

PRIMER ON URBAN ROPEWAY TECHNOLOGY AND DEFINITIONS

By Martin Pagel and Hazem El Jouzou

This article introduces the terminology of ropeways (also called cable-propelled transit systems, cable car or cableway) in general and aerial ropeway transit (ART) or [aerial lift](#) in particular. It is compiled from various sources as indicated. We have also included terms from around the world as there are many such systems outside English speaking countries. The components of a ropeway system are first described followed by a brief discussion of the main technologies. Definitions are presented at the end.

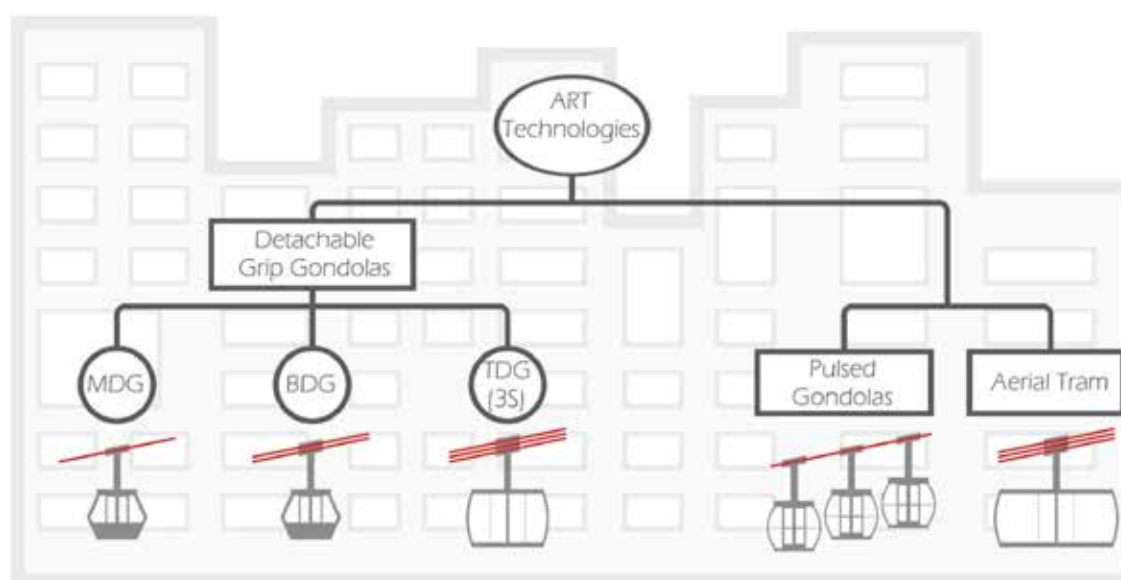


Figure 1: ART Technologies. Source: Hazem El Jouzou. Data Source: CUP, 2013

ROPEWAY COMPONENTS

An ART line consists of four major parts: the stations (terminals), the towers with roller batteries, the cables (ropes), and the cabins.

Stations - The stations are the major buildings of a line where riders get on and off the line. Each line has at least two terminals at each end with a bull-wheel. On one end the drive motor turns the bull-wheel which powers the haul-cable to move the cabins and on the other end a bull-wheel redirects the cable to form a continuous loop. Cabins slow down in the stations to allow riders to disembark and others to embark.

Some lines also have a few intermediate- or mid-stations to allow riders to get on and off along the line and change the direction of the line.

Turning-stations only change the direction of the line without allowing riders to disembark. Some mid-stations have two bull-wheels to allow cabins to switch from one cable loop to another.

A station can be at ground level, elevated or integrated into another building. A station may also provide garage space for cabins at night or maintenance.

Towers or Pylons - The towers are the pivot points which carry the cable and cabins between the stations. They bear the weight of the cabins and their passengers. Each tower has a set of roller batteries to guide the cables as the cabins pass on both sides of the tower. While traditionally towers were built as a rather utilitarian lattice structure or using one or two metal tubes, some urban installations have become more architecturally distinct such as in London, Portland Oregon and Toulouse France.

Cable or Rope - The cable supports the cabins as they travel between stations over the towers. They are made of steel strands which are twisted around a core so that they are flexible enough to wrap around the bull-wheel and over the roller batteries. In aerial tramways, there is both a haulage rope and a track rope (aerial tramways) while in MDG systems one rope supports both functions. (Alshalalfah et al, 2012). A **haul-cable** forms a loop which propels the cabins using a motor at one station. In a monocable system the haul-cable also carries the cabins while in multi-cable systems the cabins travel on wheels along one or two additional support cables.

