ROPEWAYS IN NORTH AMERICA
IMPACTS, BENEFITS AND OUTLOOK

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AUTHORS BIOGRAPICAL SKETCH

Jim Fletcher, P.E. 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.

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INTRODUCTION

History

Rope was first reported in use for aerial transport of personnel and goods in the rugged Asiatic countries of India, China and Japan in the 1400s.[2] Early ropeway development moved, we believe, from the Asiatic countries to Europe in the 1400s with the movement of goods as the main incentive for development. It is reported that the Spanish Conquistadors used ropeway technology in the gold mines of Columbia in South America circa 1530s. Between 1860 and 1870, the Germans and the British introduced the circulating monocable ropeways for material transport with what could be considered as significant installations.

The late 1800s saw the increasing use of the ropeway for moving materials especially precious metal ores in the mountain regions of North America. This was made possible by the development of wire rope technology in the mid 1800s when wire drawing and wire rope stranding techniques were developed. The British refined the wire rope manufacturing techniques that allowed for the production of smooth, lock coil track strand and thus the ability to significantly increase the through-put capacity of aerial ropeways. By 1900 hundreds of installations had been constructed to move minerals in the western United States. It is estimated that 4000 material ropeways have been built in North America since 1860.[3]

Material ropeways were used in both world wars in the 20th century to move military supplies. By the end of WWI, over 2500 aerial systems were in operation on the Italian-Austrian border[4]. Because of the prices for precious metals could not support mountain development of mining, the aerial ropeway did not see much advancement between WWI and WWII.

The systems used for material transport prior to WWII consisted primarily of two types, (1) the circulating carrier system supported by one or two fixed ropes (track ropes) and driven by a single hauling rope with power transmissions at the upper station or (2) the jig-back or reversible carrier system with a similar roping system as the circulating system. The circulating carrier system at that time were comprised of multiple carriers with pay loads of 300 to 1800 pounds and arrived at the stations at fixed intervals where the haul rope attachment devices were either manually or automatically uncoupled, some remained coupled but the most efficient were

[2] Dwyer, Charles F. "Aerial Tramways in the United States – An Historical Overview", OITAF-NACS Third Continental Symposium, August 1988, PP 178-192.
[3] McLellan, Robert "Historical Review of Unusual, North American Ropeways in the Post War Era", OITAF-NACS Sixth Symposium, September 1994, PP 245-265.
[4] Ibid

uncoupled, and the carrier loads were discharged. The carriers continued to move around large radius rails during the loading or unloading processes for their travel to the opposite station. Thus the system was called a circulating one. The hauling

rope was provided its traction by a large diameter wheel connected to a power transmission. Carriages that provided the housing for the haul rope attachment devices and the connection for the carrier utilized small wheels that traveled across the track ropes, fixed rails on the intermediate support towers and on the station rails. These systems are often referred to as bi-cable systems meaning there are one or two fixed ropes for supporting the carriers and one or infrequently two ropes for towing the carriers. The fixed ropes are called track ropes and historically have exhibited various constructions from stranded to lock coil. The towing ropes which are referred to as haul, traction or circulating ropes almost always exhibit stranded construction with six strands each made up of from 15 to 40 wires.

The jig-back carrier system used either one (single reversible) or two (double

reversible) larger carriers connected end-to-end by a single rope with the carriers reversing at each station. In the 1920s and 1930s, the maximum carrier pay load was less than 3000 pounds. In either system the stationary ropes provided for the support of the carriers and a track on which they could operate. The jig back carrier systems were limited in their through-put capacity in tons/hour (tph) by the fact that there were at most only two carriers and as the length of the system increased the capacity decreased. Either system was limited by the maximum size of the rope and the strength grade of the wires that could be manufactured at that time. As the vertical difference between the stations increased, higher rope tensions were required.

In addition the monocable circulating system was used but did not provide the ability to transport larger capacities, 100 to 200 tph, in the mountain regions. One exception to the capacity limitation even though the vertical transport was only 100

feet was a tram used at the Hollinger Gold Mining Company in Ontario, Canada.[5] This system was used to transport sand and gravel for backfilling mines, provided a through-put capacity of 190 tph, traveled at a speed of 525 feet per minute (fpm) and had a carrier capacity of 1900 pounds. This through-put capacity or the carrier capacity would not have been possible with the more typical steep gradients, up to 35°, experienced in mountain mining regions.

For the period from the late 1800s until the 1970s, most material tramways were of the bi-cable circulating type since they could typically deliver much higher through-put capacities over longer distances than could the jig-back type system. Typically these ropeways delivered at peak times 50 to 300 tons per hour. Prior to the 1930s, remarkably, given the limitation of rope technology this type of tram could deliver 6000 tons per day.[6] During the period prior to 1940, this type of material ropeway offered a great deal of flexibility to the mining industry as demonstrated by the application at the San Francisco Del Oro mines near Parral, Mexico where the system traveled 3000 feet underground thus eliminating a costly transfer. Additionally, during this period a tramway 54 miles in length operated in Columbia, South America using multiple powered sections where the carriers were automatically uncoupled and recoupled at intermediate stations with the towing ropes and power transmissions being independent for any section.[7]

Relative to material ropeways the latter half of the 20th Century saw a relative decrease in the importance of the these systems as compared to trucks. This can primarily be attributed to the economics involved in the investment in trucks as compared to aerial ropeways. With road construction being highly financed by public entities, the costs of building and maintaining roads were not a part of the consideration when comparing the life-cycle costs of aerial rope systems to trucks in a typical mining operation. Certain applications of material ropeways did counter this situation. One was the use of the ropeway for transport of tailings from coal

[5] Metzger, O.H. "Aerial Tramways in the Metal Mining Industry-Part 1", Bureau of Mines Circular 6948, September, 1937, Page 4.
[6] Ibid, Page 6.
[7] Ibid

processing plants to remote mountain dump sites in the Eastern US. From 1950 to the 1970s, Interstate Tramway Company supplied most of the material ropeways in North America. Other manufacturers included Riblet Tramway Company and Heron Engineering. Worldwide Breco dominated the post WWII material tramway manufacturing.

