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Airship in wood harvesting: the case of the FLYING WHALES' LCA60T

Stella Yu ZHOU¹, Michèle RENAUD¹

¹ FLYING WHALES, 15 Rue Pagès, 92150 Suresnes, France – stella.yuzhou@flying-whales.com,
michele.renaud@flying-whales.com

Abstract

Forest is a treasure given by Nature with high environmental, economic and societal value. With growing demand on construction and increasing population, the global consumption of timber is estimated to rise. However, today's logging activities remain largely manual, relying heavily on skidder and logging trucks, which require substantial investment in infrastructure. Consequently, it builds up the operational costs and creates destruction to the forest and its ecosystem to a certain degree. Much of the areas remain unexploited, notable on mountains. Furthermore, illegal logging remains a major cause to deforestation and forest degradation, urging forestry management organizations to increase measures to protect forest and preserve biodiversity.

In addressing the social, environmental, and economic problems, FLYING WHALES entered into partnership with the French National Forests Office (ONF) and brings forward a solution that facilitates logging operations while preserving forests. Alternative to current operating mode, the airship LCA60T debarks felled wood in hover mode and transports them to logistic platforms or directly to sawmills. The LCA60T airship allows harvesting even in remote areas, without needing to build new infrastructure or use existing ones. It supports wood construction by increasing harvest in a sustainable way. Moreover, it helps to better manage forest resources by gaining access to new harvest areas.

This paper discusses specifically the drawbacks and limitations of the current mode of operation by land infrastructure, and proposes two different modes of operations by airship, while providing pragmatic comparison between transport by land vs. air. Overall, the report aims at underlining LCA60T's capabilities in forest exploitation and preservation, by giving a thorough examination of the today's logging value chain and existing challenges and opportunities.

Keywords: sustainable forest management, airship, innovation, low-impact logging

Introduction, scope and main objectives

Skidding and the transport of logs are a crucial part of the supply chain of the wood industry. Today, many challenges remain present in this sector, requiring a revamp in the logistics design: climate change requiring more demand of wood materials in construction so as to contribute to carbon neutrality, the cost of constructing and maintaining roads are ever increasing both economically and environmentally, and the created roads result in an increasing amount of illegal activities.

Since 2017, the project of LCA60T (Large Capacity Airship 60 Tons) of FLYING WHALES has intended to answer the need of ONF (Office National des Forêts¹) to mobilize wood resources in areas difficult-to-access in the French territory. The airship, capable of carrying up to 60 tons of freight, is able to fly over the mountains in hovering, hence reducing environmental footprint and rendering more flexibility of transport.

This study has several objectives:

- ✓ Understand the wood sector and its value chain from logging to transformation;
- ✓ Propose added value of LCA60T in the wood sector to the identified problems;
- ✓ Evaluate global need of airship in wood harvesting.

A) Operational Scenarios with Existing Solutions

Wood harvesting today involves forestry machinery such as skidders, bunchers, loaders, and forwarders. A common schema of the logging and transport process is illustrated below (see Figure 1).

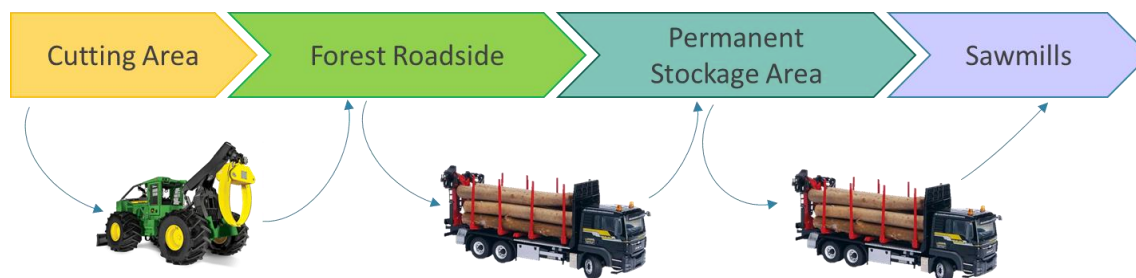


Figure 1: Current Solutions of Wood Harvesting

Today, this process, though much simplified, is widely adopted in the logging industry around the globe for the most part of the forests. However, several operational constraints exist.

