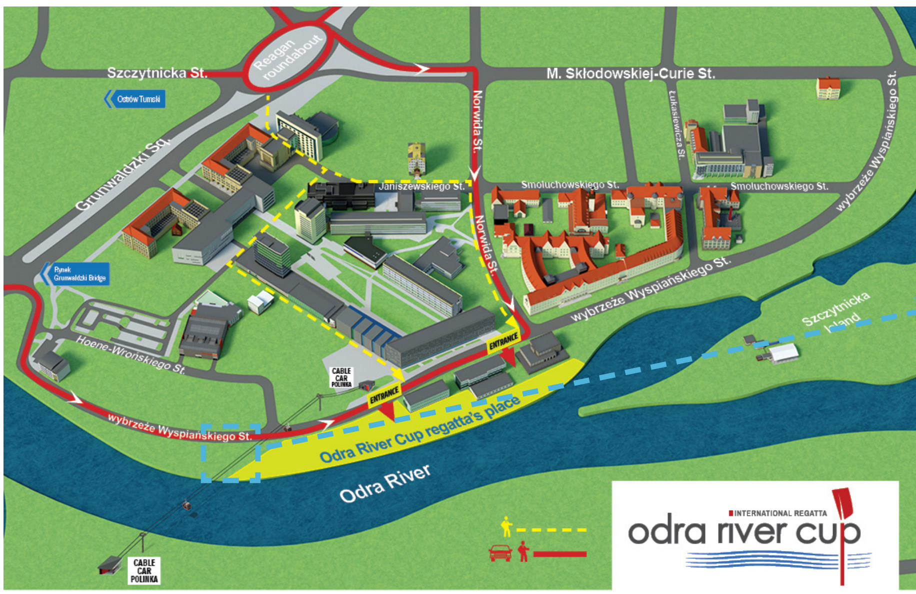
1. Multi-station cable car systems in such settings generally cost in the low-to-high 8 figures.
2. Aerial systems tend to cost less than bottom-supported automated people mover systems. This is a highly subjective statement, however, as most costs will be within station architecture.
3. As systems such as these tend to be built within a single landowner's property, permitting is typically expedited and approvals more easily obtained than those that are built within public rights-of-way.

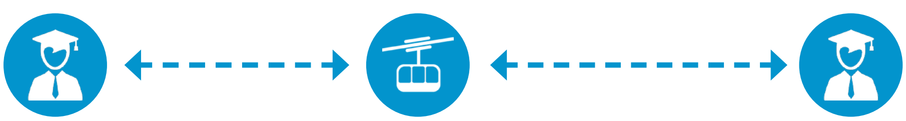
Re-Purposing This Concept Within Pittsburgh – Universities

A number of universities are located in Pittsburgh. These include the University of Pittsburgh, Carnegie Mellon University, Duquesne University, Chatham University, and Carlow University.

Since many post-secondary students do not have access to a car, many rely on public transit for daily transport.

An aerial gondola system connecting to these activity nodes could be a logical place to investigate whether a ropeway would be feasible.





The University of Wroclaw in Poland built a gondola to improve connectivity within its campus.

(MORE) Points to consider when designing a Recreational & Institutional Circulator:

4. Institutional Circulators are generally offered to the public as a free-from-charge service. They are seen by project developers as critical pieces of infrastructure to move people, staff and goods throughout their properties.
5. Recreational Circulators, conversely, typically charge a fee to pay for capital, operations & maintenance costs. These systems are not seen as essential transportation links but rather amusement attractions.
6. Hybrids that blend Institutional and Recreational characteristics are also commonly found.

4.4 RE-CONNECTORS

Multi-station gondola systems in urban environments initially found their footing as a means to re-connect disadvantaged communities that suffered from community ills caused in large part by physical isolation from the surrounding urban fabric.

Cable car systems such as those in Caracas, Venezuela and La Paz, Bolivia were originally imagined as a means to re-connect those isolated communities to the wider economic opportunities offered by their communities and were generally speaking successful in their implementation.

Pittsburgh suffers from similar issues, most notably within the Hill District. While geographically close to such features as Downtown, West Oakland and the Strip District, the Hill District suffers from extreme topographical isolation. Residents of the Hill District are predominantly economically disadvantaged and rely upon public transit services that are lacking within the area.

