Future Perspectives of Ropeways In North America

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Ropeways in North America have a varied history of use over the last one hundred and thirty years. In the late 1800's tramways were used to exploit minerals in the mountainous regions and still have some use in coal transportation today. In the 1930's the ropeway started to be used in ski resort areas as a chairlift. The advance of the use of ropeway systems over the next 50 years was concentrated in the resort and recreation business. More recently, the ropeway has been applied as a propulsion device for transit systems in airports and urban centers.

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INTRODUCTION

History

The ropeway as a transport device has a history in several market segments. Early in its use in North America in the second half of the 1800's, the ropeway provided a transport mechanism for materials including iron ore and precious metals. In the late 1800's and early 1900's the ropeway in North American was exploited for transport of coal as well as other materials. The coal tramway in North American was revolutionized by Interstate Equipment Company in that higher capacities could be moved utilizing a circulating systems of cars. With this development, capacities of 360 tons per hour were achieved.

The ropeway as a 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. In Los Angeles, California in 1901, Col. J.W. Eddy persuaded the City Council to grant him a 30-year franchise to construct and operate an incline railway on Bunker Hill to allow people to get from the shopping and business districts at the bottom of the 315 foot tall hill to the houses at the top..

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. A 3,000-foot-long funicular, it climbed to the 900-foot-high summit of Mt. Washington. Conceived by a real estate speculator to help develop his choice view lots and a hotel at the summit, it operated until 1922. 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%. From there the railroad ran small but conventional cars over a steep, sharply curved track all the way to the summit of Mount Lowe, climbing another 1,500 feet in just 3.6 miles. Hotels were built at each station which provided for land development in early Los Angeles. Two incline railways were built on Santa Catalina Island in 1904 to move visitors up from the beach to the hotel.

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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. Also, some of Pittsburgh's finest restaurants are located just a short walk from the incline's upper station. 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.

In the late1960’s the automated people mover (APM) was conceived and implemented in North America. The cable 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. The system represented a fully automated 1500 foot single reversible, two 50 passenger car installation. The system provided 1000 passengers per hour per direction (PPHPD).

In 1982 the Mud Island Monorail, the first automated suspended shuttle, began operation in Memphis, Tennessee. The system utilizes two 180 passenger vehicles suspended from carriages which travel along a guideway beneath a pedestrian bridge. The system capacity is 3000 pphpd.

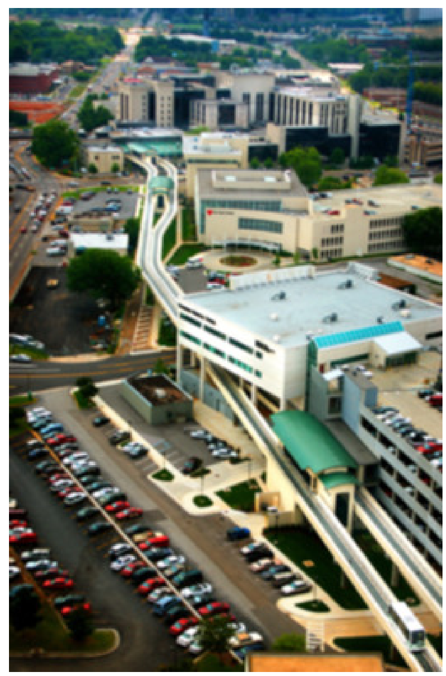
MUD ISLAND MONORAIL

In 1994 the first airport rope propelled automated people mover was delivered at the Cincinnati Airport. The system is a dual lane shuttle system of a total length of 1214 feet carrying 5700 pphpd. The system was supplied by the Otis Transportation Group now merged to form Poma-Otis. The system uses air flotation to provide a high-quality, ride comfort.

As noted in the above picture the rope propulsion is provided at one side of the vehicle. This was not the first application of the Otis rope-propelled, air-supported technology in North America since they had installed, in 1985, a dual lane shuttle system between Harbor Island and downtown Tampa, Florida. The system is no longer in operation.

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 to connect facilities to eliminate duplication of services.

HUNTSVILLE HOSPITAL



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; and state and federal parks. 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.

Purpose
The purpose of the analysis and discussion that follows is to provide a unique perspective as to the Future of the Ropeway in North America. What are the markets that have the most potential? What are the limitations for the ropeway in those markets?

