# Airships: Worth a Closer Look

*Abstract*

*There has been a considerable amount of research and development undertaken over the last 25 years in the field of airship-logging. This paper reviews that work in light of the likely future trends in New Zealand's logging and log transport requirements. The review incorporates consideration of likely developments relating to environmental requirements, realistic pricing of roading infrastructure and alternative forms of transport.*

*If there are advancements in airship technology together increases in the costs of road transport, then it is probable that the forest industry in New Zealand will be seriously considering the use of airships by the year 2000.*

## Introduction

In the early 1980s industry magazines frequently contained articles on new concepts and developments with airships. Since then, very little. What has happened and why? Are airships worth a closer look?

Before answering these question I will go through the history of using aircraft for forest product transport, look at the potential benefits and the circumstances in which they may be used.

## The History of Airship Logging

The idea of using airships for logging is not a new. Balloon logging was used in Sweden in 1956 and 1957. They used a balloon filled with 500 cubic metres of Helium to transport logs to the landing site. Similarly in 1963 balloons were used in both Oregon and California (USA) to help transport logs down to the landing sites.

On a different scale altogether, in the late 1950s Frank Piasecki began work on what was to become known as the Piasecki Helistat. As Mitchell[1] noted, in essence Piasecki's design was based on the idea of using an airship to make helicopters "weightless" and therefore more fuel efficient (Piasecki himself was a former helicopter designer). Piasecki's design included using an elongated blimp with two sets of struts and beams strapped to its underbelly supporting a total of four helicopters, each with 1525HP. A grandiose proposal, the finished product was going to be 10 stories high and longer than a rugby field, with a haul capacity of 25 tons. However following numerous delays and massive cost overruns (the project was being financed by the US Forest Service) when it finally did get into the air in 1985 during its initial test flights it unfortunately crashed and burned at Lakehurst, New Jersey.

Other airships have had similar misfortunes. As Mitchell[2] again noted, the Cyclo-Crane (invented by D.B. Doolittle and A.G. Crimmins and developed by AeroLift Inc. of Tillamook, Oregon) had a similar fate. The Cyclo-Crane was a large balloon

[1] **Mitchell, S.** "Lighter-than-air craft could cut coastal logging costs", *Logging & Sawmilling Journal* February 1985, p.44.
[2] Ibid., p.45.

with four wings. The wings were designed to "fly" the balloon like a plane. As Schabas and Douglas noted[3], when the balloon was loading or unloading the helium-filled balloon would revolve at 16 RPM. As it picked up speed in forward flight, the rotation would slow down to compensate for the increasing velocity of the wings *vis-a-vis* the air. This was so the wings always have a constant velocity - a combination of rotation and forward speed. In 1982 AeroLift completed a 1.8-tonne test model of the Cyclo-Crane. Unfortunately before it was able to be tested an unusually heavy windstorm ripped it from its moorings, and it crashed into a nearby field. AeroLift then rebuilt a test model of the Cyclo-Crane in 1985 which was tested and, as of 1988 (the last available reference on the subject[4]) its test results looked promising.

More recently in 1992, the "Spyder" balloon/cable hybrid, has shown promise[5]. Developed by Dale Hoke, a 360Kg working prototype was trialed over a 127 day period starting in June 1992. The test results of the prototype were reported as very encouraging. It appeared easy to operate, it had a very respectable load capacity given its size, and, probably most importantly, it safely withstood several thunderstorms, when bedded down[6].

**Aircraft Logging**

Throughout the world, and particularly in the USA at present, there is a move towards "ecologically sound" forestry[7]. Great emphasis is being placed on the "development of a better scientific understanding of basic ecology and methods of management that reduce environmental impacts[8]" of forestry. Within this current environment, the potential of airship logging is being reviewed[9].

An obvious case for the use of aircraft in logging is where the cost of road access is very high. Where access costs are high (up to NZ $200,000 per km[10]) and/or timber volumes are low, the construction of roads would result in a high cost per unit of timber extracted. Aircraft logging may be the only economically viable option.

If re-establishment of the area is intended after foresting, then the benefits of roading must include its subsequent use for planting, tending and production thinning.

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[3] **Schabas, W. & Douglas, J.** "This balloon with wings could dominate 20% of logging in B.C.", *Pulp and Paper Canada* Vol.80, no.12.

[4] **Lambert, M.B.** "Full Suspension Logging With a Powered Balloon", in *Pacific Northwest Skyline Logging Symposium* 7th: Portland, Oregon: 1988, p. 142.

[5] **Lambert, M.B.; Hoke, D.; Bergstrom, G. (1992)** "Lighter Than Air Logging Under Multiple-Tethered Ground Control", International Mountain Logging And Eight Pacific Northwest Skyline Symposium.