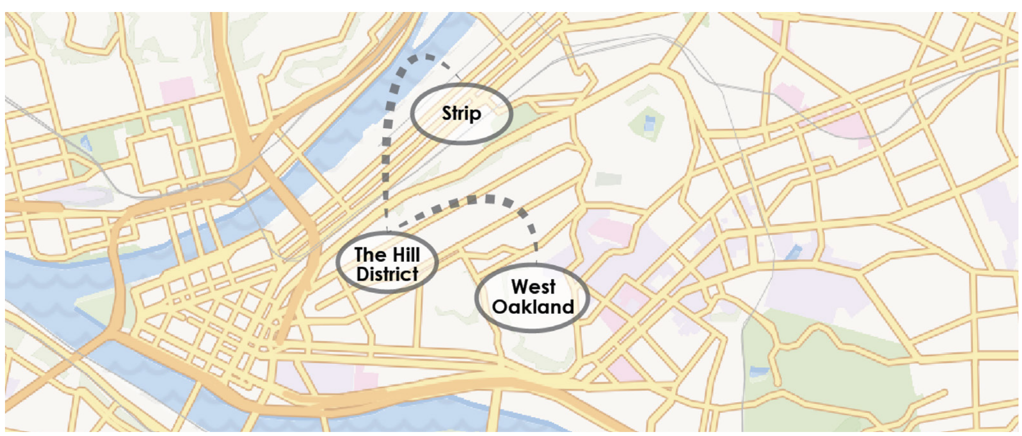
Doppelmayr supplied the electro-mechanical equipment for the Caracas, Metrocable. The first Caracas Metrocable is 5 stations long with a little more than a mile in length. It connects directly to the Metro/subway and allows residents living in isolated hilltop communities access to wider transportation options.

Re-Purposing This Concept Within Pittsburgh – The Hill District

A multi-section gondola system could alleviate that disconnection by knitting the area into the wider cityscape and transit network. Traveling from the Strip District, for example, up to the Hill District and onwards to West Oakland would connect the Hill District to jobs, education, recreation and transit resources that are critically lacking within the existing community.

Things to consider when implementing a Re-Connector system –

1. Significant resources will have to be expended on public outreach within the targeted community to ensure the necessary buy-in from local residents.
2. Re-Connector systems should feed into higher-order public transit systems to allow residents to get into and out of their community in a fast and convenient manner so as to connect them to economic and educational opportunities.
3. Wherever possible, cable car stations and towers should be designed so as not to displace existing residents and businesses.
4. Systems such as these can typically be built for sums in the low-to-high 8 figures.
5. It is critical to utilize the cable car system not as a second-tier transit technology targeted to disadvantaged communities but rather as a fully-integrated part of the city's wider transportation network.



Using a multi-station cable car to connect isolated communities such as the Hill District to employment and education opportunities in the surrounding areas could open up significant economic growth opportunities for residents in said communities.

4.5 BROWNFIELD CABLE CARS

Cable car planning within the urban environment can be very challenging. Finding an alignment that serves the most number of people while still being able to "fit" within the given dimensions of a city's streetscape is no small challenge. Adding in the vertical component of a system's design and the potential to compromise residential privacy; cable car planning is a very challenging discipline of constant compromise to realize an effective alignment.

Those compromises, to some extent, can be eliminated when paired with a design-stage Brownfield redevelopment. As the brownfield development can somewhat be designed around the cable car, the need for excessive physical compromises to realize the cable car's design is greatly reduced.

Within the Pittsburgh context, the brownfield Hazelwood development site to the south-east of downtown would be an ideal environment to implement a cable transit system. As more jobs and residents are expected as the area develops, city planners have an opportunity to craft the Hazelwood site's master plan around the cable car thereby dramatically increase the site's connectivity.

Given that new developments that include fixed-link, higher-order transit systems realize a significant value uplift in rents and prices-per-square-foot, it would be theoretically possible to pay for the capital costs of such a system by capturing said value uplift and allocate it to the repayment of a gondola system's capital costs.

