Report of Lab 2

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Contents

1 Response to Questions on Lab 1

Several questions were raised in the lab 1 report. The following is a response to those questions.

1. *The detail of the failed circumnavigation attempt.*

Answer 1: During an attempt at becoming the first woman to complete a circumnavigational flight of the globe in 1937 in a Purdue-funded Lockheed Model 10-E Electra, Earhart and navigator Fred Noonan disappeared over the central Pacific Ocean near Howland Island. The two were last seen in Lae, New Guinea, on July 2, 1937, on the last land stop before Howland Island and one of their final legs of the flight. She presumably died in the Pacific during the circumnavigation. Nearly one year and six months after she and Noonan disappeared, Earhart was officially declared dead.

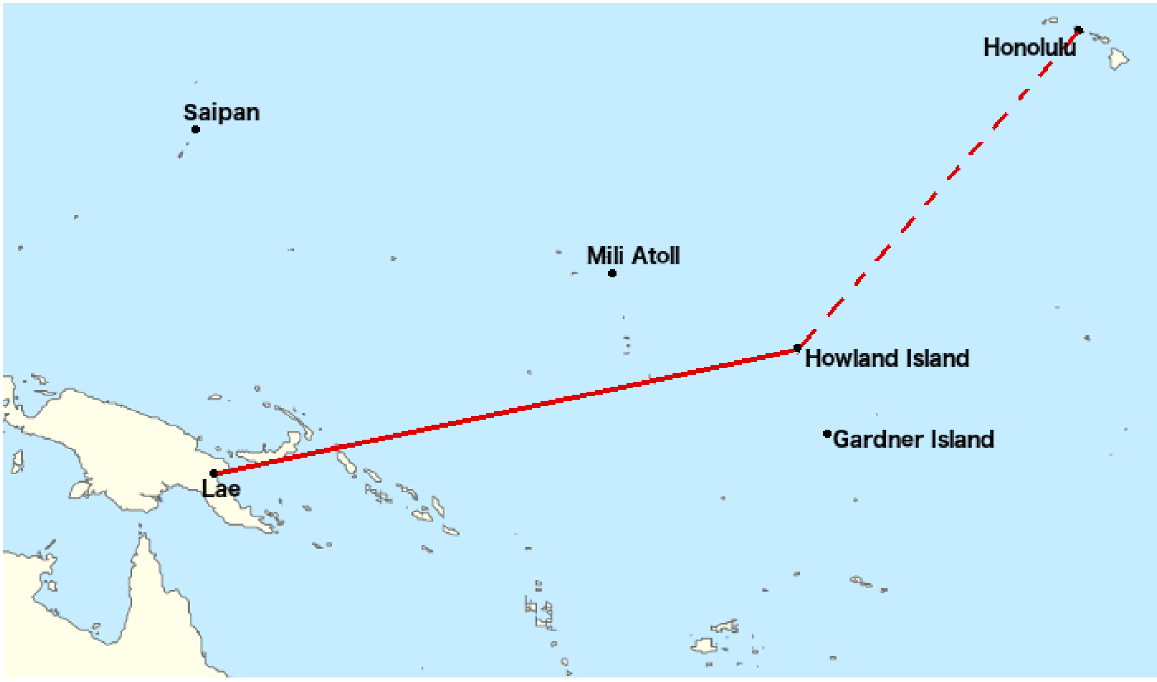

Figure 1: Earhart's last flight path (red) superimposed on a map of the Pacific Ocean. Dashed line indicates the last presumed course from Howland Island.

Many researchers believe that Earhart and Noonan ran out of fuel while searching for Howland Island, ditched at sea, and died. At 6:14 AM Itasca time, Earhart estimated they were 200 mi (320 km) away from Howland. As the plane closed with the island, it expected to be in radio contact with Itasca. With the radio contact, the plane should have been able to use radio direction finding (RDF) to head directly for the Itasca and Howland. The plane was not receiving a radio signal from Itasca, so it would have been unable to determine a respective RDF bearing. Although Itasca was receiving HF radio signals from the plane, it did not have HF RDF equipment, so it could not determine a bearing to the plane. Almost no communications were transmitted to the plane. Consequently, the plane was not directed to Howland, and was left on its own with little fuel. It is widely believed that the plane eventually ended up very close north of Howland Island, or on the way turning to the south to look for the other island, known as Gardner Island (now Nikumaroro).

2. *Why the design failed?*

Answer 2: One of the factors that contributed to the decline of the Model 10 Electra was the introduction of newer, faster, and more efficient aircraft designs. As commercial air travel became more popular, airlines sought planes that could transport passengers more quickly and at a lower cost. The Electra was considered outdated compared to newer planes like the Douglas DC-3, which offered more space, comfort, and speed.