[6] Ibid., pp.115-119.

[7] Ibid., pp. 108-110; and **Whittenbury, C. G. (1992)** "The Aerial Forestry Initiative", International Mountain Logging And Eight Pacific Northwest Skyline Symposium.

[8] **Forest Service (1990)** *The forest service program for forest and rangeland resources: a long-term strategic plan.* USA Forest Service, Washington D.C. p.1-7.

[9] **Lambert, *et al* (1992)** *op. cit., p.115.*

[10] Ibid., p.43. Note currency converted in New Zealand dollars.

Aircraft logging can also be used where traditional logging places too large a disturbance on the general public, due to road closures etc. Recent logging in the Tongoio forest in Hawke's Bay is a good example of this. There could be up to ten minute delays per cycle with cable systems which the public would regard as unacceptable compared to thirty second delays with a helicopter, which was acceptable.

The combination of conventional transport costs, environmental constraints, and the value of the log will determine the situations where aircraft have to be considered. These have already arisen in New Zealand in respect of high value indigenous logs (Timberlands, Westcoast) and have been used in actual forest operations (clearfelling P. Radiata and P. Nigra in Tongoio), thinning CHH Napier and clearfelling CHH Thames.

| Situation | Site | Log Value | Stand Density | Haul Distance | Road Costs | Road Environment Impact |
|---|---|---|---|---|---|---|
| Indigenous Selection | Westland | High | Low | Long | Very High | High |
| | Northland | High | Low | Long | Very High | High |
| Exotic Clearfell | Tongoio | Medium | High | Short | Very High | Very High |
| Exotic Thinning | Napier | Medium | High | Short | ? | ? |
| Exotic Clearfell | Thames | Medium | High | Short | High | High |

The trends in each of the aspects that influence the decision on aircraft logging seems clear even if the magnitude and rate of change is not:

- conventional transport costs
  - will increase
- environmental constraints
  - will increase
- value of the log
  - will increase

The result will be increasing consideration of the use of aircraft in logging.

**The Limitations of Aircraft Logging**

There are two important factors limiting the use of aircraft in logging:

(1) The costs involved in using the aircraft. One approach to reducing helicopter logging costs has been the development of the K-Max helicopter which is a small purpose-built logging helicopter with low operating costs and relatively high payloads.

(2) The immature nature of the market. There is a lack of both volume and continuity of work. Consequently there is a lack of effective competition within the logging aircraft market.

The use of helicopters in logging in New Zealand is a recent phenomenon.

N.Z. Logging Industry,
Research Assn. Inc.
P.O. Box 147,
Rotorua

First tried in 1980s, the recent work with the Bell 214ST and 205 and the Hughes 500C has provided sufficient evidence to suggest they are economically viable in an increasing number of situations.

There are, however, still very few helicopters at present in New Zealand doing logging work. The reason for this is the large machines need continuity of work in order to minimise the high fixed capital cost. This means that there is little competition in the provision of helicopter logging services and prices are probably higher than would exist with a bigger market.

There has not yet been any airship or balloon logging in New Zealand. It is unlikely that research and development will take place in New Zealand given the level of high risk investment required and the limited resources the local economy and forest industry.

**Airships Vs. Helicopters: Performance and Costs**

Helicopters are presently used in logging remote and inaccessible forests in New Zealand. However there are two barriers restricting their widespread application: cost and production rate. The ownership, operating, and maintenance costs of heavy-lift helicopters are high ($4,000 - $8,000 per hour).

Airships can carry out logging in unroaded areas. As noted by Lambert[11] airships offer the following theoretical advantages:

- are self-powered in getting to the unroaded logging sites;
- can vertically lift and lower trees and logs;
- possess full suspension inhaul;
- have accurate placement of lift hook and payload;
- have up to a 16 ton load capacity;
- can make fast U-turns;
- have relatively low ownership and operating costs;
- can hover and unload at low engine speeds for fuel economy;
- produce minimal wind for ground personnel to contend with during unloading;
- require minimum ground area for mooring and can be tied down during adverse weather; and
- production rates can be easily accommodated by existing ground crews.

Airships are also fast. One airship already at the prototype stage[12], developed by Nick Woll from Oregon, USA, is capable of travelling at speeds in excess of 120 Km per hour and can accelerate from 0 to 90 Km per hour in about 5 seconds, when unloaded.

The ownership costs of such a balloon, when compared to those of a helicopter of similar capabilities (eg a Vertol 107), are claimed to be very favourable. With an initial investment cost of about NZ $4 million, an amortisation period of 10 years, 20 percent salvage value, interest at 10%, and 1600 productive hours per year, the cost of ownership of a

[11] **Lambert, M.B. (1988)** *op cit.*, p. 142.