<u>Things to consider when implementing a Brownfield Cable Car —</u>

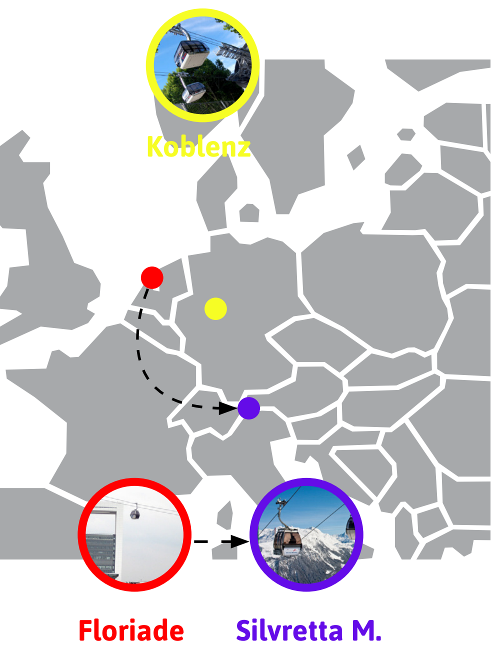
1. As a cable car only intersects with the ground at station and tower areas (as opposed to entirely along its linear length) the need for soil remediation should be reduced.
2. A cable car system is not much different than other forms of fixed link transit. Principles such as transit-oriented design can be applied to a gondola system in the same way as they would be with other standard modes.
3. By integrating cable cars into a project planners' thinking at an early stage, the brownfield development can be designed around the cable car yielding far fewer compromises and reducing the capital costs of the gondola as a whole.

4.6 TEMPORARY "TEST-DRIVE SYSTEMS"

Little known to most people, but cable car systems are frequently implemented as a means of providing temporary transportation large scale events and attractions like Worlds Fairs, Expos and garden shows.

The two case studies below of the Floriade Cable Car and the Koblenz Cable Car describes how two cities have used ropeway technology to temporarily improve transportation within and to special events.

Systems such as these, once disassembled, are repurposed in a different configuration oftentimes at ski resorts or other special events.



Floriade Cable Car

The Floriade Cable Car was built in Venlo, Netherlands to improve guest transport for a horticultural festival in 2012. To enhance system economics, event organizers planned the cable car as a temporary installation which was to be sold off as a ski lift to the Silvretta Montafon ski resort in Austria after the festival ended in October 2012.

This cable car demonstrates how a ropeway system can be reused and shipped off for another purpose to maximize financial returns.

Koblenz Cable Car

The Koblenz Cable Car in Germany was designed to connect garden show visitors to the event grounds (located on a hilltop) from Koblenz's city center.

The system was primarily installed as a temporary transport device for the 6-month long event. However, as locals fell in love with the system, they gathered over 100,000 signatures which convinced stakeholders to transform the system into a permanent fixture.

Re-Purposing This Concept Within Pittsburgh

Lacking a specific event or attraction to justify the use of a temporary cable car system, Pittsburgh city planners could consider using a temporary cable car as a means to "test-drive" the system and allow citizens and bureaucrats to familiarize themselves with the technology.

A system circulating within Schenley Park, a connection between Hays Woods across the river or a connection from the top of the Duquesne Incline to the stadium district on the north side of the river would be a logical connection.

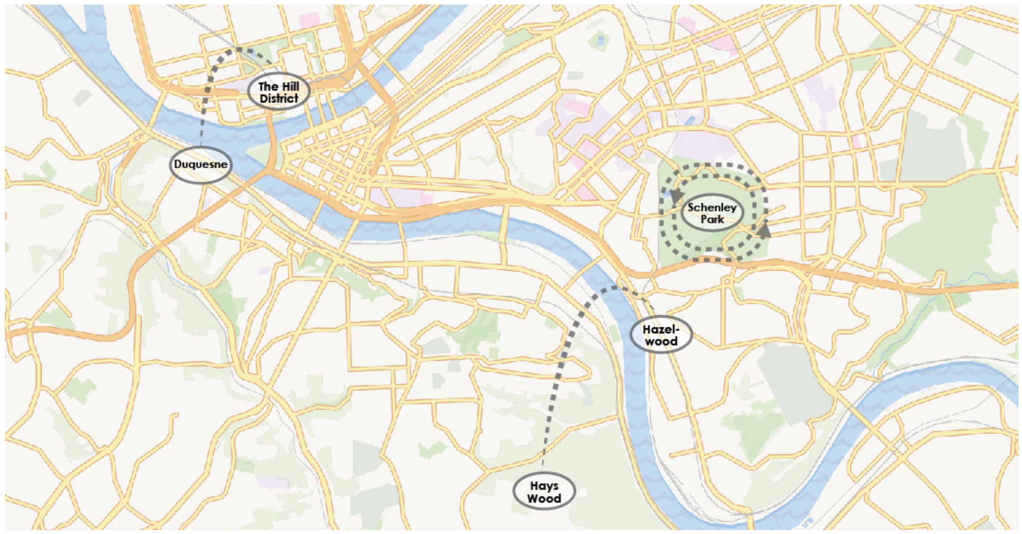
In order for such a thing to work financially, one of two instances would occur.

