ORGANIZZAZIONE INTERNAZIONALE TRASPORTI A FUNE

OITAF
Bozen/Bolzano
Congress 2017

Trends in North American Urban Cable - 2016

Mike Deiparine, PE
Jim Fletcher, PE, FASCE

Bozen/Bolzano 6 - 9 June 2017

Biographical Notes

Mike Deiparine, PE

Mike Deiparine, PE has over 20 years in experience in the ropeway industry. He is a mechanical engineer with experience planning, designing and implementing a variety of ropeway systems. His work includes the automated people mover at Toronto's Lester B. Pearson International Airport and the modernization of the Roosevelt Island Tram. Mr. Deiparine remains on the forefront of urban cable in North America and is an active participant in the American National Standards Institute (ANSI) B77.1 Committee for Passenger ropeway Systems and the ANSI/ASCE Committee for Automated People Movers.

Jim Fletcher, PE, FASCE

Jim Fletcher, PE has demonstrated project management experience in design, planning and implementation for transit and transportation projects nationally and internationally exemplified by his work as Project Director for the Automated Transit Systems at Charles de Gaulle Airport in Paris and as Technical Project Manager of Schedule Risk Assessment for the Seismic Retrofit of the Suspension Span for the San Francisco Oakland Bay Bridge.

Mr. Fletcher has been a major contributor in the development of national standards for Transit. For 27 years he has been a member of the American National Standards (ANSI), B77.1 Committee for Passenger Ropeway Systems and has served on the ANSI-ASCE Committee for Automated People Mover (APM) systems for 13 years. He has served as one of the charter members of the steering committee that formed the APM Standards Committee. Mr. Fletcher is a past President of OITAF-NACS; has served on the OITAF Management Committee and was President of the Organizing Committee for the 8th International Congress for Transportation by Rope in 1999 in San Francisco.

Introduction

Purpose

The purpose of the information and discussion that follows is to provide the current developments in urban cable in North America and to discuss recent trends and concerns. What situations have the most potential for ropeways and what are the limitations for the ropeway in those situations?

The following discussion will attempt to use this history to provide some predictions as to what lies ahead for the ropeway industry in North America. We look forward to readers' comments and questions.

History

The ropeway as a passenger transport device in an urban setting had an early experience in San Francisco in the 1870's with the introduction of the cable car which is well known worldwide. Other cities in the United States and Canada started to utilize funicular railways at various locations in the early 1900's.[1] In the 1890's, a funicular railway was constructed in Los Angeles from a station at Rubio Canyon to the peak of Echo Mountain, on an alignment of 2,650 feet at grades varying from 48% to 62%. Far more ambitious was the Mt. Washington Railroad in Los Angeles that was built just to the east of downtown in the early 1900's and operated until 1922. A 3,000-foot-long funicular, it climbed to the 900-foot-high summit of Mt. Washington.

On November 16, 1895 the railroad known today simply as "The Incline" opened, rising up the steepest part of Lookout Mountain in Chattanooga, Tennessee. Built by John Crass and the Lookout Mountain Incline Railway Company, this funicular has an incline of 72.7% at one point, making it one of the steepest passenger Inclines in the world. Literally millions of residents and tourists have taken this ride up to the top of Lookout Mountain.

The Duquesne Incline in Pittsburgh, Pennsylvania built in 1877 allowed residents to be transported to the top of Mount Washington and is operational today. The Duquesne Incline is one of two fully-operational inclines that scale Pittsburgh's Mount Washington. The Monongahela Incline also operates about a quarter-mile to the east. Several other inclines also operate in Pennsylvania.

All of the above mentioned systems are bottom supported ropeway systems. The focus, however, of this paper is largely on aerial systems as there is tremendous interest in them. As described below, there are few urban aerial transit ropeways in North America, with many under consideration.

