PLANNING FOR LOG TRANSPORT USING AN AERIAL CABLEWAY

Shane McMahon
LIRO

SUMMARY

In this paper I will discuss the components and characteristics of aerial cableway transport systems, providing some examples along the way of where they are appropriate and the types of equipment used. Following that I will focus on specific issues that need to be considered when planning for a cable transport system.

WHAT IS AN AERIAL CABLEWAY?

An aerial cableway is a tight (standing) skyline system capable of full load suspension. Typically, these systems combine a sledge-mounted hauler with one or two drums, and a clamping skyline carriage. Skylines can be rigged as single span or multispan with the addition of intermediate supports and skyline jacks (Figure 1).

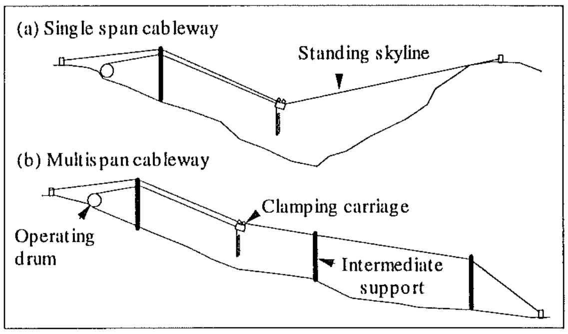

Figure 1 - Components of (a) single span and (b) multispan cableway systems

It is preferable to place the hauler at the top of the span to transport logs downhill using gravity as the motive force, thereby not requiring a high powered machine. Using the mainrope on the drum, the hauler can pull itself up steep slopes without the need for cutting access tracks. Engine gearing, a fan brake and drum/disc brake are all used to control the descent of the load.

Alternatively, this type of system can be used to transport loads uphill towards the hauler. However, in this case a hauler may require substantially more power than if transporting loads downhill.

Long spans in excess of 2000m are possible with the use of intermediate supports and an open-sided carriage.

These systems have been around for about 100 years during which time they have been referred to as skyline cranes, swinging yarders, European long span skylines, and cable cranes. There are various manufacturers of these types of systems, including Wyssen, Gantner, Nansei, and Iwate-Fuji.

These systems have been used as extraction and transport systems in difficult terrain, having enjoyed considerable success in Europe. In the past, they have seen less success as extraction systems in the United States, Canada, and New Zealand probably because:

- the system and crews were introduced directly into production situations without going through a testing and learning programme
- they are typically lower producers than other skyline systems
- correct rigging is crucial for operation, particularly if using intermediate supports, and rigging is complicated and time consuming requiring an experienced crew
- rigging times are not easily offset by high production rates (Bloomberg and Liley 1985).

Many of you may have memories of the early use of Wyssen haulers in the 1950's by the Forest Service in Otago, Whakarewarewa and Golden Downs. In the 1980's, Wyssens were used by the Marlborough Catchment Board at Koromiko and by the Wairarapa Catchment Board at Blairlogie. Even more recently, they were used at Rai Valley, east of Nelson.

Interestingly, it was ten years ago when the subject of aerial cableways was addressed at the 1985 LIRA Seminar. The enlivened discussion during the session dealt with many of the problems experienced with the use of the systems to date, including those which I have listed above. I think that many of the issues raised back then are still important today and need to be considered when planning for use of such a system whether that be for extraction or transport.

Despite the early misgivings about aerial cableway systems in general, they increasingly have a role in the logging of some of the more difficult and challenging terrain in New Zealand. Change in the location of the available wood resource over the last ten years, and perhaps more importantly, concerns about the impacts of logging and transport on the environment has placed more emphasis on doing the job right.

This leads me back to the topic of this paper, aerial cableways for log transport. Obviously, what we are talking about here are fixed skylines which transport log lengths after primary or secondary extraction to a landing for further processing, load out onto a truck or barge, or directly onto a barge.

WHAT SITUATIONS SUIT AERIAL CABLEWAYS?

Because we are talking about a transport system, aerial cableways may provide a viable alternative where construction and maintenance of roads to a grade, width and surfacing suitable for trucks or forwarders are:

- not possible
- very expensive
- likely to pose a potential risk of increased surface erosion or mass wasting in an area where erosion, water quality and sedimentation are major issues
- likely to result in adverse public reaction to the visual impact.