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 know world wide. Other cites in the United States and Canada started to utilize funicular railways at various locations in the early 1900's.[8] In the 1890's, a funicular railway was constructed in Los Angeles from a station at Rubio Canyon to the peak of Echo Mountain, 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.

The one urban-transport aerial ropeway system in North America is the Roosevelt Island Tramway which was started in 1976 to provide passenger transport from the Roosevelt Island residential community to mid town Manhattan traversing the East River. It was recently modernized in 2010.

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

In the late1960's the automated people mover (APM) was conceived and implemented in North America. The rope propelled systems have played a role in this development of APMs since the early years of use. In May of 1981, the VSL Metro Shuttle began carrying passengers at the Circus Circus Hotel in Las Vegas. In 1982 the Mud Island Monorail, the first automated suspended shuttle, began operation in Memphis, Tennessee.

In 1994 the first airport rope propelled automated people mover was delivered at the Cincinnati Airport. The system used air flotation to provide a high-quality, ride comfort.

Automated application of the rope-propelled system has been further utilized for connecting remote parking areas to office buildings or museums such as the Mystic Center in Boston completed in 1997 and the Getty Museum completed in 1996. Additionally, the

rope system has been used at the Huntsville Hospital in Alabama; Oregon Health Center in Portland and the Clarion Hospitals in Indianapolis, Indiana to connect facilities to eliminate duplication of services.

The automated rope-propelled systems have continued to be applied at casinos such as the DCC system connecting three hotels in Las Vegas, Nevada.

The dual lane shuttle system with two 5 car trains providing 3200 pphpd connects the Luxor, Mandalay Bay and Excalibur hotels.

The ropeway has been used in various other applications in North American including ski resorts starting with the chairlift in the 1930's; theme parks; state and federal parks; access to telecommunications and radar dome sites and construction of bridges and dams. The ropeway was a center of attraction at two World's Fairs in North America, the Mississippi Aerial River Transit in 1984-1985 in New Orleans and the Vancouver Expo in 1986 in British Columbia.

The aerial ropeway was used to transport personnel to mountainous mining regions in North America starting around 1900.[9] During the period from 1900 to 1920 bicable gondola systems were used for transporting passengers for sightseeing.

In 1934 the T-Bar surface lift for skiing was invented by Ernst Constam, a Swiss engineer, which led to the installation of the first chairlift, a single seater, in 1937 at Sun Valley, Idaho by American Steel and Wire in collaboration with engineers of the Union Pacific Railroad.[10] In 1946 Heron Engineering installed the first double chairlift, a bicable, at Berthoud Pass, Colorado. Post WWII ski area growth flourished with the return 10th Mountain Ski Troops and thus the expansion of the use of various ropeways at resorts in North America. From 1960 to 1990 approximately 1300 passenger aerial ropeways for skiing were installed in North America at resorts in the United States and Canada. In 1981 the first four-passenger detachable chairlift in North America was installed at the Breckenridge ski area in Colorado. During the period from 1960 to 1980 there were few enclosed cabin passenger ropeways installed in North America as the chairlift provided a skier-accepted, economical means of uphill transportation for the resort marketplace.

As skiing developed from the mid 1980s until today, the customer demanded more comfortable, higher speed uphill transportation and thus more, higher capacity gondolas and detachable chairlifts have been built. As skiing has become more attune to the customer as well minimizing environmental impacts, the total number ropeways built since 1990 has decreased dramatically from what was experienced between 1960 and 1990. These new lifts, though, carry many more passengers at higher speeds thus allowing more skiing time.

[9] Dwyer, Charles F. "Aerial Tramways in the United States – An Historical Overview", OITAF-NACS Third Continental Symposium, August 1988, P182

[10] McLellan, Robert "Historical Review of Unusual, North American Ropeways in the Post War Era", OITAF-NACS Third Symposium, August 1988, P 64

Purpose

The purpose of the analysis and discussion that follows is to provide the historical ***Impacts and Benefits*** and to provide ***Outlooks*** for rope transportation in North America for the next 25 years. What have been the major contributions of rope transportation? What have been the primary benefits and setbacks? What markets have the most potential for ropeways and what are the limitations for the ropeway in those markets?

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

IMPACTS

The ropeway development in North America to date has been comprised of two distinct periods. The first, the use of the ropeway for gold and silver ore transport, had a dramatic impact in the late 1880s but was short lived in its intensity as the price of these metals crashed in the late 1890s. Throughout the 20th century the material transport ropeway continued to be used, but its economic impact was relatively small.

Ski Resorts

The second impact period for ropeway technology began in earnest in the 1960s as a means for passenger transport in the developing ski resort industry. Current statistics[11] indicate that there is over 2000 functioning rope systems in North America most of which are operating at ski resort for winter tourism. Data collected through research,[12] indicates that for the period 1964 to 2011, 47 years, that approximately 3000 chairlift, gondola and aerial tramway rope systems were installed at resorts in North America.