Another issue with the Model 10 Electra was that it had a reputation for being difficult to handle. The aircraft was known for being heavy and hard to maneuver, which made it challenging for pilots to fly in certain conditions. This reputation was further cemented by the tragic disappearance of Amelia Earhart and her Electra.

2 Mission Profile

2.1 Mission Profile regarding the Structure

In terms of aircraft maneuverability, the Model 10 Electra was designed to be stable and predictable in flight, with a maximum design load factor of 4.4 g. The aircraft was not intended for aerobatic maneuvers or high-performance flying, but rather for efficient and reliable transportation.

The impact of maneuvering loads on the aircraft structure was carefully considered during the design process, with engineers using advanced stress analysis techniques to ensure that the aircraft could withstand the stresses of normal flight operations. However, as with any aircraft, excessive or sustained high-g maneuvers could potentially cause damage to the structure or lead to fatigue cracking over time.

The maximum speed of the Model 10 Electra was approximately 210 mph (338 km/h), which was considered fast for its time. The materials used in the construction of the aircraft, including aluminum alloy and steel, were chosen for their strength, durability, and resistance to fatigue and corrosion. However, prolonged exposure to high speeds and stresses could still cause wear and tear on the materials, which is why regular inspections and maintenance were necessary to ensure the aircraft remained airworthy.

2.2 Mission Profile Specific Requirements

The Lockheed Model 10 Electra is a remarkable aircraft that has been designed to cater to various mission profiles. It is a twin-engine, all-metal monoplane whose design reflects both versatility and elegance. Each mission profile has specific requirements that the Electra has been engineered to meet with true values and performance.

For **passenger transport**, the Electra's cabin is required to offer ample space and comfortable seating for proper number of passengers. The seats are required to provide maximum comfort, thereby ensuring that passengers arrive at their destination feeling refreshed and relaxed. In addition to this, the cabin's aesthetic design and finishing exude sophistication and class, to make it a preferred choice for business or leisure travel where luxury is a priority. In practice, the Electra has ample and comfortable space for up to 10 passengers and perfectly meets all the requirements for comfort and sophistication.

When it comes to **cargo transport**, the Electra is built to deliver. Its cargo is asked to provide ample space to carry up as much cargo as possible to across long distances. The cargo hold should also be designed to withstand harsh weather conditions, making it ideal for transporting goods across difficult terrain. Additionally, its robust should ensure that heavy machinery and other bulky items are transported safely and securely. In practice, Electra is able to carry 670 lb (304 kg) mail and baggage. If no passengers are carried, the cargo capacity is increased to 1,984 lb (900 kg).

As for **aerial surveying**, Electra should provide good view of below. In practice, the Electra's sleek design and large windows make it an ideal for such mission. The cockpit offers an unobstructed view of the terrain below, providing an excellent platform for scientific research or environmental monitoring. The aircraft's high-altitude capabilities make it easy to capture detailed images of the landscape from above. This data can then be analysed to gain insights into the environment's changes over time accurately.

In **search and rescue missions**, time is of the essence. The Electra's endurance and range should be engineered to ensure that it remains in the air for extended periods. In practice, with ith a range of 810 mi (1,300 km, 700 nmi) and the ability to stay airborne for up to 10 hours, the Electra covers vast areas of land and sea, providing much-needed support to search and rescue teams on the ground. Its powerful engines and robust construction, as required make it capable of navigating challenging weather conditions in remote locations.

Finally, when it comes to **military reconnaissance** operations, not only the requirements of both aerial surveying and search and rescue missions are needed, but also speed and altitude are essential. Moreover, the aircraft should be well navigated and in good condition of communication to make the reconnaissance successful and mean The Electra's ability to reach speeds of up to 210 mph (182 kn, 338 km/h) at 5,000 feet (1,524 m) makes it the perfect aircraft for gathering intelligence on enemy positions and movements. Its advanced navigation and communication systems provide crucial support to military personnel by relaying real-time data from the skies.

In all, the information above is summarize in the Table 1.

Table 1: Mission Profile Specific Requirements

Mission Profile	Requirements
Passenger transport	(Cabin) offer ample space and comfortable seating for proper number of passenger (Seat) provide maximum comfort The cabin's aesthetic design and finishing exude sophistication and class
Cargo transport	Provide ample space to carry up as much cargo as possible to across long distances Withstand harsh weather conditions Robustness
Aerial surveying	Provide good view of below
Search and rescue missions	Long endurance Long range
Military reconnaissance	Provide good view of below Long endurance Long range Fast speed High operation altitude Good and reliable navigation and communication system

3 Wing structural arrangement

3.1 Discussion of the wing structural arrangement

The Lockheed Model 10 Electra has a complex wing structure, consisting of several elements such as the spars(2), ribs, skin and aileron. The wing structural arangement is shown in Table 2.