---

[1] Fletcher, Jim "Future Perspectives of Ropeways in North America", OITAF-NACS Tenth Symposium, August 17-19, 2009, Lakewood, Co

Current Systems

Roosevelt Island Tram, New York, New York [2]

Roosevelt Island is an Island in New York City separated from Manhattan by part of the East River. During the 1970s, the island became attractive for additional development except that it was poorly connected to the rest of Manhattan. At the time, there was no subway stop on Roosevelt Island so no direct connections to Manhattan existed, except for water taxis. In 1976 the Roosevelt Island Tram opened as a temporary transit connection to Manhattan, to be in service until the subway stop was completed. The system was a 3100' jig back tramway with 125 passenger cabins. The subway stop was not completed until 1989, by which time the Tram had become an integral part of Island culture. As the Tram aged, a number of efforts were conducted to advise what to do with the ageing system.

Following a much publicized outage in 2006, a detailed effort was undertaken to determine the Tram's future. Due, at least in part, to island residents' affinity for the Tram, it was ultimately decided to replace the Tram rather than to remove it. As part of the USD25 million renovation, the system was reconfigured to be two parallel independent single reversible trams (or a dual haul system) using the original tower and station infrastructure. The new system opened in November 2010. Today the tram carries more than 2.5 million passengers annually between Roosevelt Island and Manhattan.

Portland Aerial Tram, Portland, Oregon [3]

Around 2000, Oregon Health & Science University (OHSU) evaluated connectivity options for its main campus atop Marquam Hill. A tramway to connect the facility to the South Waterfront district gained attention and support following this and subsequent evaluations. The vehicle route between Marquam Hill and the South Waterfront involves a number of intersections, a steep hill and crossings of Interstate 5

---

[2] "Roosevelt Island Tramway". *Wikipedia.org*. Retrieved May 14, 2017.

[3] "Portland Aerial Tram". *Wikipedia.org*. Retrieved May 14, 2017.

and a number of other major thoroughfares. Because of these obstacles, a tramway became the preferred option for the connection.

In 2006, the Portland Aerial Tram opened its roughly 3300’ route using 2 x 78 passenger cabins in a jig back configuration. Most of the 1.4 million annual passengers are associated with OHSU although the system is open to public. The cost of the system was approximately USD57 million, far above the initial estimates, which led to some level of controversy.

Telluride Gondola Transit System, Telluride, Colorado [4]

In 1996, the Telluride Gondola Transit System opened to connect Telluride with Mountain Village. Prior to the gondola, the drive between the two towns was an 8 mile drive on typical mountain roads. The system was built to carry residents and visitors between the two towns with a total of five stations at select locations along the roughly 3 mile route. The system has become the default transit in the area and carries nearly 3 million passengers annually, free of charge. Planning efforts are under way to update and upgrade the gondola, including a desire to roughly double the system capacity.

Systems Under Consideration

Recent Studies

General descriptions of several urban cable proposals studied in the public realm are presented below. While many more studies of varying intensities have certainly been completed, those listed below are publicly available and involved serious consideration and analysis of their proposals. The background information provided is intended to generally summarize the proposal and its context.

Georgetown-Rosslyn Gondola, District of Columbia [5]

In early 2016, a study was commissioned to assess the merits of a connecting Georgetown with Rosslyn by way of a gondola. Georgetown is a part of the Washington, DC area and is home to Georgetown University; significant retail, dining and entertainment facilities; as well as a significant employment base. Georgetown does not have a local stop on the Metro subway system, the nearest of which is in Rosslyn, Virginia.

Rosslyn, Virginia is home to several large employers, including federal agencies as well as a variety of smaller employers. Rosslyn is making a significant effort to transform its image of an office community to a more vibrant multifaceted community. Employees working in Rosslyn enjoy convenient access to a Metro station located near the center of its commercial activity.

---

[4] “Gondola”. *tmvoa.org*. Retrieved May 12, 2017.

[5] “Georgetown – Rosslyn Gondola Feasibility Study Technical Summary”. *ZGF Architects*. November 3, 2016.

Georgetown and Rosslyn lie on opposing sides of the Potomac River; they are connected by the Francis Scott Key Bridge. The bridge, built in 1923, carries pedestrian, bicycle and vehicle traffic and it intersects other roadways at each of its ends. During certain times of day, bridge users can experience significant delays and congestion associated with traffic surges. The proposed Georgetown-Rosslyn Gondola was conceived to link the two areas and the Metro system in a way that would benefit current and future users from both sides of the river.