Identifying where conventional transport options are not the most feasible is the key to the use of aerial cableways; this will be discussed in a later section. However, by looking at where these systems have been used allows us to build up a picture of the suitable terrain.

Aerial cableways have been used successfully in logging operations within the fiord-like Marlborough Sounds and on the erosion-prone soils of the Wairarapa.

As you may have seen from the earlier field trips, harvest planning in the Marlborough Sounds has to contend with difficult access, steep terrain with erosive soil types, and a valuable marine water resource used for marine farming, tourism and recreation. These difficulties have resulted in several barging operations, which have used aerial cableway systems during some stage of transport. Two such operations were the Onepua Bay and Wet Inlet operations.

One of these operations, which LIRO had considerable involvement in, was the Forestry Corporation - Skylok Yarding Ltd operation at Onepua Bay (Robinson 1993; McConchie and Robinson in prep). One or two Gantner winches were used to transport both log and whole tree lengths downhill after primary extraction with a Washington 88, and secondary extraction by skidder, to a lower deck and fleeting yard (Figure 2). Log lengths were then loaded on a barge and transported to Picton.

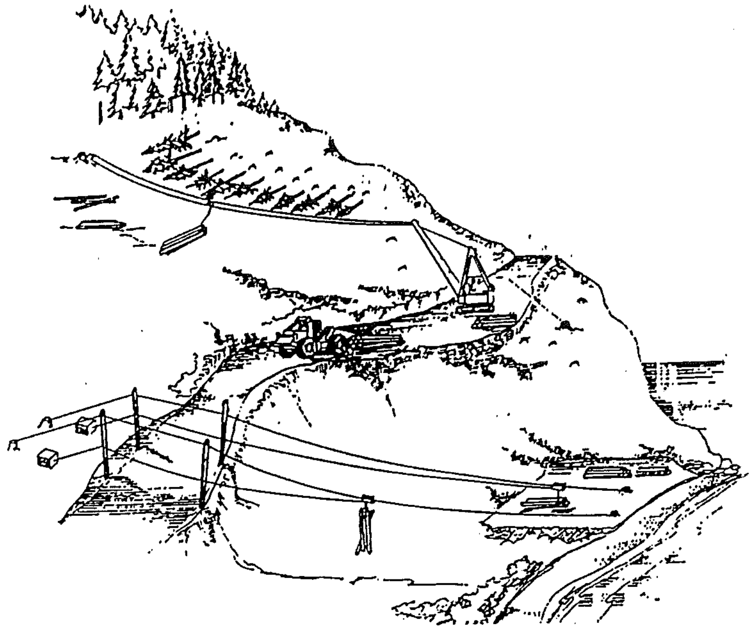

Figure 2 - Extraction and transport at Onepua Bay

The selection of a transport cableway at this site over road transport was based on:

- the cost of upgrading the ridge road at the top of the logged area, which would have required the burying of high tension electrical cables
- the potential for accelerated erosion from roads and tracks
- the potential for adverse public reaction to excessive tracking of a slope easily viewed from the Cook Strait ferries.

A second example of the use of a transport cableway in a coastal logging operation was the more recent and innovative Parapine Ltd - Sky Cable Logging Ltd operation at Wet Inlet. A Wyssen winch unit was used at this site to transfer log lengths from a processing landing down to a barge anchored just offshore (Figure 3). In this case, the skyline was anchored to the seabed by some large blocks of concrete. Logs were stacked on the barge with a Bell Ultralogger which was also lowered onto the barge via the cableway.