[11] National Ski Areas Associate, www.nsaa.org Active Tramway Database, Sid Roslund,Technical Director, 133 South Van Gordon St, Suite 300, Lakewood, CO. 80228, (303) 987-1111, sidr@nsaa.org.

[12] Ski Area Management, SAM, Lift Sold Data Editions, 1964-2011, 45 Main Street N, Woodbury, CT 06798, (203) 263-0888, www.saminfo.com,

The following Figure 1 shows the number of passenger chairlift ropeways that are still being operated, constructed in 5-year intervals since 1945. As was discussed in detailed research that I presented,[13] there is a significant back log of obsolescent ropeway equipment that is currently being operated that will have a major impact on future investment. In considering the ski resort market segment, the future for rope systems lies in replacement of current systems due to obsolescence. Obsolescence occurs because a system can no longer perform as designed or no longer provides the comfort or capacity required by the user.[14] According to the data supplied by Sid Roslund at NSAA, the average age of the fixed grip chairlift is 25 years; the detachable grip chairlift is 15 years; the gondola is 26 years and the tramway is 25 years. Based on empirical data, it can be deduced that the expected obsolescence of a chairlift occurs between 20 and 25 years; that of a gondola between 25 and 30 years and that of a tramway from 35 to 40 years. At first glance it would appear that the ski resort rope transportation systems in North America are reaching a point where there obsolescence may limit passenger acceptance or challenge acceptable operating standards based on current codes.

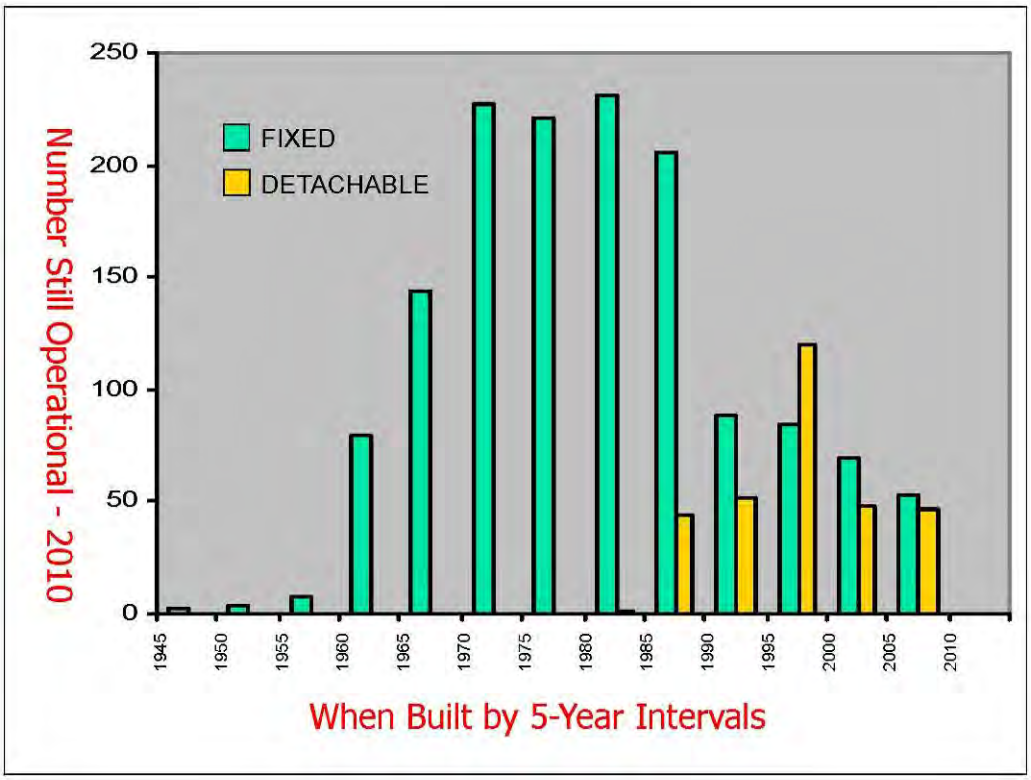


Figure 1 – Passenger Ropeways Constructed

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

[14] Farwell, Ted, "Economic Retirement Criteria for Ski Lifts," Vail Aerial Tramway & Ski Safety Seminar Proceedings, 3rd Annual, August 23, 1983.

Automated People Movers

Rope propelled people movers made their mark in North American initially in the recreational gaming industry in Nevada in the 1980s and continues to grow and expand in this market. Currently, there are six systems operating in the gaming market in Nevada as detailed in Table 1. In the recreational and institutional markets there are a total of 9 systems operating so it is apparent that the Nevada gaming industry has been a major factor in the development of the rope-propelled people mover with over 100,000 passengers per day.

OPERATOR	YEAR BUILT	PASS/DAY	MANUFACTURER
Circus Circus - LV	1981	4000	SDI
Circus Circus - Reno	1986	6000	SDI
Mandalay Bay - LV	1989	75000	DCC
Mirage Treasurer Is	1994	5000	SDI
Primadonna	1990	5000	SDI
City Center – LV	2009	10000	DCC
Mud Island – TN	1981	2000	SDI
Getty Center – CA	1997	15000	Otis
Huntsville – AL	2002	2000	Otis

Table 1 – APM Rope Systems – Leisure & Institutional

Presently there are 26 automated people movers operating at airports in North American with an average daily ridership of 1,100,000.[15] Six of these systems are rope propelled systems with an average daily ridership of 150,000. Worldwide there are 49 systems operating at airports with a total average daily ridership of 1,800,000 including 9 rope-propelled systems with a total daily ridership of 230,000. The following Table 2 lists the current worldwide applications of rope systems operating at airports.