The study effort evaluated a variety of options with numerous alignments and station locations, eventually settling on a small number of viable, high-utility alignments. Broadly speaking, these alignments were roughly 3500' in length, with two stations. Minimum ridership was projected at roughly 6500 passengers per day, with potentially 10,000 or more daily rides. The total project cost was estimated to be USD80-90 million. Given the anticipated ridership and the current Metro fare structure, it was anticipated that the gondola would be nearly revenue neutral on a recurring annual basis.

Throughout the study, the primary potential barriers to building the system were identified to include:

Permitting Issues. The study effort identified no fewer than 20 agencies or bodies having some level of approval authority. It can be reasonably argued that this proposal encounters an unusually complex permitting environment. The study assessed that the project could be permitted, but that acquiring those permits may require 4-6 years.

Use of Public Funds. A number of parties, both organized and not, indicated concern that the Washington, DC area currently has many other infrastructure needs, on which public money would be better spent. This concern reflects not only the perspective that the link may not be a priority to most people of the area, but also that the mode is not understood as serious transit.

San Diego Skyway, California [6]

The Skyway is a proposal to connect San Diego Bay to Balboa Park. For years, it has been desirable to link the two iconic parts of San Diego with an effective transit mode connecting downtown, nearby neighborhoods and San Diego's premier park. The chosen route consists of 4 stations over roughly 4 miles, primarily along 6th Avenue. The system would cross both Interstate 5 and State Route 163, both significant roadways. The system is expected to serve around 3000-4000 commuters and tourists daily. Implementation costs were approximated to be USD65-75 million.

The study identified challenges to include the major highway crossings, placement in two historic zones and proximity to an airport. Even with these challenges, the study found the potential system to be feasible and was enthusiastic about it potential.

Banff, Alberta [7]

In 2015, the Town of Banff, Alberta commissioned a Long Term Transportation Study (LTTS) to review transportation alternative in the Town. The Town of Banff is located within Banff National Park, one of the country's most popular national parks. Visitation to Banff fluctuates by the seasons with many visitors coming within a 90 day summer window. Banff is a narrow town with few major roadways

---

[6] "San Diego Bay to Balboa Park Skyway Feasibility Report". *Parsons Brinkerhoff*. June 19, 2015.

[7] "Banff Long Term Transportation Study". *Stantec*. July 2016.

accessing its attractions and retail areas. Unsurprisingly, vehicular traffic within Banff can be significantly delayed during peak visitor periods.

The LTTS looked at a variety of transportation solutions, one of which was a transit gondola. The proposed gondola consisted of 5 stations over a total length of 4 kilometers. Project capital costs were estimated at CAD50 million. While the system was not expected to be revenue positive in the near term, it was projected that the public subsidy would be lower than other transit modes and that the subsidy would decrease over time.

The gondola proposal was expected to offer more frequent service than the current bus system with a more enjoyable ride. Major hurdles to implementation included permitting within the National Park, impacts to iconic views (both natural and built) as well as capital cost concerns.

Other Proposals

Many other gondola proposals have surfaced in locations throughout North America. Not only is it beyond the scope of this paper to describe all of them, but it would be a futile exercise to do so. Many of the proposals are not under serious consideration and have nearly no chance of advancing toward study or implementation in the near future. However, some of these proposals stand above the rest as having greater merit, greater support and a higher likelihood of reaching additional study and implementation.

Below are described our understandings of some of the more high-profile proposals and their status. It is not intended that all the relevant project details or reasoning are presented here, but rather enough information to facilitate the overall discussion of North American urban cable that is the subject of this paper.

Cleveland Skylift, Cleveland, Ohio [8]

The City of Cleveland, Ohio has a waterfront area along Lake Erie separated from much of the City by highways, railroads and waterways. The waterfront areas includes prime residential real estate, parks, retail opportunities and other tourist attractions. Cleveland Skylift is a proposed gondola to connect a number of these locations to each other and to other parts of the City. The proposal is currently championed by a private party who seeks to raise private funding for the system. The private party is in collaboration with the City, the Port of Cleveland and other interested parties to secure assurances that the system would be allowed and supported by authorities before advancing fundraising and additional study efforts.