Cabins or Cars - The cabins are the vessels which transport the riders. Circulating ropeways may use hundreds of small cabins with seats while reversible ropeways use two large cabins with passengers usually standing. Cabins are lightweight with large doors on one or both sides; most offer large windows and vents, others heated seats, fans or air-conditioning depending on local climate needs. Some provide Wifi, cameras, lighting and two-way communication systems.

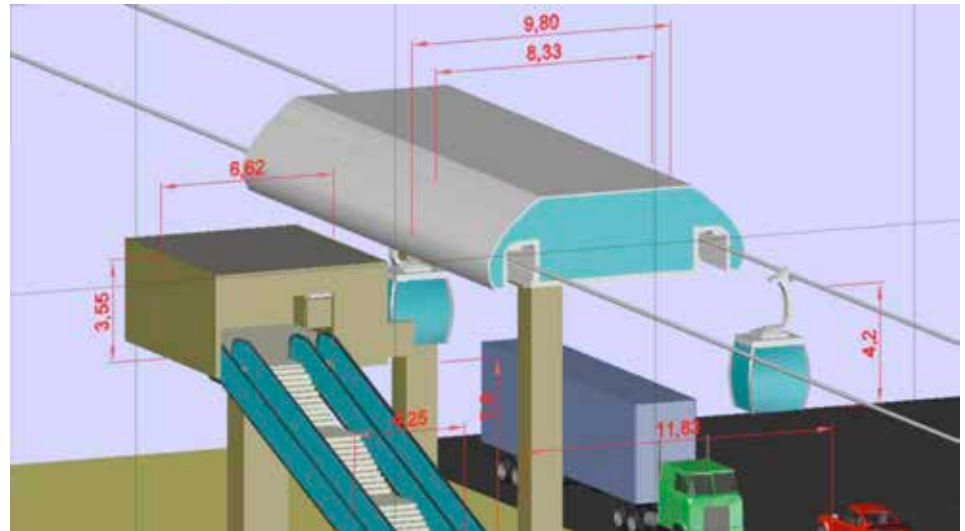


Figure 2: Example of station design with minimum footprint.

Source: Hazem El Jouzou. Data source: Doppelmayr Urban Solutions, 2015.

ROPEWAY TECHNOLOGY

Ropeways come in different types; they can be categorized by three different aspects:

- **Support** - **Aerial ropeways** are supported by cable from the top while **track-based ropeways** are supported on the bottom, with rails on the ground or elevated structure with some type of wheels on rails or track.
- **Propulsion** - **Reversible ropeways** go back and forth (or up and down like an elevator) whereas **circulating ropeways** keep going around in a loop (like an escalator). Reversible ropeways usually have two cabins which are connected via haul-cable - while one cabin goes up the other one goes down; or one or two cars are each connected by cable with a counter weight.
- **Grip** - While the two cabins of reversible ropeways are always affixed to the haul cable (**fixed-grip**), with circulating ropeways any number of cabins can either be affixed (fixed-grip, e.g. basic chair lifts) or the cabins get detached in the station (**detachable-grip**). While propulsion on fix-grip ropeways needs to slow down or stop for boarding, on detachable ropeways the haul-cable loops continuously while cabins detach for boarding.

Track-based ropeways examples of reversible technology are **funiculars** (hundreds worldwide including [Pittsburgh Pennsylvania's Inclines](#), Hong Kong, Buda castle in Budapest Hungary, and several in Lisbon Portugal; Naples Italy; and Lyon, France) while examples of circulating, detachable-grip technology is the classic cable cars (e.g. in San Francisco California (built in 1870s) or a cable liner (automated guideway transit) which are often used as automated people movers (APM, e.g. [Oakland California's airport connector](#), built in 2014).

Table 1 presents the common terms used for aerial and track based ropeways. Table 2 presents some of the international terms for aerial ropeways.

Table 1 Types of Ropeways		
	Aerial	Track-based
Reversible	Aerial Tram	Funicular
Circulating	Gondola lift	Cable liner / AGT / Classic Cable Car

Table 2 International terms for aerial ropeways				
	English	German	French	Italian
Generic	Ropeway (Cable Car)	Seilbahn	Téléphérique	Funivia
Reversible	Aerial Tram(ways)	Pendelbahn	Téléphériques va-et-vient	Funivia a va e viene
Circulating	Aerial Gondola	Umlaufseilbahn / Gondelbahn	Télécabines	Cabinovia

The following presents a description of the main **aerial ropeway technologies**; which are also illustrated in Figure 1.

Cable car, cableway, and ropeway: Various terms which are used to describe a cable-propelled transit system.

Aerial ropeway (or aerial cable car) - generic term for ropeways where cabins travel between stations and are supported at the top either by the haul-cable (mono cable) or by one (bicable, 2S) or two separate support cables (tricable or “3 Seile”, short 3S). The cables themselves are supported by towers. The more support cables, the fewer towers are required and higher wind stability.