AIRPORT	YEAR BUILT	PASS/DAY	MANUFACTURER
Cincinnati – OH	1994	35000	Otis
Detroit - MI	2002	50000	Otis
Mexico City - Mexico	2007	25000	DCC
Minneapolis – MN	2000	10000	Poma-Otis
Minneapolis – MN	2004	7000	Poma-Otis
Toronto - Canada	2005	25000	DCC
Birmingham – UK	2003	10000	DCC
Tokyo – Narita	1992	40000	Otis
Zurich – SW	2003	30000	Poma-Otis

Table 2 – APM Rope Systems - Airports

As shown above the two most developed market segments are ski resorts uphill transit and airport automated people movers which have made the most impact for ropeway technology in North America in the last 50 years. In both of these

[15] Fabian, Lawrence, Airfront.21, www.airfront.us, lfabian@airfront.us.

marketplaces, the ropeway has been able to provide the most economical means for transporting passengers and thus has provided more capital for economic expansion. Based on my empirical analysis, automated people mover systems would not have been utilized in the gaming resorts in Nevada without the economic advantage provided by the rope system when compared to other conventional urban transport.

Classical Systems

Aerial ropeway systems have been used in various applications outside the ski resort marketplace. In fact before skiing became commercial venture starting in the late 1930s, gondolas were used in various site seeing applications in North America. An early ropeway for passenger transportation was constructed in Knoxville, Tennessee to cross the Tennessee River in 1893.[16] One of the longest operating ropeways for carrying passengers began operation at Niagara Falls, New York in 1916 and operated until 1984 when it was replaced with another ropeway. A early notable ropeway that was used for both skiing in the winter and sightseeing in the summer is the Cannon Mountain, New Hampshire double reversible ropeway completed in 1938.

Several other installations used primarily sightseeing systems have been built over the last 50 years. Two notable exceptions include the Roosevelt Island Tramway in New York City and the Portland Aerial Tramway in Portland, Oregon. The Roosevelt Island Tramway is the only aerial ropeway operating in North America that is truly an urban transport system providing convenient daily service for 2,000,000 people yearly between Manhattan and Roosevelt Island located in the East River. The tramway originally put into service in 1975 was recently modernized to provide two independent reversible tramways operating on a common set of towers. The tramway is owned and operated by the Roosevelt Island Operating Corporation, a subdivision of the State of New York.

The Portland Aerial Tramway connects two hospital centers of the Oregon Health and Science University (OHSU), one on Marquam Hill with another on the South Waterfront. The tramway allowed the use of marginal land for the expansion of hospital to provide increased

[16] Dwyer, Charles F. "Aerial Tramways in the United States – An Historical Overview", OITAF-NACS Third Continental Symposium, August 1988, P182

patient, education and research needs with easy access between the two campuses. OHSU provided most of the money to build the system and provides operation and maintenance services while the City of Portland owns the system as part of the transit network.

BENEFITS

The benefits of ropeway transport in North America can be categorized into three areas:

- **Economic**
- **Safety**
- **Environment**

Economic

For the skiing industry in North American, the ropeway and its technological improvements over the last 50 years have been the major economic drivers for the growth of skiing. Today there are approximately 75,000,000 skier-day visits to North American Resorts. From previous analysis[17] the capital depreciation generated cash from skiing operations of approximately $10 per skier-day. This cash therefore could potentially be leveraged into investment of $40 per skier day or $3,000,000,000 annually. The total revenue from skiing today is approximately $75 per skier day or $5,650,000,000.

Ski resorts in North America employ approximately 155,000 persons during the winter months and 27,000 in the summer months.

For the automated people mover industry in North America, the rope-propelled system has provided a much more economical solution for lower capacity systems than the traditional rail technologies. Thus, the recreational gaming markets in Las Vegas have been able to incorporate rope propelled automated technology into their developments. Rope-propelled systems in this industry have been applied from $7,000,000 to $20,000,000 per mile whereas typical rail systems range in cost from $40,000,000 to $100,000,000 per mile for these capacities.

In the airport market the self-propelled systems with on-board vehicle power have historically dominated the market. Currently in North America, 25% of the airport systems operating are rope-propelled systems, but they carry 14% of the riders. Worldwide at airports 18% of the systems are rope-propelled and carry 13% of the riders. From this it can be seen that the rope-propelled systems service the lower capacity applications, but they do provide an economic benefit for the customer especially in infrastructure cost reductions due to the lighter vehicles.

[17] Fletcher, Jim “Future Perspectives of Ropeways in North America”, OITAF-NACS Tenth Symposium, August 17-19, 2009, Lakewood, Co, P 9.9

With recent development of the detachable-grip technology being utilized for the rope propelled system, they are able to bring cost advantages to higher capacity systems as was seen for the Zurich Airport system and more recently for the BART-Oakland Airport Connector system.

Safety

When compared to other means of transit in North America, the ropeway has an excellent record. During the period 1960 through 2010 there were approximately 2,800,000,000 skier-day visits to resorts in North America.[18] Based on historical assessments, there are approximately 5.5 rides per skier-day over the last 20 years. Prior to that there were approximately 7.5. Using these numbers, the total number of rides would total approximately 18,200,000,000.