First of all, the current machinery and equipment can only work on gentle slopes, where the inclination is less than 30°. This creates an imbalance in terms of exploitation as gentle areas are too much exploited compared to their steep counterparts (30° - 70°) where abundant resources remain untouched. As a consequence, the ecosystem is disturbed, especially in low-angled areas.

¹ ONF is the National Forestry Office of France, under the French Ministry of Agriculture. ONF manages the public forest domain in metropolitan France and in the overseas territories like French Guiana.

Furthermore, on steep slopes, although logging activities can be undertaken by helicopters or by cables, the high cost remains the main blocking point for the generalization logging by this means.

Secondly, in tropical forests, where exploitation of high-valued wood is frequent, weather conditions remain a big challenge limiting the efficiency of operation and transport. In a tropical humid climate, wet season takes up the majority of the time of the year, rendering created forest tracks impossible to access and maintenance high. In certain areas, operators are obliged to create even broader tracks (up to 30 meters in width) as it allows the sun to reflect the road and dry it up quickly for passage of trucks. The limited annual time of operation, possible only during the 2-month dry season, and the prerequisite of creating wider roads again place a limit on the productivity of the logging activities and damages the environment.

Regardless of the types of forests, many challenges are shared as forests remain inaccessible:

- Additional wood resources in natural forests are located in areas that are too steep for logging trucks.
- Some forest areas are sensitive because of clay soil, which limits or obviates use of machinery most of the year.
- It becomes more and more complicated to build access roads because of protected natural areas banning access to these resources.
- In some countries, infrastructure is not developed so as to avoid trafficking (of wood, gold or human).
- Global warming prevents conventional means of logging and transportation to access the resources (ex: permafrost in Russia melted during longer period, banning trucks from classic itineraries).
- Construction and maintenance costs of logging roads are too high compared to expected revenues, inducing negative return on investments.
- Increasing opposition from communities to allow existing road infrastructures' use because of heavy trucks (e.g., 57 tons trucks) damaging them.

B) Operational Scenario with LCA60T

FLYING WHALES will render wood harvesting possible in difficult-to-access zones, i.e. areas which lack infrastructure. The airship LCA60T is a rigid airship with a length of 200 m by a diameter of 50 m. A cargo hold is situated at the bottom of airship that measures 96m long by 8m wide by 7m high. The cargo goes either in the hold or under sling. A hoisting system is developed to allow loading and unloading of cargos with winches. The solution mainly solves two issues: transporting over-dimensional cargos that is complicated to mobilize by infrastructure, and/or providing a logistic solution that contributes to low environmental impact. Examples of applications include wood, renewable energies, industries, constructions, and humanitarian aid and disaster relief.

The operational scenario in the wood application is illustrated as follows (see Figure 2). The LCA60T will arrive directly above the cutting area and load 60 tons of logs into its cargo hold with the help of ground staff. The logs will then be transported directly to sawmills or to transit zones where logs are then loaded on logging trucks and are delivered to sawmills by road.