Because the system proposal is under development, a precise description and scale cannot be provided. The proposal is to connect roughly 10-14 locations around the city in a phased approach. Phase 1 is envisioned as connecting a few core locations along the waterfront and near a transit location(s). Phase 1 would have 5 or 6 stations and a total length of roughly 3.5 miles. Future phases would depend not only on the success of the initial system, but also on the areas of interest to be connected.

Staten Island, New York to Bayonne, New Jersey

The Staten Island Economic Development Corporation (SIEDC) is championing a potential gondola to connect Staten Island (a borough of New York City) with Bayonne, New Jersey. Bayonne lies across the

---

[8] "Our Plan". *Clevelandskylift.com*. Retrieved May 4, 2017.

water from Staten Island and notably has rail transit connections to Manhattan and the rest of the New York City transit system. Currently, one way commutes from Staten Island to Manhattan may require 90 minutes or more by public transit. SIEDC expects the gondola connection could reduce that commute time significantly.

The proposed gondola would roughly parallel the Bayonne Bridge, connecting two stations separated by approximately one mile. SIEDC has issued a Request for Proposals to perform a more detailed study of the gondola's potential.

East River Skyway, New York, New York [9]

The East River Skyway is a proposal to connect the boroughs of Brooklyn and Manhattan near the Williamsburg Bridge. Brooklyn is a vibrant growing community separated from Manhattan by the East River. In particular, residents and businesses in the Williamsburg neighborhood of Brooklyn depend heavily on transit connections to Manhattan. While subway connections exist today, the East River Skyway proposal has received significant attention since those connections are planned to be completely interrupted in 2019 for repairs to the subway tunnel. This is expected to impact 100,000 one way riders or more on a daily basis for around 18 months.

The proposed initial Phase would connect the Williamsburg Bridge Plaza to the Williamsburg waterfront and subway connections near Delancey Street. The initial phase would be roughly 1.5 miles in length and is contemplated as a 3S gondola. Future phases of the East River Skyway would extend to locations along the Brooklyn side of the East River, where waterfront transit service is not currently favorable.

Chicago Skyline, Chicago, Illinois

The Chicago Skyline is a proposal to connect the Navy Pier (a popular tourist destination, event location and landmark) with Franklin Street Bridge and Millennium Park. The gondola would roughly parallel the Chicago River, requiring a series of bends in the alignment. Unlike most of the other systems on this list, this proposal is largely an attraction. As such, it should be expected that ridership would consist largely of tourists with some local contribution for whom the trip happens to be convenient or a leisure activity.

The system proposal has service to three passenger stations and a number of intermediate angle stations over a roughly 2.5 kilometer route.

Wire One, Austin, Texas [10]

Wire One is a proposal advanced by private parties interested in improving the overall commute in Austin, Texas. Austin has a central business area with typical North American characteristics. Traffic into and out of the area during commutes is heavy and congested; travel times can be unpredictable. Current transit is largely limited to busses which do not have dedicated lanes or priorities to prevent them from suffering the overall congestion. Further, residents and visitors make trips along the same major routes for daily activities such as dining and shopping.

The Wire One proposal would connect a series of stations along South 1st Street allowing commuters to access the system at locations of their convenience. The system proposal is under development, but would connect roughly 15-20 locations along an 8 mile route. As such, it is the longest and perhaps

---

[9] "East River Skyway". *Eastriverskyway.com*. Retrieved May 16, 2017.

[10] "Wire-One". *Argodesign.com*. Retrieved May 24, 2017.

most ambitious of the publicly known serious proposals in North America. The proposal's champions are in discussions with local officials to convince them of the system's merits as a public transportation element.