Further it is estimated that the average passenger ride encompasses 0.7 miles giving a total of 12,740,000,000 passenger miles. From Table 3 – Ropeway Accidents North America, the total fatalities from 1960 through 2010 is 21 for a rate of 0.001154 per million passengers or 0.001648 per million passenger miles. In other words, there is one passenger fatality for every 900 million passengers carried on ropeway systems which exceed maximum safety requirements for automated transit systems where safe is defined as one in 100 million.

[18] National Ski Areas Associate, www.nsaa.org, 133 South Van Gordon St, Suite 300, Lakewood, CO. 80228, (303) 987-1111.

The following Table 3 lists the major ropeway accidents during the last 50 years[19].

LOCATION	DATE	FATALITY	INJURY	COMMENT
Nebraska Fair	7/65	2	48	Gondola-Tower Failure
Raton Pass, NM	6/68	1	7	Chairlift-Rollback
Pomerelle, Idaho	1/73		10	Chairlift-Rollback
Vail, CO	3/76	4	5	Gondola TR Wire
Jiminy Peak, MA	1/77		10	Chairlift Deropement
Hunter Mountain, NY	1/78		4	Chairlift Rollback
Squaw Valley, CA	4/78	4	32	Tram-TR Derope Wind
Heavenly, CA	4/81		17	Chairlift-Deropement
Big Powderhorn, MI	2/84	1	8	Mechanic in BW
Keystone, CO	12/85	2	48	Chairlift-BW Failure
Maple Mtn, MI	12/89	1		Tow-Clothing Caught
Sierra Ski Ranch, CA	4/93	1	1	Grip Caught in Sheave
Whistler, B.C., Canada	12/95	2	10	Chairlift-Grip Detach
Snow Valley, Ont., Can	12/96	1	1	Chairlift Deropement
Lutsen Mtn, MN	8/00		6	Gondola-Grip Failure
Angels Flight, L.A., CA	2/01	1	7	Funicular-Brake Failure
Mt. Sunapee, NH	12/07		1	Chairlift-BW Derope
Blackcome, B.C., Can.	12/08		10	Gondola-Tower Failure
Heavenly, CA	9/09	1	1	Zip Caught Chari
Devils Head, WI	12/09		14	Chairlift-Rollback
Sugarloaf, ME	12/10		8	Chairlift-Deropement

From information published by the U.S. Federal Aviation Administration, there were 1482 fatalities with 12,890,000,000 passengers for the period 1991 through 2010 for a rate of 0.1150 per million passengers and 3277 fatalities with 19,180,000,000 passengers for the period 1960 through 2010 for a rate of 0.1701 per million passengers. According to the Bureau of Transportation Statistics, www.bts.gov, the passenger miles flown from 2000 through 2010 was 5,894,365,632,000 or an average of 535,851,421,000. Using this as a 20 year average from 1991 through 2010 would yield a total of 10,717,030,000,000. The fatality rate for this 20 year period would therefore be 0.000138 per million passenger miles.

From statistics published by the U.S. Department of Transportation, transit ridership for all modes totaled 84,000,000,000 for the period 1998 through 2007. Using this period, it is estimated that the total transit ridership for the 21 year period from 1990 through 2010 was 176,400,000,000. The total fatalities for this period were 5681 for a rate of 0.03221 per million passengers.

[19] Visual Compendium of Ropeway Accidents, AAA Snow Sports, Illicit snowboarding Blog

For the period, 1998 through 2007, the total passenger miles traveled were 423,000,000,000 and for 1990 through 2010, the total passenger miles traveled were 830,783,000,000. Thus the fatality rate was 0.006840.

For transit the modes included in this analysis were:

- Automated Guideway
- Commuter Rail
- Demand Response
- Heavy Rail
- Light Rail
- Motor Bus
- Van Pool

The following Table shows the comparisons among ropeways, commercial airlines and transit in North America for fatality rates based on passengers transported.

COMPARISON	FATALITIES	PASS ($x10^6$)	RATE	PERIOD
Ropeways	21	18,196	0.001154	1960-2010
Airlines	3277	19,180	0.170100	1960-2010
Transit	5681	176,400	0.032210	1990-2010

Table 3 – Fatality Rate per Million Passengers

The following Table shows the comparisons among ropeways, commercial airlines and transit in North America for fatality rates based on total passenger miles.

COMPARISON	FATALITIES	PASS MILES ($x10^8$)	RATE	PERIOD
Ropeways	21	127.4	0.1648	1960-2010
Airlines	1482	107,170	0.0138	1991-2010
Transit	5681	8,308	0.6840	1990-2010

Table 4 – Fatality Rate per 100 Million Passenger Miles

From a report published by the National Ski Areas Association[20] , the following Table was presented,

COMPARISON	YEARLY PASS MILES ($x10^6$)	AVERAGE # OF FATALITIES/YR.	RATE PER 100 MILLION MILES
Ski Lifts	224.25	0.324	0.144
Elevators	1,360	6.000	0.441
Automobiles	2,925,000	39,000	1.330

Table 5 – Fatality Rate comparison (NSAA)