Presently there are 20 automated people movers operating at airports in North American with an average daily ridership of 932,000.[1] Four of these systems are rope propelled systems with an average daily ridership of 97,000. Worldwide there are 34 systems operating at airports with a total average daily ridership of 1,276,000 including 7 rope systems with a total daily ridership of 182,000. These statistics point out that the rope systems are now providing service for the lower capacity systems. This is based on the fact that in North America 20% of the systems currently operating are rope systems, but they transport only 10.5% of the ridership. The worldwide numbers show a small increase in ridership to 14.3% given 20.5% of the total number of systems.

The most entrenched and mature market for rope transportation systems in North American is of course the ski resort market. Current statistics[2] indicate that there are over 2000 functioning rope systems in North America most of which are operating at ski resort for winter tourism. Data collected through research,[3] indicates that for the period 1964 to 2004, 41 years, that just under 3000 chairlift, gondola and aerial tramway rope systems were installed at resorts in North America.

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.

MARKET SEGMENTS

As shown above the two most developed market segments are ski resorts uphill transit and airport automated people movers. It could be argued that the airport market, for rope systems, is anything but developed with suppliers currently struggling. Today, there is one rope system that is being implemented at the Toronto airport. Although suppliers are re-positioning, there is some indication that owners recognize the benefits provided by the lower cost of rope systems as applied in airports. This is evidenced by redesign of physical structure and accommodation of procurement specifications to allow rope systems to be offered for new systems at the Miami and the Las Vegas Airports. As shown by the installation at the Zurich Airport, rope systems that provide higher capacities will increase the potential for such systems.

Ski Resorts

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

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[3] Ski Area Management, SAM, Lift Sold Data Editions, 1964-2005, 45 Main Street N, Woodbury, CT 06798, (203) 263-0888, www.saminfo.com,

perform as designed or no longer provides the comfort or capacity required by the user.[1] 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 9 years; the gondola is 20 years and the tramway is 26 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.

Let's further analyze these numbers to determine what they mean in terms of annual replacement. There are currently 755 fixed grip chairlifts that are older than 25 years and 998 that are older than 20 years. Please allow some assumptions such that the magnitude of the issue can be framed. Considering the fixed grip chairlifts over 20 years which total in this sample 998, let's make the following assumptions:

- That half of them will continue in service or be retired in the next 5 years.
- That half of them will be replaced with a detachable chairlift, in 5 years.
- That the average VTFH[2] for the replacement is 2000.

The average annual VTFH replacement would therefore be:

$$[(998/2) \times 2000]/5 = 199{,}600 \text{ (100 systems)}$$

Please remember that this is only the fixed grip chairlifts and that the above assumptions are conservative as to the total requirements. From the above average age of gondolas and tramways, major refurbishment and replacement of them will be required starting in the next 5 to 10 years to forestall obsolescence. The number of gondolas in this sample is 51. Most of the tramways in this sample already fall into the obsolescence category since they have not had major refurbishment. It should also be remembered that this considers no growth in terrain requiring ropeway systems.

Figure 1 represents VTFH installed annually in North America from 1969 through 2004 a total of 36 years. The maximum annual number is approximately 166,000 installed in 1998 which is far below what the demand, based on obsolescence, will be over the next 25 to 50 years. The question becomes then is the supply constricted by manufacturing capacity, by resort capital or by regulatory constraint?

Figure 2 shows the comparison from 1977 to 2003 of VTFH installed to the average earnings before interest taxes and depreciation divided by the average revenues (EBITD/REV) for resorts in the United States.[3] There is a loose trailing correlation to VTFH installed versus

[1] Farwell, Ted, "Economic Retirement Criteria for Ski Lifts," Vail Aerial Tramway & Ski Safety Seminar Proceedings, 3rd Annual, August 23, 1983.
[2] 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.
[3] "Economic Analysis of US Ski Area" 1994-2004,NSAA Ski Area Survey, RRC Associates, Inc., 133 South Van Gordon St, Suite 300, Lakewood, CO. 80228, (303) 987-1111. Goeldner, C.R.; Buchman, T.A.; Hayden, G.S.; DiPersio, C.E., "Economic Analysis of North American Ski Areas", 1976-1993, Business Research Division, Graduate School of Business Administration, Colorado University

EBITD/REV. It appears that a better correlation exists in comparing VTFH installed with Health (DEBT/EBITD). The resort market place has been willing to take on more debt to provide for investment in ropeway equipment, as shown in Figure 3. This is done to provide some indication as to what level of return is required to allow capital investment and provide for cash flow to service debt. The other question becomes is there enough available gross cash flow to support the required level of investment to over come the predicted obsolescence?