In the first instance, the City of Pittsburgh would partner with a handful of other cities within the 100RC. Each city would have their "turn" test-driving the cable car from between 6-12 months. Each would charge a fare for the "ride" and the system would be sold off for spare parts once each city has used the system.

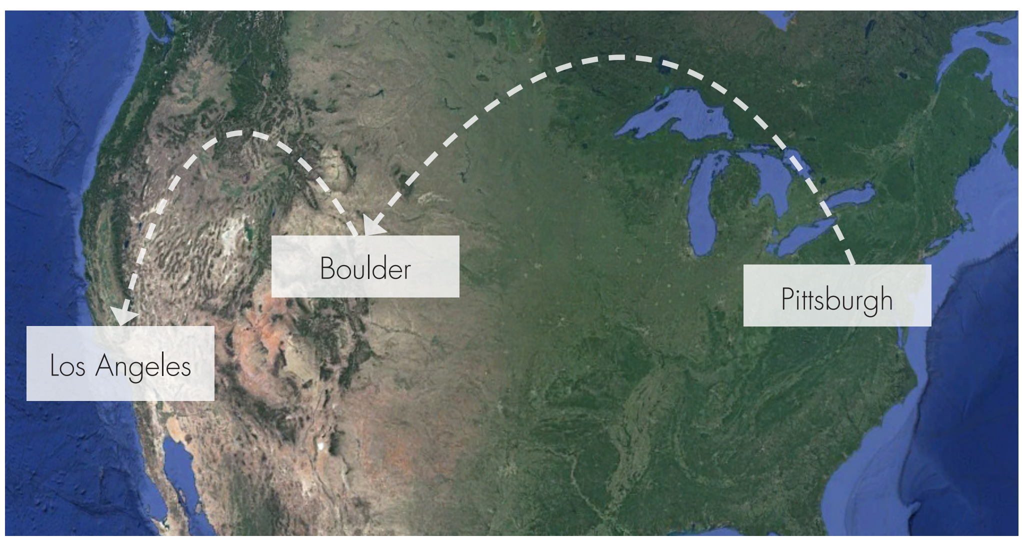
In the other instance, the system would be built with the intention of decommissioning it only to have the public request to have the cable car remain. Both are viable strategies, but are generally speaking mutually exclusive to one another.

<u>Things to consider when implementing a Temporary Cable Car —</u>

1. When designing a temporary system, it is best to have a plan for where the system will eventually "live" after it has been decommissioned.
2. Counter to the previous point, system designers should anticipate the public's desire for the cable car to remain after it is built. As such, having a specific destination for the decommissioned cable car could be in direct conflict with the community's desire to keep the system in place.
3. It is not necessary for a decommissioned cable car to be rebuilt in the same configuration as its original design. Designs should, however, be developed in tandem so as to ensure that the maximum number of parts and components can be reused from one configuration to the other.
4. Not all parts of a cable car system can be reused. Components like the cable itself will not be reusable. System planners should factor in these elements into their economic models to ensure sound financials.



A wide variety of opportunities exist within Pittsburgh to implement a temporary gondola system within the key would be to finding an installation location that is attractive enough to generate fare-paying riders while having sufficient enough space to demonstrate the technology and educate the community.



The idea of a "road show" of a touring gondola system is a unique but intriguing proposition. By uniting multiple cities within the 100RC network into such a tour, multiple cities would be able to experience the benefits of the technology with little risk. As each city would be able to charge a fare for all riders, the capital costs of a system could be amortized across a wide swath of people.

4.7 GRAND TRUNK CABLE CAR

Historically transit planners have looked at cable car systems as a means to connect two points directly. While new developments in Latin America have begun to change that perception, most still believe cable transit systems to only be appropriate in short-distance configurations only capable of moving a modest number of people.

This perception, however, is changing. Long distance systems in Vietnam have challenged the upper limits of how long a single section of gondolas can be while the Mi Teleférico system in La Paz, Bolivia has showcased the fact that a city's entire fixed-link transit infrastructure can be built with cable cars.

The system is constantly being expanded and includes dozens of stations and dozens of miles of gondolas stitching the various areas of the city together into one unified whole.