Evaluation

Comparisons to Other Modes

Like all modes of transportation, ropeways have both favorable and unfavorable characteristics. To further complicate the matter, some of the characteristics may be favorable in one situation and unfavorable in another. However, a few generalizations can be made to facilitate a comparative discussion:

Capital Cost. When compared to other dedicated path modes such as dedicated busways, rail lines or automated people movers, ropeways are generally less expensive. Unlike these other modes, ropeways require very little linear infrastructure between stations and the infrastructure required is generally much less expensive. For example, as noted above, the Georgetown-Rosslyn Gondola study estimated a total project cost of USD80-90 million. It is nearly inconceivable that separate infrastructure with similar capacity and a similar level of service could be constructed for a similar amount. Likewise, modifications to the Francis Scott Key Bridge, if possible and desirable, are likely to cost multiples of the projected gondola cost.

Short Implementation. Compared to other modes requiring new infrastructure, ropeways can be built relatively quickly. This is in large part due to the fact that ropeways require very little construction along the alignment. The primary construction activities are at stations, with comparably simple construction at tower locations. While case by case details will control, construction timelines of approximately a year or two are not unreasonable. This compares favorably to construction of a new bridge or roadway.

Aerial Clearance. One of the clear advantages of ropeways over other modes is that they are able to avoid obstacles by passing over them, often providing a comparative advantage. However, in some situations, the elevated operation of a ropeway is a disadvantage. This can be particularly true when implemented in an urban area where privacy rights and view impacts are important. While there are some solutions and mitigations for these issues, it cannot be denied that the cabins (typically) travel above ground level. This affords some viewing from the cabins and it places the cabins within some scenic views.

Route Flexibility. Like subways and other rail transit, ropeways have no route flexibility. Once the stations are built, changing the route essentially requires rebuilding it. When compared to busses, which have the flexibility to travel wherever roads are available, this can be a significant disadvantage.

Capacity. Depending on the particular technology chosen, ropeways can provide transit capacities from a few hundred to around 5000-6000 passengers per hour, per direction (pphpd). This compares favorably to nearly all bus operations. In gross terms, a modest-high capacity gondola is roughly equivalent to a bus serving any given stop every minute, or less. However, in very high demand scenarios, ropeways are unlikely to provide the capacity of subways or other full sized rail lines.

Travel Speed. One of the advantageous of ropeways compared to other modes is that the travel time is generally quite predictable. Unlike a bus route in a traffic-laden environment, the ropeway moves at a nearly continuous speed except for slowing at stations or for load/unload events. This makes the travel time between points – which is important to passengers - much more reliable than that of modes in traffic. Generally speaking, with a number of assumptions, this speed is roughly 10-12 miles per hour, including stations. In many situations, these speeds are faster than or comparable to busses in traffic. However, over long distances where a bus or other mode can achieve high speeds, ropeways compare unfavorably. Likewise, subways, which have dedicated rights of way, are able to achieve much higher speeds between stations, depending on their safety criteria.

Comfort. Modern North American public transit systems are increasingly concerned with and accommodating to passenger comfort. Climate control is present in nearly all new busses, light rails and subways. The large, heavy vehicles associated with these modes, combined with their availability of on-board power make providing air conditioning and heating nearly a trivial matter. This is an area in which ropeways traditionally trail other modes and the expectations of the commuting public. While solutions for climate control on ropeways are under development and are installed at a few locations, they are not currently the standard for ropeways.

Familiarity. While the basic technology of ropeways is old, proven and arguably mature, much of the public remains uneducated on the mode's potential. This is acutely problematic when that lack of familiarity exists in places where decisions on transit solutions are made. Urban planners, traffic engineer and others are, on the whole, becoming increasingly aware of the advantages and limitations of ropeways. However, a good understanding of the potential is the exception rather than the rule. Likewise, the travelling public is also not widely familiar with the mode. This compounds the image problem because even if the local official knows of the advantages of ropeways, the public may not take a ropeway solution suggestion seriously. Accordingly, a progressive planner may face ridicule from the public, their peers or their supervisors for suggesting a ropeway. This, of course, may impact their willingness to evaluate the mode seriously.