[12] Ibid., p.143.

production run powered balloon is estimated to be about NZ $440 per productive hour. The ownership cost is claimed to be conservatively estimated at less than 50% of the cost of a comparably rated helicopter on a productive hour basis.[13]

**Safety Factors**

Helium-filled airships have one very significant safety advantage over helicopters - if you make a mistake in a helicopter you have dead men and broken machinery all over the mountain side. With an airship nothing much happens. If you should attempt to lift a load that is too heavy for it, it simply won't go anywhere (the result of its natural buoyancy from being filled with helium). Airships will not crash due to being overloaded: they simply will not be able to take off. In light of the fatal Russian helicopter crash last year, this fact is significant.

**The Present Situation**

At present, it is believed that there are no airships being used in actual logging operations.[14] There are a number of possible reasons for this:

1. The degree of reliance by the airship developers upon both public sector subsidies. This funding may run out at any time, causing an abrupt end to the research into airship usage.
2. Question marks over airships susceptibility to adverse weather conditions (eg the Cyclo-Crane crash in 1982).
3. The unproven technology, especially in the field of logging.

**Prospects for the Future**

Given the present situation, will airships have any role to play in the future? There are several reasons why they might.

It is probable that road transport costs will substantially rise. This would make the relative cost of using airships correspondingly lower. The costs of road transport may rise for any of the following reasons.

- Greenhouse Effect concerns. The Government in the future will probably enforce charges to road users to pay for the $CO_2$ emissions created by the road construction and use;
- The possible charging in the future for other environmental effects of roads and road use such as accidents, noise pollution, stormwater pollution;
- In the future Government may also pass taxes which force road users to pay the actual economic costs (as opposed to the environmental costs) of their road usage.

Carbon taxes could add up to ten cents per kilometre to transport costs.

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[13] Ibid., p.150.

[14] Private correspondence with Mike Lambert, May 1994.

Other road use externalities could add up to five cents per kilometre to transport costs.

**Capital costs of roads**

At present road users are not charged for the cost of capital that is invested in public roads.

But there are no free lunches and there is no free capital. There is a cost to all the capital that is invested in public roads and it is currently being borne by the taxpayer not the road user. A full discussion of the cost of capital is attached as Annex I.

Shipping has to meet its cost of capital, rail now has to meet its cost of capital, air transport has to meet its cost of capital. It is inevitable that road users will eventually have to face up to paying for the cost of capital invested in roads.

The 11,000 Km of State Highway network is valued at about $16 billion, on a depreciated replacement cost basis, excluding the value of the land. There is a further 84,000 Km of roads, for which no valuation is available; but it seems unlikely that the total value of New Zealand's roads is much less than $30 billion.

On average, 250,000 vehicles travel each kilometre of road per year. Applying a 10% capital charge would result in road users paying an additional 25 cents per kilometre. However, to optimise supply and demand for road transport it is the long run marginal cost (the price of adding the next kilometre to the network) that should be used as the basis for charging users: this figure could be as high as 40 or 50 cents per kilometre.

The effect of introducing realistic capital charges for roading will be to end a long standing tax payer subsidy and significantly increase the cost of road transport, including log transport.

**Conclusions**

1. Road transport costs will rise in the future, possible dramatically.

2. There will be a resurgence in coastal shipping and rail.

3. Aircraft logging is established in a specialist niche in New Zealand.

4. Airships are a form of aircraft that have theoretical potential that has not yet been convincingly demonstrated in practice.

5. The best hope for economic harvesting of many forests in the next century, that are not adjacent to rail or ports, will be airships.

6. Airships will definitely be worth a closer look by the year 2000.

## ANNEX I

### Cost of Capital

### Consume or save

Individuals and society always face a fundamental choice between consuming resources today or saving them and investing in the expectation of future benefits.

Current consumption is only deferred in the expectation that the sacrifice so made will result in increased benefits in the future.

In economic terms the resources that are saved for investment are called "capital".

### The benefits of saving

The amount by which the future benefit of an investment is expected to exceed the current sacrifice is the expected profit or return. It is the reward for taking the risk of forgoing current consumption.

When the aggregate of the investment decisions in an economy is positive the result is economic growth. Without profits there would be no reason for people to invest and economic growth would cease or become negative.

Another name for the reward that the owner of capital expects when investing is the "cost of capital". This cost of capital, or expected return, will be higher in situations where the investor faces higher risks.

### Financial markets

The various processes by which individual savings are gathered together and then distributed among the available investments is the operation of financial markets.

The returns offered to investors (the owners of capital) also act as a means of rationing the available capital between all the investment projects that are available. The financial markets provide an auction system that allocates the available capital and in the process sets the price or cost of that capital.