Transport directly onto the barge was selected because of:

- the steep rocky coastline below the operation, not allowing ground-based access to a barge point
- Wet Inlet has the major concentration of mussel spat within the area (Wilks 1980)
- lengthy road access, requiring considerable upgrade

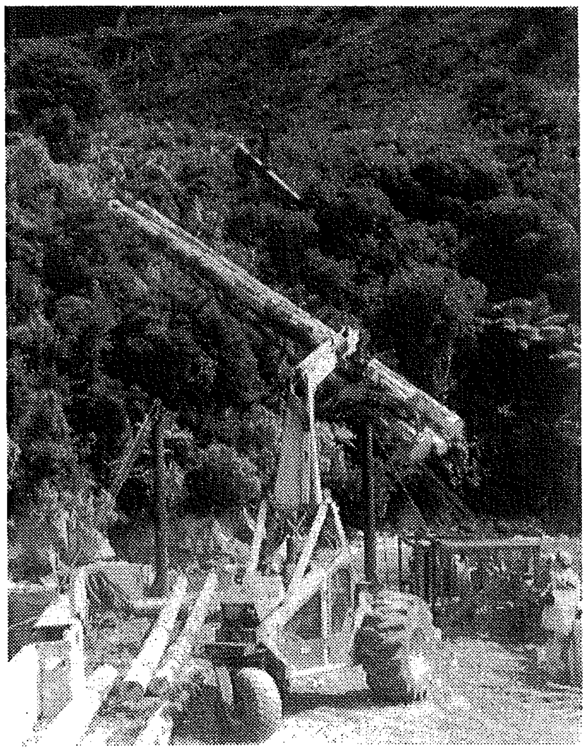

Figure 3 - Logs being loaded on the barge at Wet Inlet

During the early years of the resurgence of interest in aerial cableway systems, a Wyssen system was trialed as a transport system at Blairlogie Gully in the Wairarapa. The details of this operation were discussed by several speakers at the 1985 LIRA seminar (Blakemore; Bloomberg and Liley), but essentially the setup was similar to that at Onepua Bay, with logs being transported downhill over a water course to a lower landing.

Looking at where cableway transport systems have been used, it is relatively easy to identify sites that have physical or economic impediments to the use of conventional transport systems. In contrast, identifying the potential for accelerated erosion or adverse public response is less easily. Nevertheless, the potential for adverse environmental impacts will in some areas be the key issue needing to be addressed by a harvest/transport plan.

WHAT ARE THE POTENTIAL PROBLEM AREAS?

Before discussing the steps that should be taken to judge the feasibility of a cableway transport system, I will highlight some of the potential problem areas when planning for such operations. These issues refer not only to cableway transport systems but also to conventional cable and cableway extraction systems.

Planning for and operation of cableway systems requires special attention to the:

- skills required to rig and operate the system.
- safety and production considerations
- balancing production

Rigging and operational skills

An understanding of the productivity limits of cableway systems is one of the skills needed to rig and operate a cableway safely and productively. One of the common themes that come through from reports on cableway systems is the need for an experienced work force to rig and operate the system. With rigging time for a new skyline taking between one and four days, there is considerable pressure on the crew to ensure that production delays are minimised. The use of intermediate supports in a multispan setup will require further skills in support placement, tree climbing and rigging. Obviously, getting the job done right the first time counts for a lot of production time. As I mentioned at the beginning of this paper, rigging skills are crucial, the lack of which may have contributed to the slow adoption of cableway systems.

Safety and production considerations

As I have alluded to, the productivity of aerial cableway systems, as with any cable system, can be affected by the competing requirements of deflection and suspension. To ensure full suspension, it may be necessary to have the skyline tight. However, this will reduce deflection, reducing the safe loading capacity of the skyline (defined by skyline safe working load).

Unlike, live skyline systems where the skyline can be lifted and dropped during inhaul to optimise load size to skyline tension, the standing skyline of a cableway system should be tensioned to provide full suspension over the entire span. In this way, any obstacle along the span will limit payloads for the entire span.

Unsafe skyline tensions can result from wanting to add that extra log to the load, particularly where safe payloads are perceived as not being high enough.

Balancing the production

Often, one of the drawbacks of using an aerial transport cableway instead of a conventional transport system is the low productivity of such systems (Table 1).

Table 1 - Productivity figures from New Zealand cableway transport studies

Hauler	Transport distance (m)	Productivity (m^3/6.5 hr day)	Author(s)
Wyssen (W30)[1]	600	63	Bloomberg and Liley
Wyssen (W30)	300	83	(1985)
1 Gantner (HSW80)	650	94	Robinson (1993)
2 Gantners	650	200	

Note: 1 - Tree length extraction, cycle time modified by subtracting extraction-specific elements from reported mean cycle time.