Operational Convenience. One of the most significant advantages of ropeways lies in their operations. Unlike busses and trains, ropeways and particularly gondolas have nearly continuous departures. Unlike trains and busses, there is no need to note the time of the next vehicle, since headways are generally between seconds and a few minutes. This allows passengers the freedom to travel without needing to carefully schedule their arrival for boarding. Broadly speaking, the passenger boards upon arrival rather than either hurrying to make a boarding or waiting a long time for the next one. However, this nearly continuous boarding has the downside that the cabins typically move throughout the boarding process. While recreational users are largely accustomed to boarding this way, some urban commuters are not. Cabins can be stopped in the stations as needed, and with growing exposure, commuters are likely to adjust to become familiar with boarding the moving cabins.

Opportunities

Reviewing the characteristics of ropeways, studies thereon and developing projects allows us to make some observations about where the greatest opportunities lie. It should be noted that these observations are not meant to exclude other opportunities, nor should they imply guaranteed success. Rather, the observations are intended to highlight the situations where an urban cable solution is likely to compare favorably with other transit modes.

Simple Alignments. Alignments which connect a few points rather than replacing, for example, an entire bus route compare favorably. Simple point to point or multipoint alignments are well proven applications of ropeway technology. While the technology may well be able to serve more complicated alignments, there is effectively no experience with such in North America. As a result, large networks are viewed skeptically, creating a higher burden of proof. Further complicating the matter is that complex alignments will naturally require larger systems at greater costs. Those greater costs result in greater perceived project risk. The combination of the high skepticism and the perceived higher risk are, in the near-term, likely to make implementation difficult. Accordingly, until there is greater acceptance of the mode, simple alignments are preferable.

Transit Over Obstacles. One of the most significant advantages of ropeways over other modes is the ability to cross obstacles with nearly trivial effort. Situations where there is an obstacle of some sort – natural or built – will create comparably greater hardship for other modes compared to ropeways; roadway diversions, bridges or tunnels can be complicated and expensive. Consequently, in a comparative analysis, ropeways can be favorable if a slope, a river, a highway, a rail line or other obstacles separate the stations.

Many Potential Applications. This paper has summarized a specific few of the more visible ropeway proposals. In fact, there are a great many instances where a ropeway may be appropriate. Some of those applications will be recognized by local authorities or professionals. Some of them will be recognized by private citizens who have no authority whatsoever on the transit solutions. Some of them will be recognized by people within the ropeway industry. For the last group, the burden lies with the industry to actively seek consideration of a ropeway. Conversely, those within the industry have the responsibility to provide honest – if sometimes unfavorable – assessments on system proposals.

Growing Interest in the Mode. Interest in urban cable solutions has grown dramatically in the last few years. It is beyond the scope of this paper to identify all the reasons for the increased interest, but a few reasons stand out. The cost profile of ropeways is certainly a factor. Private and public sector parties are trying to improve transit connectivity with increasingly constrained budgets. They are therefore looking for solutions – both traditional and non-traditional – which meet their needs at lower costs. Because of the success and visibility of some of the extant systems, those parties are finding that ropeways may offer favorable solutions.

Concerns

While there are many opportunities for urban cable in North America, there are also a number of concerns. These concerns present real barriers to widespread ropeway adoption, even if the concern is only a perception.

Need Government Support. As noted above, a number of proposals have been and will continue to be identified by private parties, whether individuals or institutions. While those proposals may gain momentum and may generate a great deal of press and interest, private interest is often not enough to advance a project. In most cases, government approval will be required to implement a project. In cases where the entire alignment is privately held, this may not be true, but those cases are few and extraordinary. The vast majority of projects will involve multiple landowners, public facilities, public rights of way or public funds. In those cases, government support is essential as it manages community assets. This is true even for privately financed projects if they cross, enter or abut the public domain. In addition to the system layout, government support can be important for financial reasons. Nearly all transit systems are subsidized by public funds. In the event that a ropeway system is not anticipated to be revenue positive, subsidies will be required. Government agencies are in a unique position to provide those subsidies and therefore government support may be critical to the project success.

Image Remains an Issue. While ropeways have advanced considerably in their ability to move passengers efficiently, the image remains an issue. The stereotype that ropeways are for resorts, tourist installations or for the county fair remains prevalent in North America. With increasing interest and publicity, that image has begun to change, but it is pervasive. Many people in the general public as well as in the transportation professions still do not consider ropeways as real transit. Overcoming this bias requires not only educating the population at large, but also providing project specific information when needed.