The operations of the financial markets continually set and adjust the cost of capital. In the process they provide a measure of the opportunity cost of spending capital in any other way. That is, if a person decides to spend the capital, then the market rates indicate the opportunity that has been passed up.

### Types of capital

In the market there are two basic types of capital: debt and equity.

> Debt capital usually has a fixed return (interest rate) and the investor (lender) has a low risk of losing the invested capital.
>
> Equity capital accepts a variable return and a much higher risk of loss. Consequently, over time, the return to equity capital has to be high enough to encourage the holders of capital to take the extra risk.

### Opportunity cost of capital

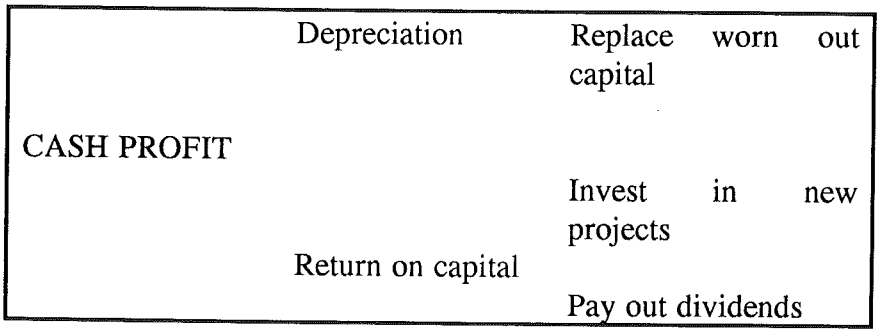
Any activity that uses capital is depriving the owners of the capital (ie savers or investors) of the opportunity of investing elsewhere.

Unless the investors are in some way constrained from withdrawing their capital, they will not leave it invested in that activity unless it is producing a return equivalent to what they could obtain in another investment with similar risk. That is, the activity will have to produce a return equivalent to the opportunity cost of capital for the investor.

All investors have an opportunity cost associated with any investment that they make. They always have to consider and compare the returns that they get from their investment with the returns that they could get from alternative investments.

**Return on capital**

The return on capital comes from the profits that are made by the activity after providing for the replacement of capital equipment that has worn out. This residual profit can be either retained in the business to expand it (thus increasing the value of the owners equity) or paid out to the owner in the form of dividends.




**Government**

In the case of Government activities all those that use capital impose an opportunity cost on Government. This is the opportunity that the Government would otherwise have to invest that capital elsewhere (or leave it in the hands of its taxpayers for them to invest) and get a financial return.

Government business activities should therefore produce a return on capital that is commensurate with the risks of their business. If they do not do so, then they are depriving the Government of the opportunity to obtain a better return for the taxpayers in some other investment. They are also being subsidised compared with their private sector competitors who cannot remain in business without producing an adequate return on capital.

Government services such as roading, defence, justice, treasury, parliament, do not sell services or products to the public and are not typical private sector businesses. They do, however, use capital and where such services do not account for the opportunity cost of the capital that they use, then they are not

showing the full cost of the service that they provide.

**Calculation of cost of capital**

Although it has limitations, the capital asset pricing model (CAPM) is the best available means of calculating the required cost of capital. In essence it takes the risk free rate, which is assumed to be Government Stock, and adds a premium for the risk associated with the activity. The measure of risk is the expected variability in the returns that will be generated by the activity.

This expected cost of capital allows for the fact that there will be periods when the returns will be lower than that calculated and other periods when they will be higher.

**Calculation of returns on capital**

Economic or accounting returns.

Returns on capital are usually calculated from accounting data. Such data does not necessarily reflect the real economic situation because of:

- Timing issues relating to tax liabilities;
- Accounting depreciation differing from the real depreciation of the assets;
- Accounting allowances for stock and work in progress differing from the real value;
- Accounting treatment of leases not reflecting the real obligations.

Empirical studies indicate strongly that market values are set by expected economic returns rather than reported accounting returns.

Relationship of return on capital to business value calculations

The data used to calculate required rates of return in the CAPM are market data that reflect economic rather than accounting results.

Business plans almost invariably report and forecast accounting returns. It would be more appropriate, and consistent with the approach to business value and CAPM, to use or include a calculation of economic returns.

**Economic value added (EVA)**

When an economic interpretation is applied to financial accounts it is possible to compare the economic return earned with the cost of capital for the business and determine whether economic value has been maintained, added or destroyed.

Unless the economic return of the enterprise meets, or exceeds, the cost of capital, then economic value is being destroyed and the government would be better off putting the funds involved into another activity or returning them to the taxpayers.

**Conclusions**

Businesses and Government activities must include a cost of capital in the price of their services in order to show the true cost of their services. Road users should face the full cost of the

capital that they use. Their payments should produce, over time, a full commercial return to the roads owner that reflects the risk of the roading business.