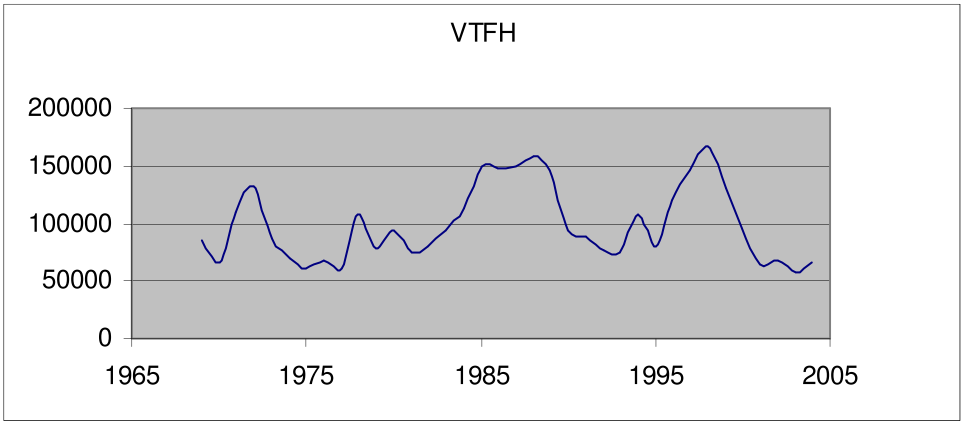

FIGURE 1

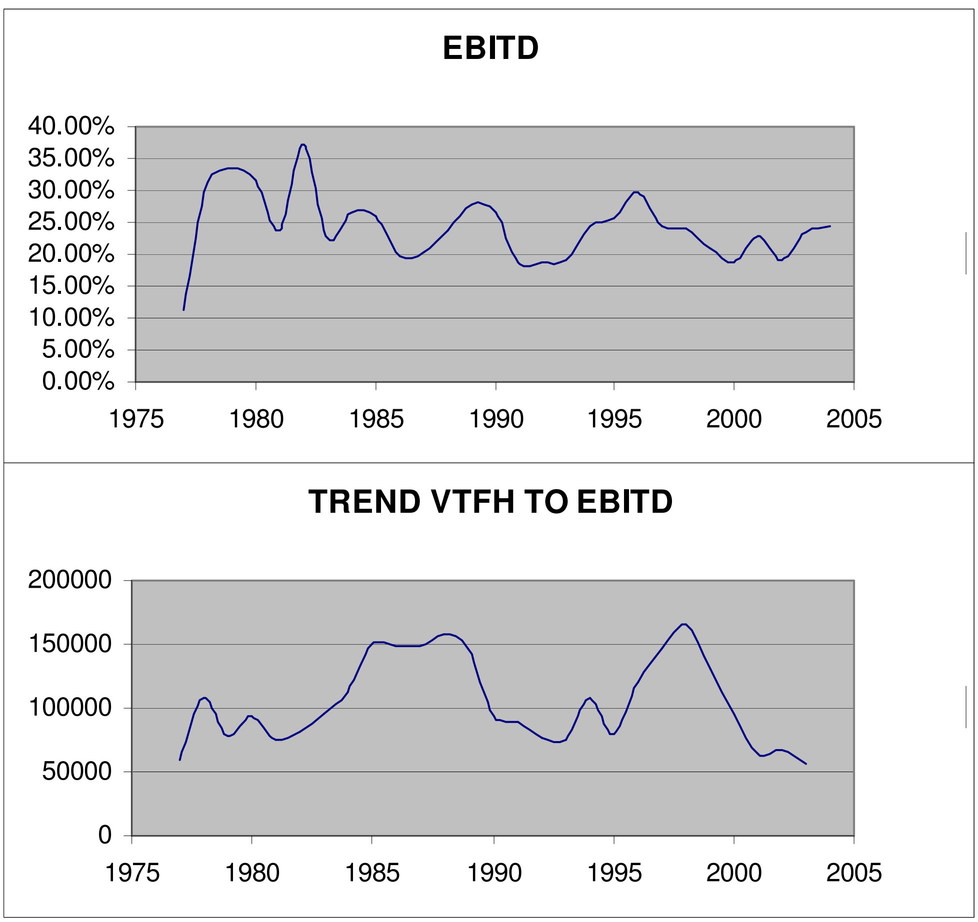

FIGURE 2

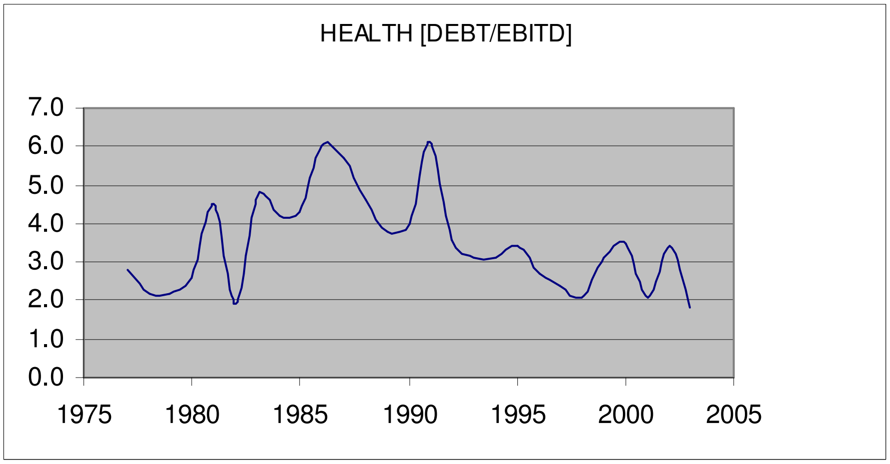

FIGURE 3

Figure 3 representing data from the annual NSAA survey, shows that the resort market is willing to take on more debt if serious safety deficiencies are discovered or if new technology can provide a positive skier perception. This is shown in 1986-1987 with the surge in detachable equipment purchase and again in 1991 when Lift Engineering detachable equipment was being replaced. During these two periods profits were also depressed.

Therefore, what is the cash flow available that can be used to provide capital for replacement of ropeway equipment? Using the same NSAA data, from 2000 through 2004, 5 years, the average depreciation per skier in 2005 referenced dollars is \$7.93. Considering that an acceptable Health ratio is 2.0 then the depreciation could be leveraged at about four times. Based on empirical analysis, 30% to 40% of this amount is available for ropeway replacement or refurbishment. Using 30% for our replacement analysis, the total capital/skier visit available would be as follows:

$$(\$7.93 \times 4) \times 0.30 = \$9.52$$

Skier visits in the US from the 92-93 season through the 04-05 season has varied from 52.1 million to 57.6 million. In Canada they have varied from 16.5 million in 94-95 to 19.5 million in 03-04. For the US the average for the last 5 years is 56.6 million and the average for Canada from 00-01 through 03-04 is 19.0 million. Using a conversion factor of one Canadian\$ is equal to 0.8239 US\$, the Canadian investment per skier visit will be factored down by this amount. Therefore the total capital/skier visit available for Canadian resorts would be:

$$(\$7.93 \times 4) \times 0.30 \times 0.8239 = \$7.84$$

Therefore, an estimate of the annual available capital for ropeway equipment replacement and refurbishment in North American based on resort performance over the last 5 years is as follows, in 2005 \$:

US \$9.52 x 56,600,000 = \$538,832,000
Canada\$7.84 x 19,000,000 = \$148,960,000