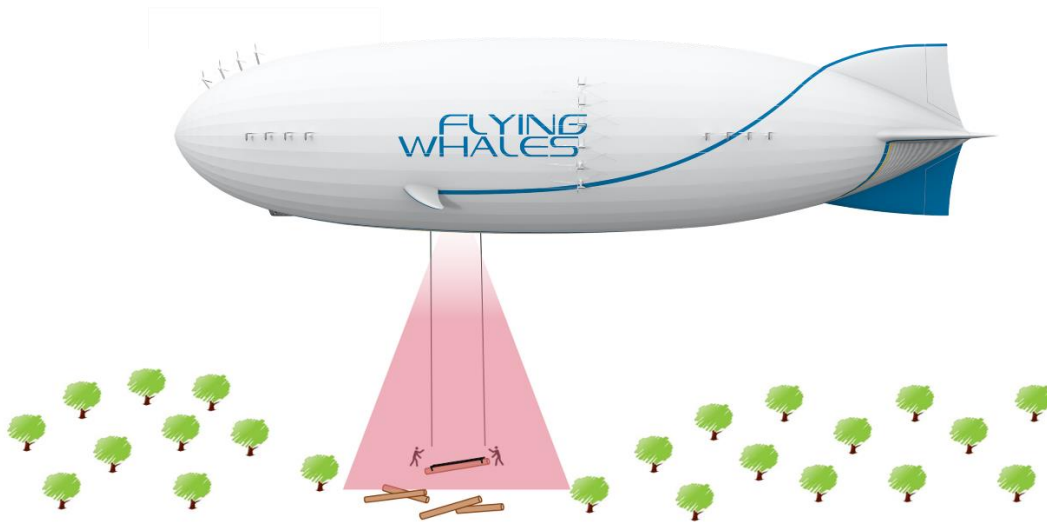


Figure 2: Loading wood on the LCA60T cargo hold (FLYING WHALES)

Two concepts of operation are being considered, corresponding to different types of forests.

The first Concept of Operation is an ideal scenario where the airship replaces the function of skidders in mountain areas. After the trees are felled, the LCA60T comes directly above the cutting area, load the logs, and transport to a permanent stockage area, waiting to be dispatched then by trucks for delivery to sawmills which are located in proximity (see Figure 3).

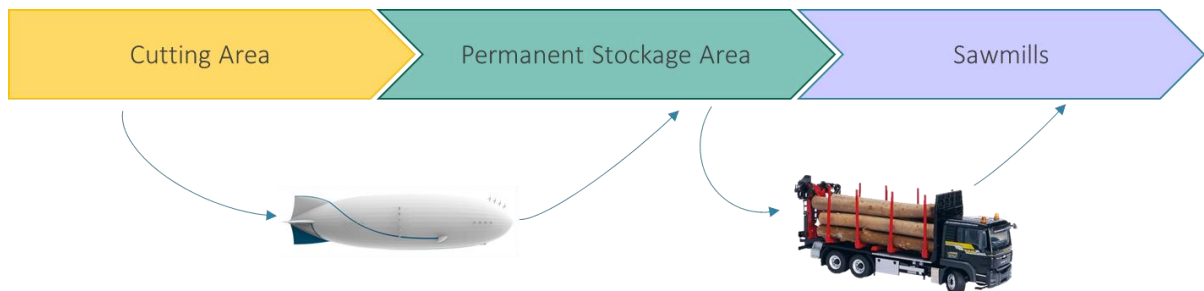


Figure 3: Concept of Operation 1

In tropical forests where canopy is dense, direct loading of trees above a plot could be complex. Therefore, a second scenario is envisaged adapting to this complexity.

In this scenario, skidders will be needed to gather felled trees to a deposit area or roadside in the forest. The airship then loads up the trees from the deposit area and transports to logistics platforms which are accessible all year round. These platforms are usually located near road networks where transport to sawmills is convenient. The truck then comes to pick up wood and delivers to mills (see Figure 4).

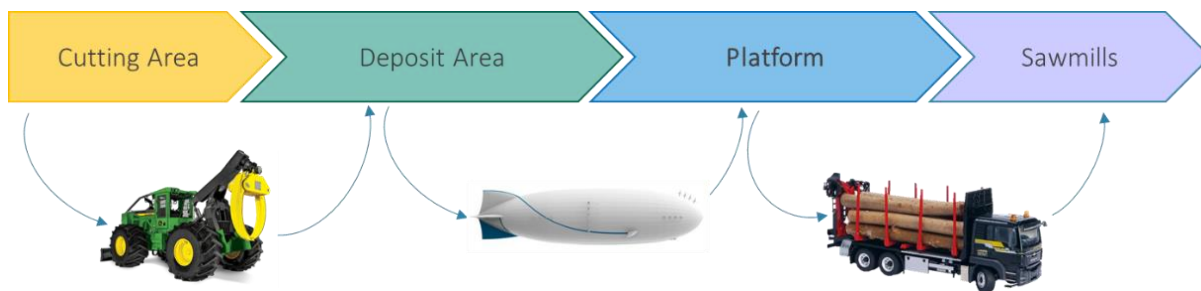


Figure 4: Concept of Operation 2

By this means, FLYING WHALES' LCA60T will avoid the creation of large forests roads and skid trails, which are currently generating a lot of logistical issues and represent a huge budget for communes each year. Wood harvesting and transportation will be easier and simpler.