Generally speaking, the productivity is most influenced by constraints on load size imposed by deflection and suspension requirements over the typically long spans.

As a component of a logging system, transport system productivity needs to be in balance with the extraction, processing and fleeting/loading components (Figure 4) to ensure optimal utilisation of machines and manpower. If daily extraction and/or processing exceeds the productivity of the transport system, then there is potential to under utilise the extraction machinery or manpower. Conversely, a similar situation may result if the fleeting and loading out components of the system also exceed the productivity of the transport system. To some extent, differences in hourly productivity between the system components may be balanced by extended operation hours or even double-shifting, if landing area allows.

An alternative to manipulating the operating hours is to operate two transport cableways in parallel, as was the case with the Gantners at Onepua Bay (Table 1). At times of high production by the Washington, operation of the second Gantner allowed a doubling of daily production by the transport component of the system.

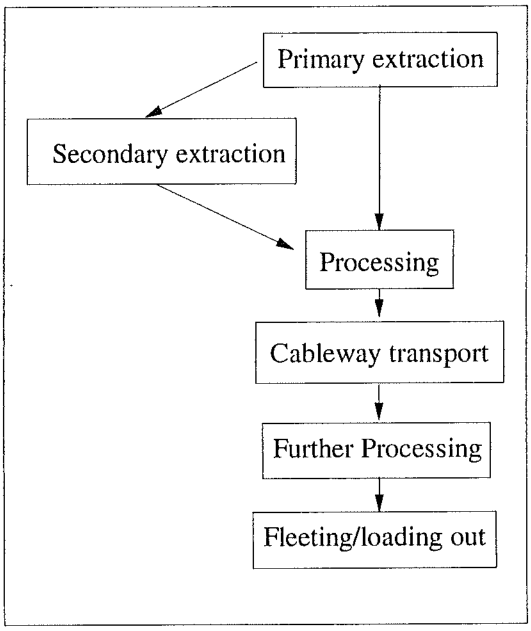

Figure 4 - Components of the logging system

HOW DO YOU PLAN A CABLEWAY TRANSPORT SYSTEM?

Cableway systems are not the only alternative to difficult transport situations. However, do not let the problems encountered during the early trials of these systems in New Zealand in the 1950's or 1980's discount cableways entirely. What is required is a systematic assessment of the transport alternatives.

It is important to recognise through all stages of planning that terrain or environmental impact considerations may have higher priority than logging costs. This may be particularly so where an adverse environmental impact may effect more than just the viability of logging within the effected setting or compartment.

Planning for an aerial cableway system is perhaps a little misleading, as planning must cover all facets of access, extraction, processing and transport. What we are planning for is an overall system that includes cableway transport, not a specific component of that system. Therefore, when assessing several system alternatives, it is useful to compare estimated total system costs.

The cost of a total logging system ($/m^3) will be the sum of the road and landing construction and maintenance costs, the logging costs, and the transport costs. In addition, where difficult, sensitive terrain is being planned, it may be appropriate to include an environmental cost into the overall equation. This may be an actual dollar cost to mitigate or rehabilitate any adverse impacts, or a value that reflects the potential for loss of regulatory or public support if an adverse impact did result.

The process of planning several scenarios, of which at least one includes a cableway transport option is no mystery to this audience. However, there are several issues that need careful attention as they can greatly effect the productivity and efficiency of the selected system. These are as follows:

<u>Defining environmental objectives</u>

Defining the environmental issues associated with logging a site will be one of the first planning steps to be undertaken (Robinson 1994). This is particularly so if you are considering cableway transport as the terrain is likely to be environmentally sensitive. Having identified the issues through consultation with regulatory and research organisations, and local landowners, specific environmental objectives can be identified. These are likely to be generic of the logging system. These objectives may include something along the lines of:

- road grades are not to exceed 8^o
- road fill must be safely disposed of (end haul)
- batter slope heights not to exceed 2m without stabilisation
- roads servicing a particular setting will be "put to bed" when that setting is completed
- logs will be fully suspended over all slopes greater than 20 degrees
- the system will not impact shoreline vegetation
- no log residue is to be dropped in the tide.

As you can see, even at this stage of the planning some major constraints or costs have been placed on the system alternatives. During subsequent planning of specific scenarios, these objectives need to be revisited to assess if the planned option will achieve them.