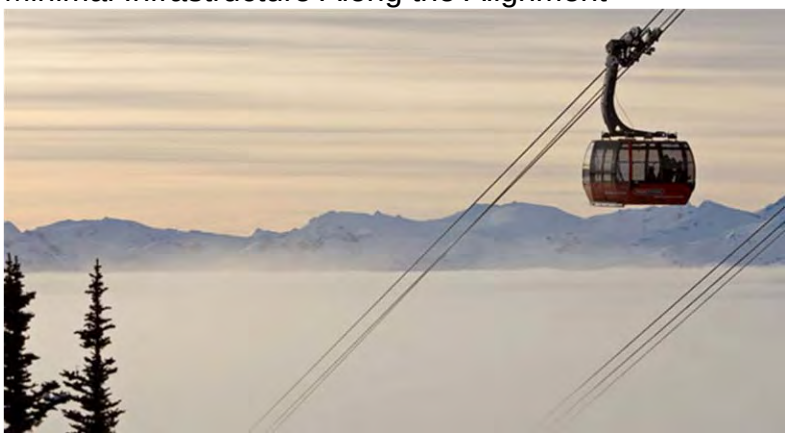
[20] NSAA Lift Safety Fact Sheet, January 12, 2011, Page 2, National Ski Areas Associate, www.nsaa.org, 133 South Van Gordon St, Suite 300, Lakewood, CO. 80228, (303) 987-1111.

When considering the number of passengers carried, it is evident that the passenger ropeway is the safest means of travel over the last 50 years. In considering passenger miles, commercial air travel is the only one that provides a lower rate than ropeways. It is not clear, though, that airline travel is less risky since the average miles traveled per passenger is much greater for airline travel than for the ropeway. Statistics show that for the last 20 years the average travel distance for a commercial airline passenger is 830 miles versus that of the ropeway of 0.7 miles. The average transit rider travels 4.7 miles. Further, the ropeway statistics encompass 50 years of history versus that of the airlines for the miles traveled comparison encompasses 20 years.

Environment

The benefits relative to the environmental impacts and sustainability of ropeway transport and its infrastructure have been highlighted in several presentations previously. They include,

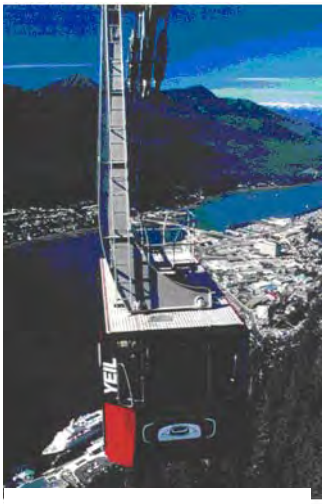
- Minimal Infrastructure Along the Alignment



Whistler – Blackcomb –CAN

- Transportation in Biologically Sensitive Areas
- Minimal Use of Resources per Passenger-Mile of Transport

Skyrail Rain Forest



Mt. Roberts - AK

- Minimal Visual Impact

The Environmental Charter subscribed to by skiing resorts in North America promotes sound environmental stewardship and, more importantly, offers a comprehensive set of 21 Environmental Principles that enable ski area operators to make sustainable use of natural resources. The Principles are the key to the Environmental Charter and address the following topics:

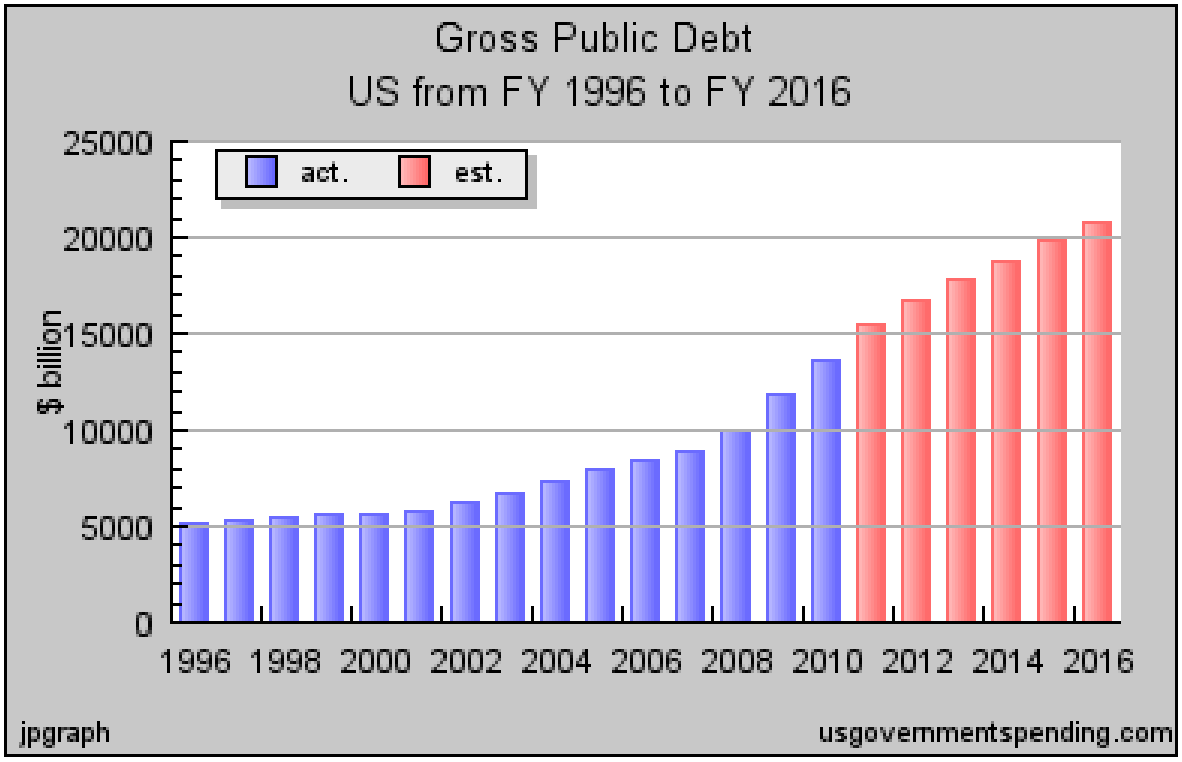
1. Planning, Design, and Construction
2. Water Use for Snowmaking
3. Water Use in Facilities
4. Water Use for Landscaping and Summer Activities
5. Water Quality Management
6. Wastewater Management
7. Energy Use for Facilities
8. Energy Use for Snowmaking
9. Energy Use for Lifts
10. Energy Use for Vehicle Fleets
11. Waste Reduction
12. Product Re-use
13. Recycling
14. Potentially Hazardous Wastes
15. Fish and Wildlife Management
16. Forest and Vegetative Management
17. Wetlands and Riparian Areas
18. Air Quality
19. Visual Quality
20. Transportation
21. Education and Outreach