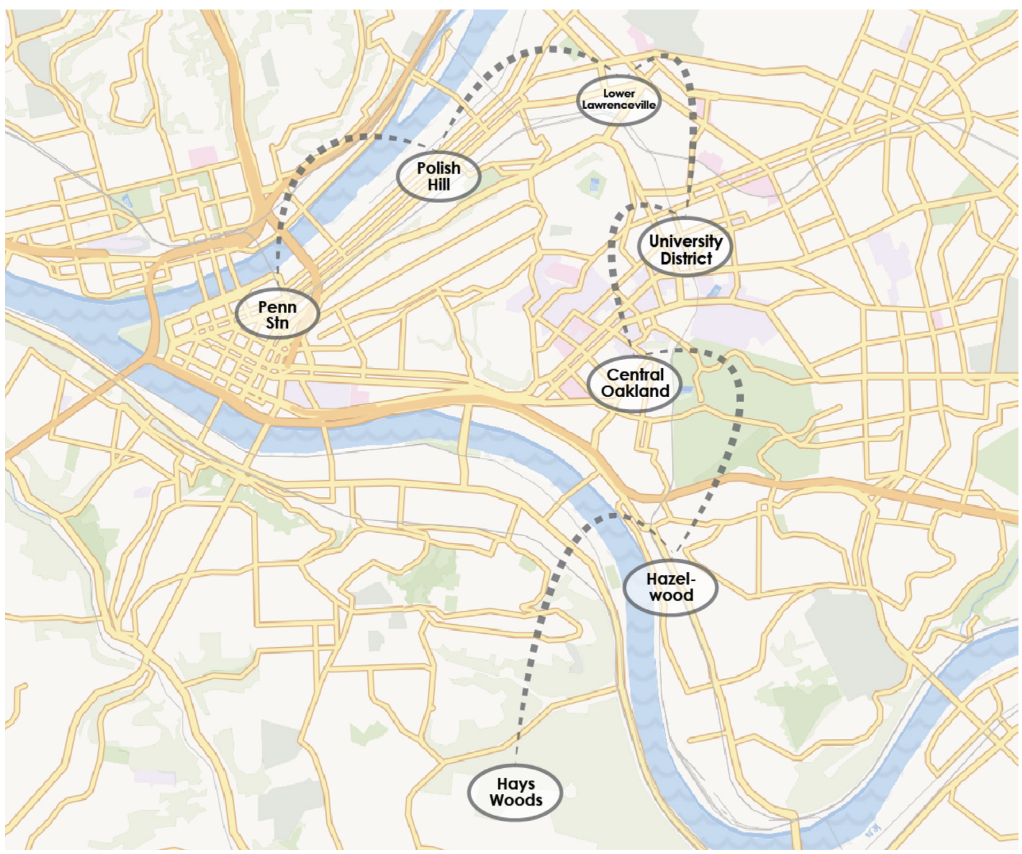
Doppelmayr has provided all the electro-mechanical cable car equipment for the Mi Teleférico cable car system in La Paz, Bolivia — world's largest cable car transit system.

Re-Purposing This Concept Within Pittsburgh — The Grand Trunk

Leveraging the valleys, parks, rivers and other corridors within Pittsburgh, the City could realize a sort-of "Grand Trunk" cable car. Connecting Penn Station, Polish Hill, Lower Lawrenceville, the University District, Central Oakland, Hazelwood and Hays Woods.

Such an alignment would connect major destinations with major residential areas and green spaces. It would be ambitious, costing in the low-to-mid hundreds-of-millions of dollars, but could be built within a matter of a few years and at a fraction of the price of other standard fixed-link modes.

In all likelihood, such an alignment would have to be phased so as to be realized.



At approximately 7 miles long with 7 stations, a "Grand Trunk" cable car in Pittsburgh would be ambitious but is technically possible. Locating stations and towers within these corridors is considered possible by this report's authors.

5 CONCLUSIONS

5.1 FINAL THOUGHTS & NEXT STEPS

This Technology, Concept & Opportunities Analysis was not meant to be prescriptive or final. It was designed to provoke thought and ideas within City staff and to present the myriad of ways the City of Pittsburgh could utilize cable transit technologies.

This is merely the beginning of what the authors hope is a long-lasting and fruitful dialogue.

Summary Talking Points —

1. Pittsburgh's topography makes the city uniquely positioned to leverage the core strengths of a cable car system.
2. Unlike other cities, Pittsburgh has the opportunity to use a wide-range of cable transit solutions from small-scale Compactbahns all the way up to major trunk line cable cars.
3. Development opportunities in Hazelwood, the University District, the Hill District and Hays Woods open up avenues to connect and reconnect these areas to the wider urban fabric.