3.2 Sketch

Isometric view of the structure is shown in Figure 2.

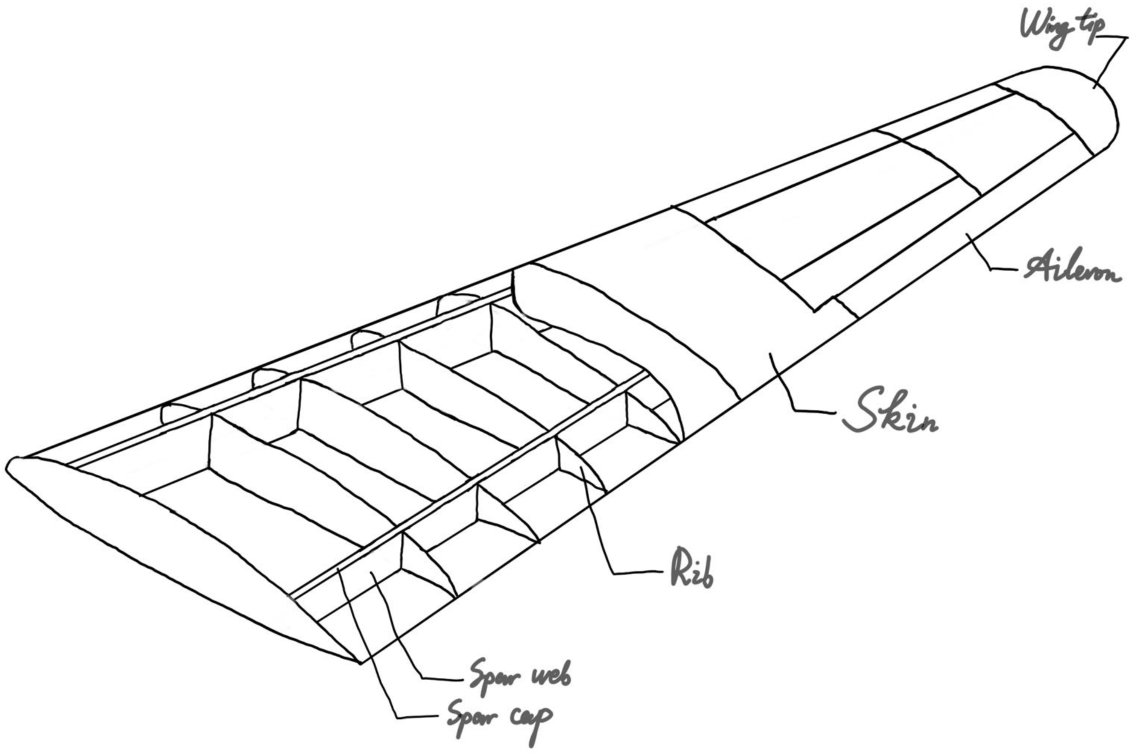

Figure 2: Isometric view of the wing structure of Lockheed Model 10 Electra

Table 2: Wing structural arrangement

Element	Assembly	Load Factor	How It Works	What Does the Element Experience	Raw Material	Load Position/Direction
Front spar	Cap Web	Bending moment, torque Shear force	Transfers lift and drag loads from the wing to the fuselage	Tension, Compression Shear stress	High-strength aluminum alloy	Along the longitudinal axis of the spar On its own surface
Rear spar	Cap Web	Bending moment, torque Shear force	Supports the weight of the fuel tanks and transfers lift and drag loads from the wing to the fuselage	Tension, Compression Shear stress	High-strength aluminum alloy	Along the longitudinal axis of the spar On its own surface
Typical Ribs	Web	Shear force	Gives the wing its airfoil shape and provides support for the skin	Shear stress	High-strength aluminum alloy	On its own surface
Reinforcement Ribs	Cap Web	Bending moment, torque Shear force	Provides additional support to the typical ribs and helps maintain the shape of the wing	Tension, Compression Shear stress	High-strength aluminum alloy	Along the longitudinal axis of the rib On its own surface
Stringers	-	Bending moment, torque	Provides additional support and stiffness to the skin	Shear stress, compression and tension	High-strength steel	Perpendicular to the surface of the skin, along the axis of the stringer
Skin	Skin	Bending moment, torque	Provides an aerodynamic smooth surface to reduce drag	Shear stress, compression and tension	Aluminum alloy sheet	On its own surface
Aileron	Truss Skin	-	Provides lateral control and changes the lift distribution on the wing	Roll moment, bending moment, torque	High-strength aluminum alloy	Perpendicular to the longitudinal axis of the aircraft Along the chord line of the wing