The ropeway promotes and allows many of the above principals to be implemented and realized.

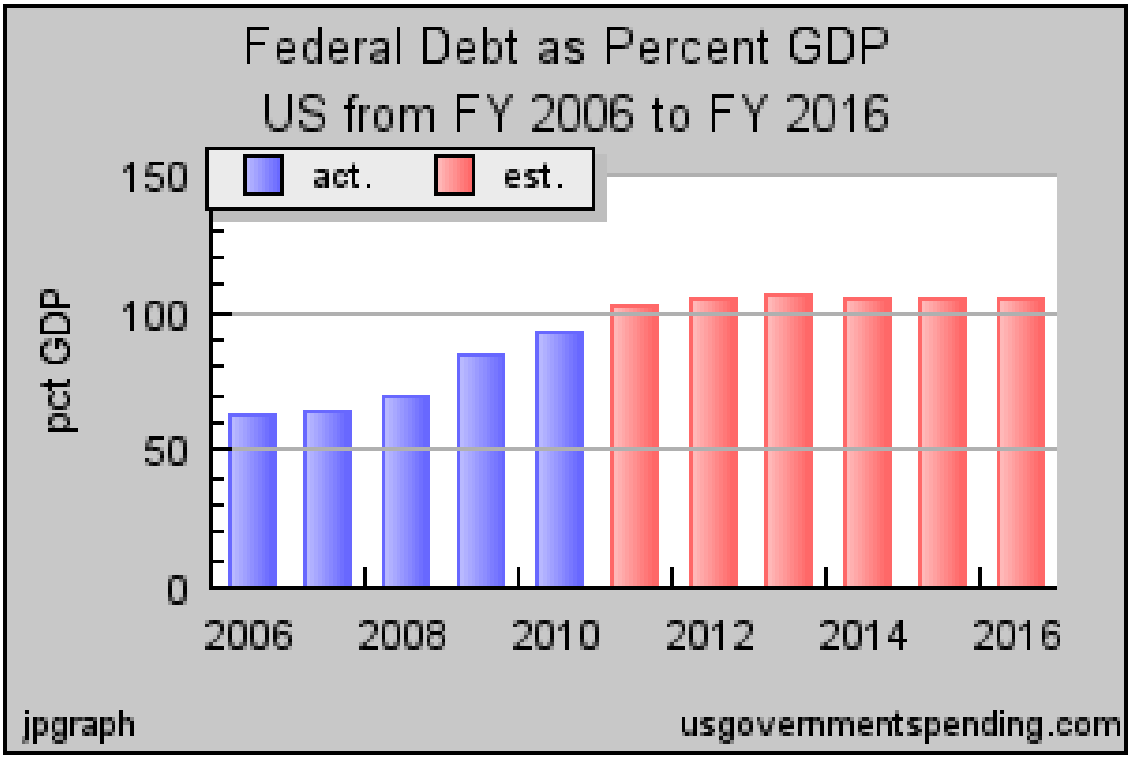
OUTLOOK

The outlook for the next 25 years has to be viewed through the larger glasses of the overall economy. The five-year outlook relative to the economy in North America is not positive. If one analyzes the markets defined in this presentation, it is apparent that the future growth is driven by the markets in the United States. Even though today the Canadian dollar is much stronger than the US dollar due to the debt to GDP ratio and the current deficit in the United States, the Canadian economy size

will not overcome a lack of growth in the US markets. Mexico has not and will not play any significant role in the ropeway markets during the next 25 years.