Creature Comforts. Providing a comfortable trip for the passengers is absolutely essential for the success of any optional transit system. As noted above, public expectations for comfort in transit have evolved significantly. Technical challenges justify both the history and resistance to providing heating and air conditioning, but public expectations for comfort are unmoved by the reasons, however rational those reasons may be. In some climates in the United States, it is nearly a fatal flaw to suggest that cabins will be unconditioned. *Unless and until* good solutions are developed *and offered*, the climate control discussion will weigh heavily against adoption of ropeways in transit.

System Costs v. Project Costs. To be sure, one of the advantages of ropeways is the low capital cost. However, it is important to understand that the ropeway is only a portion of the entire project cost. In many cases, particularly in an urban environment, the cost of the system is likely to be only a fraction of the entire project cost. Land acquisition, easements, station amenities, architectural treatments and so on can drive project costs ever higher. The relationship between the system cost and the project cost is impossible to prescribe, but ratios of between 1:2 and 1:6 should be expected, although outliers will certainly exist. The best available information should be clearly communicated at the outset of a project. Few things can damp the enthusiasm for the mode as can a series of highly publicized cost overruns.

Evacuation. One of the largest potential hurdles to wide adoption of aerial ropeways relates to emergency scenarios. For the vast majority of system faults, the system will experience either no interruption of service or a short stop followed by a restart. There are a few extraordinarily rare systems faults where the cabins cannot reasonably be returned to the stations. Under such circumstances, passengers must be evacuated from the cabins. Unlike terrestrial modes where passengers are evacuated to grade or to a walk platform, for an aerial ropeway evacuation typically requires vertical descent. Such an event is spectacular and should be assumed to be highly publicized. Without regards to statistics on injuries or dangers in an evacuation, the *perceived* danger is significant. The corresponding fear of such an event creates a hurdle which must be addressed both as an industry and on a project by project basis.

Maintenance. In typical resort applications, aerial ropeways operate for part of a day and have seasonal shutdowns. Urban applications require more rigorous operating schedules that may extend to 20 hours per day, nearly every day of the year. These more demanding operations require that maintenance be performed in short overnight periods. Larger maintenance operations may require multi-day shutdowns which, while not problematic in most resort scenarios, may be fatal flaws for an urban system. The rigors of the extended operating schedule suggest that it is prudent to select more robust components which can withstand the more rigorous operations. Further, a heavier inventory of spares and employing line replaceable units can help to facilitate the increased maintenance. For aerial ropeways to gain widespread urban adoption, these outages must be minimized and their needs must be clearly articulated.

Not a Panacea. Ropeways, like all modes, have parameters and characteristics where they are more favorable than other modes. However, cable solutions, also like all modes, have their limitations. Understanding those limitations at least as well as the benefits is important for the overall credibility of the mode. If urban cable is suggested in all situations, it will be difficult for people unfamiliar with the technology to recognize when there is a true opportunity. Potentially worse, a poor implementation as an early adopted case in North America would provide fodder for the many naysayers and critics of the technology.

Conclusions

While there are a few very successful examples in urban transit applications, ropeways system have not yet been widely accepted as a viable transit alternative in North America. There is however, significant and growing interest in in their potential to offer efficient transport under the right conditions. Many planners and transportation professionals are becoming introduced to ropeways and their competitive advantages over other modes. These advantages include the low relative cost, ease of avoiding obstacles and reasonable transport capacities. In addition, ropeways combine the convenience of low headways and effectively on-demand departures.

With a variety of backers ranging from public officials to private citizens, there are dozens of system proposals under serious consideration within the public domain. There is no way to know how many others are proposed privately, in confidence. From the authors' experience, it is certainly more than a few.

Under the right circumstances involving simple alignments and obstacles which confound other modes, it is likely that ropeways will increasingly be adopted for urban transit. This is expected to happen within the next few years. More ambitious projects with more complicated arrangements are certainly possible, but they are more likely to meet public doubt and resistance. As systems are studied, publicized and adopted in the near term, they will have the opportunity to demonstrate the potential for the technology, opening the door for more and larger implementations.