Aerial Tram(way) - reversible aerial ropeway between two stations with one cabin operating in each direction at a time. (e.g., [Portland](#) Oregon, New York City’s [Roosevelt Island](#))

Pulse Gondola - reversible aerial ropeway with groups of two or three cabins operating in each direction at a time. (e.g., [Spokane](#) Washington)

Gondola Lift - term used to describe a circulating detachable aerial ropeway.

Ropetaxi - latest technology of circulating aerial ropeway that has multiple stations and where riders can choose which station the cabin stops at.



Photo credit: Christian Meyer, Two crossing cabins of the cable car from Trockener Steg to Kleines Matterhorn above Zermatt in the Swiss Alps, LEITNER ropeways, Trockener Steg, Zermatt, Switzerland, 2022. <https://unsplash.com/photos/a-group-of-cars-on-a-cable-HM8HhmYP4N8>



Photo credit: Patrick T'Kindt, Roosevelt Island Tram, New York City, USA, 2019.
<https://unsplash.com/photos/cable-car-above-vehicles-on-crossing-road-1nZL-AwSp8k>

ACRONYMS

ART: Aerial Ropeway Transit

CUP: Creative Urban Projects (www.creativeurbanprojects.com)

pphpd: passengers per hour per direction

STRMTG: Service Technique des Remontées Mécaniques et des Transports Guidés

MDG: monocable detachable gondola

BDG: bicable detachable gondola

TDG: tricable detachable gondola

Author Details:

Martin Pagel is a transit advocate. He grew up in Germany and now lives in Seattle where he has published several transit articles on local transit blogs. During the day he is a security architect for a global cloud communications company.

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REFERENCES

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- Creative Urban Projects (CUP), (2013). *Cable Car Confidential, The Essential Guide to Cable cars, Urban gondolas & Cable Propelled Transit*. 1st ed. Toronto: s.n. www.creativeurbanprojects.com
- Doppelmayr Urban Solutions, (2015).
<https://www.youtube.com/watch?v=9dd--wAKPml>
- Transportation Research Board; National Academies of Sciences, Engineering, and Medicine. (2013) Chapter 2, *Transit Capacity and Quality of Service Manual*, Third Edition.

SIDEBAR

RESOURCES TO LEARN MORE ABOUT AERIAL CABLE CARS

To learn more about aerial cable cars we have assembled a few links of Videos, Blogs and Reports from both the technical, academic and riders' perspectives.

Author/Blog	Title of video, blog or report	Link
City Beautiful, by Dave Amos	Urban Gondolas: Transit by Cable	www.youtube.com/watch?v=vdTE4TCqkZo
Town and Tourist	"A Complete Guide to Aerial Tramways in the USA"	https://www.townandtourist.com/aerial-tram-way
Reece Martin (@RMTransit)	"Does your city need a gondola?"	https://www.youtube.com/@RMTransit https://www.youtube.com/watch?v=iNr59pNk-CHI
Curbed	"11 urban gondolas changing the way people move" (2017)	https://archive.curbed.com/2017/9/21/16340394/urban-gondolas-cable-cars-cities
Creative Urban Projects, (CUP a small planning shop in Toronto, Canada)	The Gondola Project: Learn the Basics: What is Cable Propelled Transit?	https://www.gondolaproject.com/about/ https://www.gondolaproject.com/learn-the-basics-what-is-cable-propelled-transit/
The World Bank	"Urban Aerial Cable Cars as Mass Transit Systems: Case studies, technical specifications, and business models" Sep.1, 2020 (21 case studies)	https://ppp.worldbank.org/public-private-partnership/library/urban-aerial-cable-cars-mass-transit-systems-case-studies-technical-specifications-and-business-models https://www.ppiaf.org/sites/default/files/documents/2020-01/Urban-Aerial-Cable-Cars-as-Mass-Transit-Systems-Case-Studies-Technical-Specifications-and-Business-Models.pdf
Transit Choices (transitchoices.org)	Aerial Ropeway Transportation Systems in the Urban Environment: State of the Art	https://transitchoices.org/wp-content/uploads/2016/01/Urban-Gondola-Report.pdf
UNStudio	Projects in planning in The Netherlands, Russia and Sweden	https://www.unstudio.com/en/page/14084/urban-cable-cars-sustainable-public-transport-for-future-cities
BMDV - (bund.de)	Urban Cable Cars in Local Public Transport	https://bmdv.bund.de/SharedDocs/EN/publications/urban-cable-cars.htm