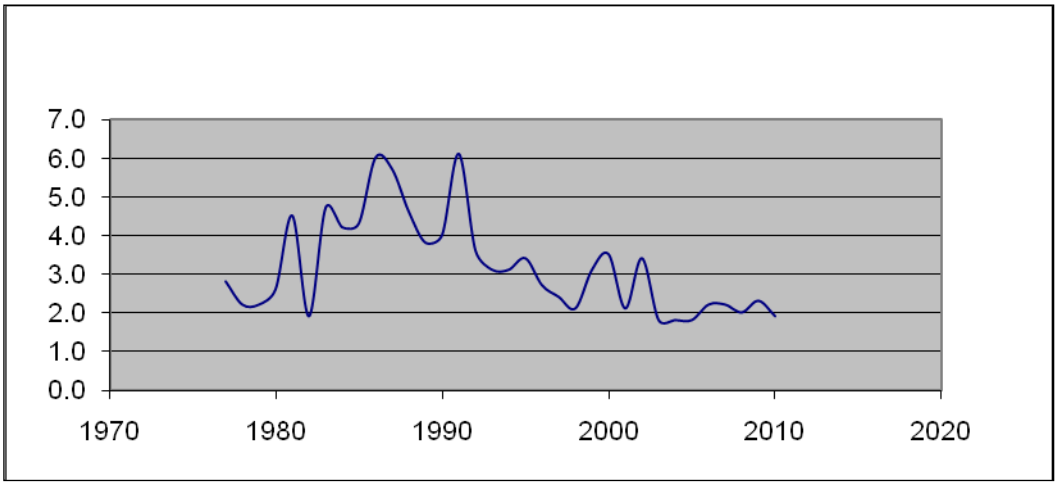


Given the stormy outlook for the overall economy in North America, the malaise will eventually end and growth will accelerate sometime between 2017 and 2020. The good news that counters the profligacy of our federal and state governments in the United States and their current financial condition is the fact that the private sector business have been making money and conserving cash including the ski and gaming resort operators. If they can continue to weather the next five years, then their investments will be able to drive the ropeway industry in North America.



Further, it appears that airports, the largest user of automated people movers is also in a good position for growth when the economy rebounds. These projects will take longer to materialize due to the complexities of the procurement and funding mechanisms.

Currently the health of the ski resort operator is good even though the overall economy in North America has not done well since 2008. The following chart shows the ratio of debt to EBITD (earnings before interest, taxes and depreciation) from 1977 through 2010.



As can be seen this ratio has been trending down since 1990 with an acceptable ratio of 2.0 or less which means that resorts have strong balance sheets that will drive investment. Further, considering that a significant amount of equipment currently being operated is older than 25 years the environment both on the supply side, cash for investment, and the demand side, the need for modernization, is excellent for expansion of the ropeway industry in North America. The capital expenditures for ropeway equipment in the United States since 2004 have totaled $437,700,000 for an average over the seven years of $62,500,000. Based on a study in 2005 by the author,[21] a conservative estimate of the required annual VTFH[22]replacement is 200,000 and the cost per VTFH, considering inflation is estimated at $1,050 giving a total of $210,000,000 which exceeds the average for the last 7 years by 3.5 times.

Additionally, this required annual investment of $210,000,000 is well within the capability of the ski resort financing given the cash flow per skier day of $10.00 leveraged 4 times yielding $3,000,000,000 in total investment capital available.

Considering the airport market for ropeway systems over the last six years does not give one a good feeling about what the next 5 or 10 years might bring. Since 2008 the overall investment in the airport people movers has been reduced due to the general overall economic conditions as well as the continued emphasis toward

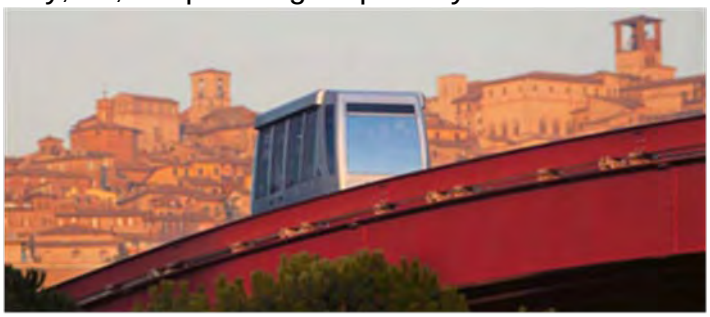
[21] Fletcher, Jim "Future Perspectives of Ropeways in North America", Page 9, OITAF-NACS Tenth Symposium, August 17-19, 2009, Lakewood, Co
[22] VTFH is the vertical transport feet per hour. To obtain VTFH for any lift, multiply the vertical rise by the hourly capacity and divide by 1000.

airport security. Since 2005 there has been one ropeway system built at an airport worldwide although there are currently two under construction in Cairo and Doha. A system was built at the Mexico City airport completed in 2007 while during the period from 2000 through 2005 there were six systems built worldwide.

Mexico City Airport

Larger institutional rope-propelled APMs have been installed since 2005, one at City Center in Las Vegas transporting 10,000 passengers per day; one at Oerias in Lisbon, 1000 passenger per day; and one in Perugia, Italy, 30,000 passengers per day. There are two major rope-propelled projects currently being implemented, one in Caracas totaling $75,000,000 in system equipment and one in Oakland totaling $100,000,000 in system equipment.

City Center



Perugia

Oakland

Given the above history during the last six years and the uncertain economic climate over the next 5 to 10 years it is problematic that much growth will be experienced in the ropeway markets in North America. When the economic conditions dictate, the ropeway will present a

cost effective solution for both the airport and leisure markets.

CONCLUSIONS

The ropeway has a long and varied history in its application in North American. When applied using state-of-the-art engineering and manufacturing principals, ropeways have provided safe and reliable transportation. Ropeway systems in North America have transported more than 18 billion passengers during the last 50 years! Currently the ropeway systems in North American transport annually 1.5 times the total population of North America which is 330,000,000, excluding Mexico!

The investment capital available to forestall the obsolescence of ropeway equipment in the very mature ski resort market is adequate. The resort balance sheet is healthy and can take on this investment. Investments between $200,000,000 and $250,000,000 annually will be required. A more critical factor is the capacity of the manufacturing sector to respond. The general economic conditions will stymie this investment for at least the next 5 years. The APM market for ropeway systems being less mature than the resort ropeway market does not provide as much clarity as to the future.