Thus based on these average performance figures for skiing resorts in North American, the total annual available capital available for ropeway investment is $687,792,000. Previously, it was estimated that the annual VTFH required for fixed grip chairlift replacement and refurbishment is 199,600 VTFH. Using current 2005 replacement costs, the average cost would be between $825 and $975 per VTFH. Using $900 per VTFH as an average, the annual required investment would therefore be,

$$199{,}600 \times \$900 = \$179{,}640{,}000$$

This is only 26% if the investment capital that could be made available based on the above assumptions.

Manufacturing capacity is another consideration. Again using empirical data, the manufacturing capacity in North America was severely impacted when the demand was high during the periods 1985-1989 and 1997-1998. The maximum VTFH delivered in North American was in 1998 at 166,182, significantly below the average needed to overcome obsolescence. Further, from a planning point of view, it is very difficult for the manufactures to provide a level of investment to support high demand since history shows such a variability in the annual VTFH as see in Figure 1. Analyzing the data shows that the average annual VTFH between 1969 and 2004 is 99,065, with a standard deviation of 32,756 and with the maximum value more than 2 standard deviations form the average.

Therefore, it is unlikely that manufacturing facilities, in the near term, can provide the required capacity to meet demands of replacing obsolescent ropeway equipment. Based on current manufacturing process and buying habits of resort operators, the annual capacity of the North American manufacturing is estimated to be between 165,000 and 175,000 VTFH. Based on revised purchasing patterns allowing for better utilization of the manufacturing facilities, the VTFH capacity could possibly be increased by 20% depending on the mix of equipment types. Under these ideal conditions, the output would just provide the requirements, which one should remember is just for fixed grip chairlift replacement.