C) Opportunities and Value Proposition

As illustrated above, the value proposition of LCA60T in wood harvesting is obvious: it is a cost-efficient way of transport allowing accessing to unexploited forest resources while promoting sustainable logging without impacting local ecosystem. Accessibility, efficiency, and low impact are key assets of LCA60T solution in the logging industry, in addressing limitations of current solutions which mainly concerns inaccessibility, inefficiency, and high environmental impact (see Figure 5).

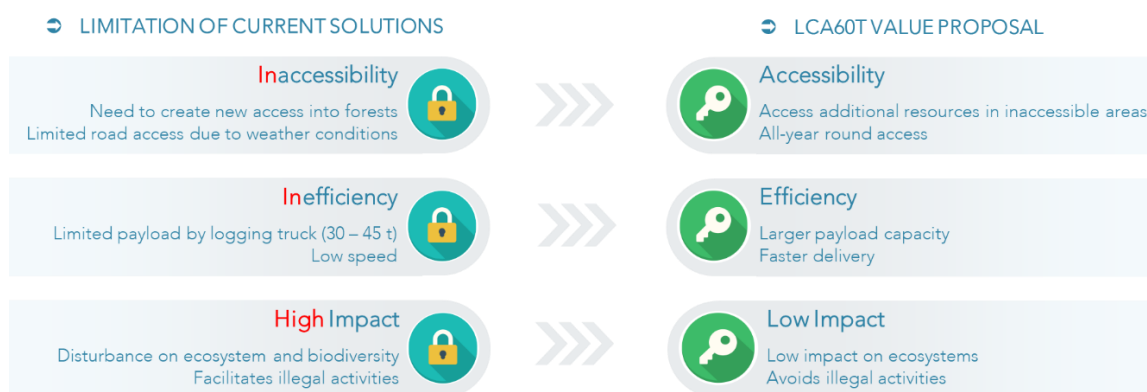


Figure 5: Comparison of Existing Logging Solution vs. LCA60T Value Proposal

Indeed, the global forestry sector is mainly facing two challenges: sustainable wood production and eradication of illegal logging activities. The use of LCA60T will help resolve these problems, in order to provide logging productivity while maintaining sustainability in forests.

Methodology/approach

The calculation of the total market size is based on a top-down approach with public information available from authorities and recognized international organizations. Data from which the calculation is based are extracted from FAO (Food and Agriculture Organization of the United Nations) and ITTO (International Tropical Timber Organization) as these are the only homogeneous sources at a global scale gathered from the declarations of the States², and therefore allow a good measure of the place of tropical timber and timber from boreal and temperate forests with distinctions by type.

Table 1: Data Sources

Data Name	Unit	Source
Forest Area 2018	000 ha	FAO
Log Production 2018	000 m3	ITTO
Export Unit Value 2018	€/m3	ITTO

From the FAO and ITTO data, only natural forests are considered in the calculation, as planted forests generally already have created access and therefore do not face logistics or infrastructural challenges. After filtering log production in natural forests, the global addressable volume is recorded at 1,9 Mm3 per year.

Then, the Annual Need of LCA60T is based on the below formula:

$$\text{Annual Need of LCA60T} = \frac{(\text{Addressable Volume} \times \text{Share for LCA60T} \times \text{Average Density})}{\text{Daily Capacity of Transport by LCA60T}}$$

Detailed explanations of variables are listed below:

Addressable Volume is the total volume of a country that an LCA60T can capture. In most cases, it is the equivalent of Annual Log Production.

Share for LCA60T stands for the share that LCA60T is able to gain from the Addressable Volume. 1% is considered an adequate average share for LCA60T worldwide, taking into consideration of the share of forest difficult-to-access and the potential market share for LCA60T.

Average Density is the assumption for wood density depending on the type of forests/wood, varying between 750 kg/m3 and 1 100 kg/m3.

Daily Capacity of Transport by LCA60T is calculated based on the LCA60T performances and its 60-tonne capacity per rotation, giving a result of 69 000 t/d.

² *Rapport Stratégique Regional - Développement intégré et durable de la filière bois dans le Bassin du Congo.* (2019). <https://www.afdb.org/fr/documents/document/rapport-strategique-regional-developpement-integre-et-durable-de-la-filiere-bois-dans-le-bassin-du-congo-109428>

Results

Overall, 158 LCA60T is estimated for the global wood market, covering the Americas, Europe, Asia, as well as Africa and Oceania.