<u>Identifying transport options</u>

Identifying transport options for a particular scenario is performed in parallel with the earthworks, extraction and process planning. The latter are likely to define where the wood is to be transported from and to, log flows and lengths.

Some transport options may include the following:

- on highway log truck
- two staging:
  - forwarder (for example, a Volvo,Terrex, or Bell)
  - rough terrain log truck (for example, a MAN 8x8)
  - skidder
  - hauler (log or tree lengths, full or partial suspension)
- cableway transport (full suspension)
- helicopter

Depending on the environmental objectives, and on the nature of the terrain (slope, distances) several of these options may be eliminated prior to determining costs for the different transport options.

Payload analyses

Determining the maximum payloads for a given cableway span is crucial for defining the likely productivity of a system.

With few cableway operators in New Zealand, there will be heavy reliance on planning software to determine optimal (safe) payloads and intermediate support and transport corridor placement. One such example is LoggerPC, which has been mentioned previously during this meeting.

LoggerPC can perform static payload analyses on both single and multispan skylines. Initially, the slope profile of the proposed corridor is entered, as are the likely locations of head and tail spars and intermediate supports.

Phase 1 multispan or standing skyline analysis estimates the limiting payload for the span given the safe working load of the skyline and suspension requirements. Modifying the position and heights of the spar and support(s) allows the planner to optimise the maximum payload.

Phase 2 analysis allows the effect of this maximum payload on skyline tensions throughout the span to be assessed, verifying the maximum payload for the operation. In addition, Phase 2 analysis can be used to determine unloaded and loaded skyline tensions at specified points along the span. This information can be used during the tensioning or pre-tensioning of the skyline.

Extraction and transport productivity

Balancing the production of the primary and secondary extraction systems with the transport system is critical to maximising system productivity and machine and manpower utilisation. Restricting the productivity of extraction will also result in an increase in logging costs relative to what it is expected.

Conventional log truck transport can accommodate fluctuations in production through utilising additional trucks. As transport costs in this case are based on a tonne/km rate the company is not penalised for variable production.

In contrast, an aerial cableway system is less flexible, capable only of modified operational hours to deal with fluctuations in production. The size of the upper landing(s) will influence the extent to which wood can be stockpiled during high production periods. If landing space is limited, then it may be necessary to plan the transport system to match the hourly productivity of the extraction system(s). Alternatively, two transport cableways may be required, with the second being used at times of high production. One of the obvious disadvantages of this option the utilisation of the second cableway may be low.

System costs by component

As I have mentioned, the benefits of operating an aerial cableway as a transport system may be reduced earthworks cost. Therefore, having decided on several system options and calculating the costs per m^3, the feasibility of the overall system can be judged by summing the component costs.

For the purpose of providing an example, Table 2 shows the operational costs for two options. Option 1 utilises conventional truck transport at a total cost of about $30/$m^3$. For an extra $6/$m^3$ the wood can be transported by cableway, with the advantage that considerably fewer earthworks were necessary.

Table 2 - Operational costs/m³ for two system options: Option 1 includes conventional log truck transport, while Option 2 utilises cableway transport.

Operation	Option 1	Option 2
Earthworks	$8.50	$2.90
Extraction	$18.00	$19.00
Transport	$3.60	$14.00
	$30.10	$35.90

On the basis of operational costs alone, a planner may choose Option 1. However, as I alluded to, there are greater risks of environmental damage associated with this option. The estimation of environmental costs of each option is subjective, but of course will depend on the sensitivity of the region to environmental impact.

In estimating an environmental cost for the operation several things must be considered:

- the maximum fine under the RMA for environmental impacts is $200,000
- rehabilitation costs associated with residue management, putting roads and tracks to bed, oversowing, amenity planting and so on may mount to several $/m³
- environmental bonds may be in the order of $50,000
- the cost to future operations (public acceptance, consents and so on) may mount to hundreds of thousands of dollars.

In the case of the example above, which was a highly sensitive 45ha area, the difference in system rates of $5/m3 amounts of approximately $100,000 for the entire operation. Because of the increased risk of impact from Option 1 it may be pertinent to estimate the environmental costs offset the difference in operational costs.

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