The effect of regulatory constraint, to be investigated in detail at a later time, will not be considered here. It should be pointed out that the current perception, and realization by some, is that the permitting process is much more protracted than in the past. This is due primarily to the much more critical application of Federal Environmental Regulation such as the National Environmental Policy Act (NEPA) and the Endangered Species Act (ESA).

Another consideration relative to regulatory constraint is the potential for a major ropeway accident that could impose replacement requirements tied to the age of the ropeway equipment.

Airport Automated People Movers

As noted above of the current systems operating at airports in either airside or landside applications, 20% are rope propelled, but they carry only 10.5% of the average daily ridership. The spread on these two percentages indicates that the rope systems are being applied on the lower capacity requirements. As the rope propelled technology advances, the rope systems will be able to offer reliable high capacity systems.

Based on historical information, airports with annual air passenger usage exceeding 10 million are candidates for automated people mover systems(APM). In 2005 there are 42 airports in North America that are exceeding that number. Of those 17 have APM's operating at the airport. Presently new systems are under construction at Toronto and Washington Dulles. Additionally, three airports, Miami, Las Vegas and Atlanta, which already have systems, are in the procurement process for additional segments. Therefore, presently 25 additional airports have the passenger demand that would indicate that an APM is required.

In addition there are another 12 airports whose present demand and growth projections indicate that they will be candidates for an APM in the next 5 years. Further, some are projecting that the passenger demand will grow from its current level of 675,000,000 to over 1,000,000,000 by 2010. If this number is in fact achieved, an additional 6 airports will become candidates.

Most airport people movers range from 0.8 to 1.5 mile, end to end. For these systems, historically the ropeway system cost is between $25 and $30 million per mile. Please note that for shorter systems the unit cost is significantly higher. Using the above data for potential market penetration, an estimate of total capital for APM system investment during the next 15 years can be made:

TOTAL NUMBER OF SYSTEMS	25+12+6 = 43
ROPE SYSTEM SHARE	0.2 x 43 = 9
INVESTMENT 2005 $	1.2 x$30,000,000x9 =$324,000,000

This level of investment, $21,600,000 annually, is probably on the conservative side given the fact that rope systems have gained acceptance over the last few years through a proven history of reliability and cost efficiency. Additionally, this number will probably increase due to future improvements in rope technology that will deliver higher capacities.

A sense of caution for the entire market must be maintained. With the increased level of security required at airports during the last four years, there has been less capital available for APM construction which has been reflected in the decrease in the number of APM systems being planned and procured. With current projections of travel demand considering the increased restrictions on passenger movements in and around airports, the APM should see a revival. This revival could be fueled by the need for land side systems to satisfy the security requirements near the airport core while providing for efficient passenger movement such as is being now considered for Los Angeles International.

Leisure and Institutional

There are currently 21 so called leisure and institutional APM's operating in North America[1]. Seven of these are operating in casino settings in Nevada and three are operating at hospitals. These two markets would be ones to consider for some moderate growth. Obviously, the casino market in North American is growing, but some caution is required as to the extent of growth. Hospitals also show promise as consolidation is taking place throughout this industry. An APM can allow expensive diagnostic equipment to be centralized and patients quickly moved to the equipment. Parking can be located on less expensive property and workers transported to the main hospital work areas.

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

Given the above, I believe that the potential is quite limited with maybe 1 or 2 systems per year. Other markets have been discussed and proposed, but none are developed to a point of making any predictions as to their viability.

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 almost 5 billion passengers during the last 25 years! Currently the ropeway systems in North American transport annually 1.25 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 $180,000,000 and $200,000,000 annually will be required. A more critical factor is the capacity of the manufacturing sector to respond. Further, there is a hesitance from the manufacturing sector to make required investments based on the historic purchasing patterns of the resort operators. Education is needed to bring the purchasers, suppliers and regulators together in order to avert a crisis situation.

The APM market for ropeway systems being less mature than the resort ropeway market does not provide as much clarity as to the future. It does appear though that based on current trends that the airport market will be robust and provides the highest potential, between $30,000,000 and $40,000,000 annually.

Questions not answered are:

What will be the level of investment in other markets – hospitals and casinos?
How will regulation affect the level of investment?
How will world events affect the level of investment?

This paper has only been able to introduce certain aspects that affect the future of ropeways in North American. Each of the subjects presented here need to be developed in more detail with research into each of the individual areas.