Author/Blog	Title of video, blog or report	Link
CERTU	Brest se dote d'un téléphérique urbain	http://www.certu.fr
Zatran	Urban cable car and ropeway in public transport	https://www.zatran.com/en/technology/urban-cable-car-ropeway/
World Economic Forum	The Advanced and Urban Aerial Mobility (AAM/UAM) Cities and Regions Coalition	https://www.weforum.org/press/2022/03/local-leaders-join-new-coalition-to-advance-urban-air-mobility-around-the-world/
World Economic Forum	Cable Cars For Paris Commuters To Launch By 2025	https://www.weforum.org/videos/cable-cars-for-paris-commuters-to-launch-by-2025
Leitner-Poma	Aerial Tramways	https://leitner-poma.com/products/aerial-tramway
Doppelmayr	Garaventa 10-MGD "Ciudad Bolívar" Bogotá, Kolumbien (2018) - YouTube	https://www.youtube.com/watch?v=BEu-jUyrN9xk
Doppelmayr	Garaventa 10-MGDs "Mi Teleférico" La Paz/El Alto, Bolivien (2014-2019) - YouTube	https://www.youtube.com/watch?v=vdCyO-J7fkio
Doppelmayr	Garaventa - "Insights" - Cablebús Mexico City - English (2021) - YouTube	https://www.youtube.com/watch?v=PPzEktoj-F0U&list=PLjPmHZ89FY_KZJk7moF8HVBX-56qXRZU0Z&index=5
Doppelmayr	The Next Level of Mobility: Ropeways as Urban Means of Transport [EN] (yumpu.com)	https://www.yumpu.com/en/document/read/62716866/the-next-level-of-mobility-ropeways-as-urban-means-of-transport-en

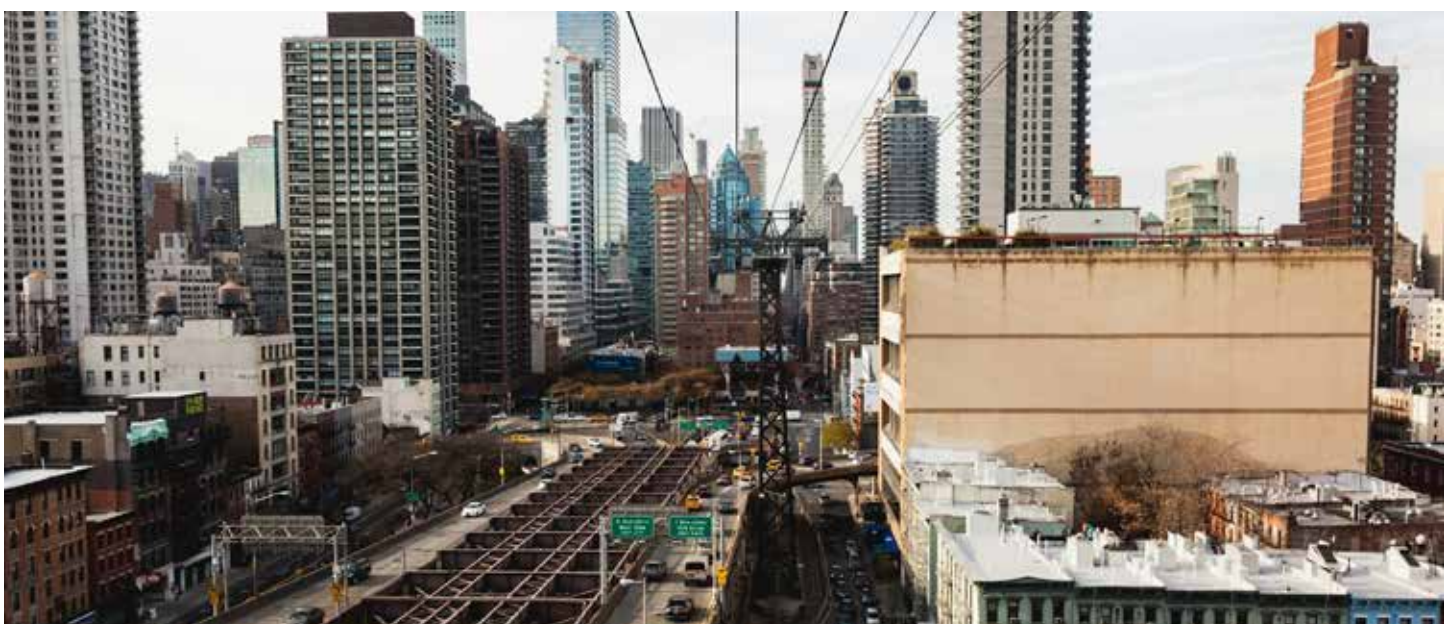


Photo credit: Dan Gold, Roosevelt Island Tramway, New York, USA 2017.

<https://unsplash.com/photos/aerial-photography-of-high-rise-buildings-wc97fT8KSkc>