The following are the recommended next steps in the event that the City of Pittsburgh, the Resilience Office or any other departments wish to proceed with further analysis and work towards the possible implementation of a cable car system:

Potential Next Steps —

1. Circulate this report to relevant stakeholders and to gather input.
2. Host Doppelmayr team in Pittsburgh to present findings and discuss future opportunities.
3. Liaise with other 100RC cities to explore whether or not there is appetite for exploring a touring test-drive system.
4. Work with Doppelmayr to sketch out further programs of work the City wishes to undertake on this file.
5. Work towards a defined project concept and put that concept forward for a Preliminary Economic & Technical Assessment.

PHOTO CREDITS

Title Page
Photo by Nicholas Chu. All rights reserved.

Page 1
Photo by Nicholas Chu. All rights reserved.

Page 2
Photo by Nicholas Chu. All rights reserved.

Page 3
Image from Klaus Hoffman report - Recent Developments in Cable-Drawn Urban Transport Systems. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Page 6
Photo by Nicholas Chu. All rights reserved.

Page 7
MGD photo by Nicholas Chu. All rights reserved.

BGD photo by Doppelmayr. All rights reserved.

3S photo by Doppelmayr. All rights reserved.
Funitel photo by Nicholas Chu. All rights reserved.

Aerial Tram photo by Doppelmayr. All rights reserved.

Compactbahn photo by Wikipedia user Panek. Used under creative commons.

Dual Haul photo by Doppelmayr. All rights reserved.

Funicular photo by Doppelmayr. All rights reserved.

Inclined Elevator photo by Nicholas Chu. All rights reserved.

Pinched Loop photo by Doppelmayr. All rights reserved.

Page 8
MGD photo by Nicholas Chu. All rights reserved.

BGD photo by Doppelmayr. All rights reserved.

3S photo by Doppelmayr. All rights reserved.
Funitel photo by Nicholas Chu. All rights reserved.

Aerial Tram photo by Doppelmayr. All rights reserved.

Compactbahn photo by Wikipedia user Panek. Used under creative commons.

Page 9
Dual Haul photo by Doppelmayr. All rights reserved.

Funicular photo by Doppelmayr. All rights reserved.

Inclined Elevator photo by Nicholas Chu. All rights reserved.

Pinched Loop photo by Doppelmayr. All rights reserved.

Page 10
Photo by Wikipedia user Panek. Used under creative commons.

Photo by Wikipedia user Slawomir Milejski. Used under creative commons.

Photo by Inauen-Schätti AG. All rights reserved.

Photo by Inauen-Schätti AG. All rights reserved.

Page 11
Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Page 12
Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Page 13
Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Page 14
Photo by Nicholas Chu. All rights reserved.

Page 15
Photo by Perry Quan. Used under creative commons.

Page 17
Photo by Ron Reiring. Used under creative commons.

Page 18
Photo by Wikipedia user John Marino.Used under creative commons.

Page 19
Photo by Wikipedia user Peter Pawlowski. Used under creative commons.

Photo by Wikipedia user Plastikspork. Used under creative commons.

Page 21
Photo by Steven Dale. All rights reserved.

Page 23
Photo by Flickr user hhm8. Used under creative commons.

Photo by Flickr user Tony Webster. Used under creative commons.

Photo by Wikipedia user Panek. Used under creative commons.

Page 24
Photo by Wikipedia user Train2104. Used under creative commons.

Photo by Wikipedia user Train2104. Used under creative commons.

Photo by Wikipedia user Train2104. Used under creative commons.

Page 25
Photo by Flickr user Tony Webster. Used under creative commons.

Photo by Inauen-Schätti AG. All rights reserved.
Screenshot from Google Maps. All rights reserved.

Page 26
Photo by Steven Dale. All rights reserved.

Photo by Nicholas Chu. All rights reserved.

Photo by Doppelmayr. All rights reserved.

Page 27
Photo by Wikipedia user Softeis. Used under creative commons.

Page 28
Photo by Wikipedia user Peter Pawlowski. Used under creative commons.

Page 29
Photo by Steven Dale. All rights reserved.

Page 30
Photo by Steven Dale. All rights reserved.

Photo by Flickr user Pierre Swillens. All rights reserved.

Page 37
Photo by Nicholas Chu. All rights reserved.

Doppelmayr Garaventa Group
Konrad-Doppelmayr-Strasse 1
Postfach 20
6922 Wolfurt, Austria
mobility@doppelmayr.com

Doppelmayr®

PIONEERED BY THE ROCKEFELLER FOUNDATION
100 RESILIENT CITIES