Table 2: Calculation and Results

Region	Addressable Volume (000 m ³ /y)	Share for LCA60T (%)	Average Density (kg/m ³)	Daily Capacity of Transport by LCA60T (T/d)	Annual Need of LCA60T
Asia (inc. Russia)	543 167	~1%	~1 000	69 000	55
Europe	455 111				28
North America	414 029				17
South America	259 071				43
Africa	71 005				11
Oceania	48 109				4
Total	1 790 493				

The results indicate that the applications of the airship technology in the wood market will mainly be in Asia, South America, and Europe, where the addressable volume is high and the logistics is time-consuming and costly.

The indicated 158 airships are the total market need at maturity, meaning that the market will take several years to fulfill this demand. Political instability, stuttering wood economy and supply chain, outdated logging and milling equipment are factors that could delay the market penetration of new innovations and technology. Therefore, the go-to-market for the LCA60T shall take some time before reaching the expected market size.

Discussion

The paper examines the current operation model in the logging industry which rely on land infrastructure and brings in a new concept of log transport with the airship. While the feasibility of the airship technology is confirmed, thanks to the collaborative study carried out by ONF and FLYING WHALES for the forests in the French Alps, and the global market need is evaluated, certain aspects remain to be explored, especially the ones on the economic and environmental equation.

First, a cost comparison analysis is needed to understand the practicality of such airborne harvesting solution as opposed to the conventional ones. In the current exploitation model, skidders and trucks are the main engines utilized during operation and the key drivers of costs. In Europe, the combined cost of skidding and transport is situated between 25 – 35 €/m³. In some mountain areas, cables are used, with a cost going up to 45 – 60 €/m³. In North America, helicopters can also be used, implying an even higher cost (above 250 €/m³).

Apart from the cost of operation, the cost-saving of creation and maintenance of roads shall also be taken into consideration. In France, an average of 50 k€ is spent on every kilometer of forest road created. If 30 km of road is created per year, a total amount of 1,5 M€ is spent each year on this CAPEX. If this cost is translated into the logging equation, a range of approximately 15 – 30 €/m³ shall be added.

Therefore, for the airship technology to be competitive, the cost per cubic meter shall be within the 40 – 90 €/m³ range. A more detailed study on the cost analysis should be further conducted in order to deepen the understanding of this subject. A similar comparative analysis on the environmental impact shall also be carried out to evaluate to what extent is the airship more environmentally friendly versus its traditional counterparts.

Secondly, more possibilities with the airship logging shall be explored. One of the biggest advantages of the airship logging is a more sustainable and healthy logging method and better forestry management overall, as it opens up new areas for harvesting while limiting the overly logged volume in areas that can be easily reached. Furthermore, logging without creating land infrastructure will also limit illegal activities such as illegal logging and mining that pose a big threat to the environment to many countries that own large forest areas.

Conclusions

In the context of decarbonization and carbon neutrality targets by 2050, wood, as a carbon neutral resource, is undoubtedly pivotal to economic development, especially in the construction sector. However, today, although the global wood consumption has the tendency to increase, the supply often struggles to meet the demand. While the world's forests are far from being over-exploited, a large part remains untouched, and one of the constraints for further log mobilization is the lack of accessibility, notably the lack of access to roads.

This paper acknowledges that the wood logistics is a complex one and is subject to different geographical and climate conditions. The challenges, out of natural or economic reasons, make FLYING WHALES' LCA60T airship solution advantageous in logging activities in out-of-reach forests in a less impactful way.

After examining the needs in different continents worldwide, the paper concludes by confirming the opportunities for the LCA60T solution to enter the wood market. A total of 158 airships is estimated every year on a recurring basis, serving the Americas, Europe, Asia, as well as Africa and Oceania. With the upside of climate change, the competitiveness of airship shall be further increased, as companies will likely be switching away from the road solutions due to increasing maintenance cost of infrastructure and a decreasing number of days of access per year.

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The views expressed in this information product are those of the author(s) and do not necessarily reflect the views or policies of FAO.

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