Certificate I: Understanding AI and Machine Learning in Africa

Course AIML02: AI and Machine Learning in Africa

Module 02: Application Case Studies

Lecture 02: Logistics

Carnegie Mellon University
Africa

Learning Objectives

1. Explain the operation of the Zipline blood delivery operation in Rwanda
2. Identify the benefits of delivery by drone in rural environments
3. Explain the different components of a Zipline drone
4. Discuss the importance of a business model for the viability of a drone service

Lecture Contents

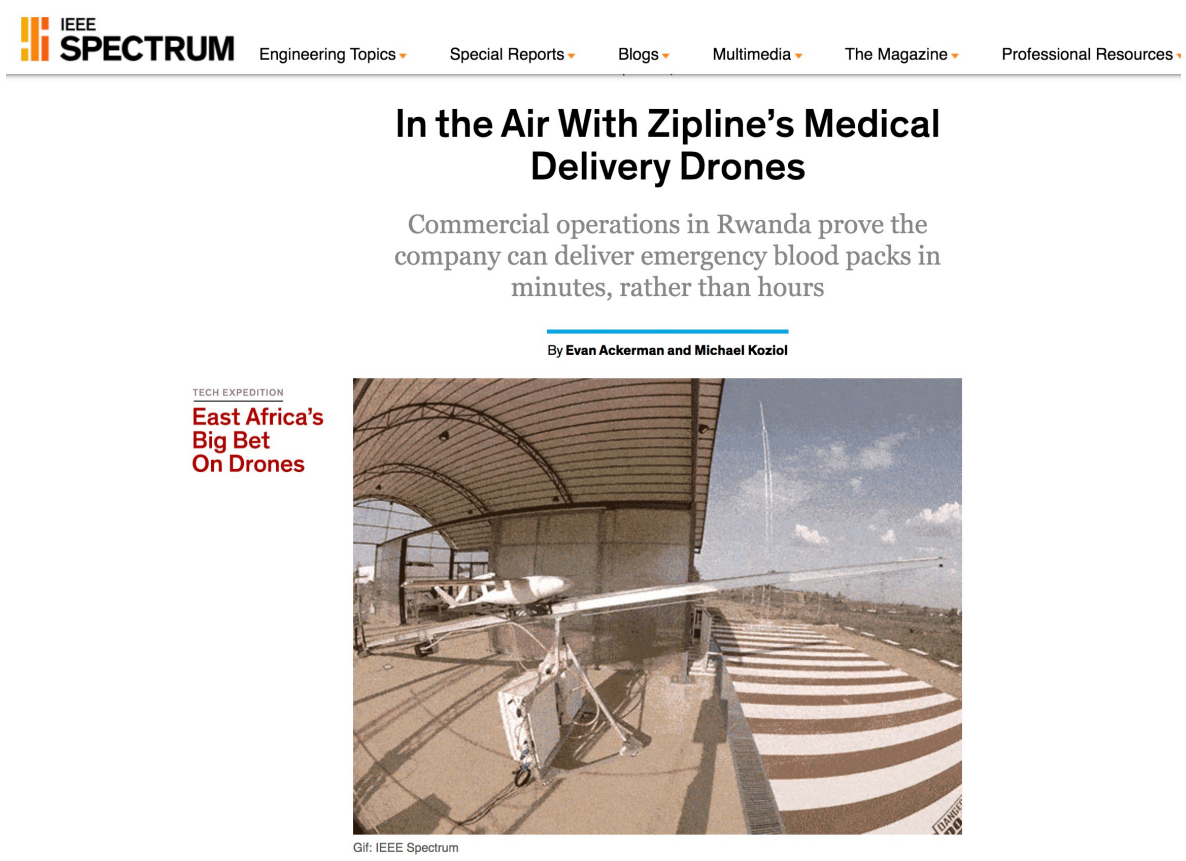
1. Drone delivery of blood products
2. The Zip drone
3. The business model challenge
4. Lecture summary
5. Recommended reading & references

Drone Delivery of Blood Products

This logistics case study is based on an article by Ackerman and Koziol (2019)

The article demonstrates that unmanned aerial vehicles – drones – can play an important role in timely delivery of critical supplies to remote rural locations

It also explains the engineering accomplishments necessary to bring that about



Gif: IEEE Spectrum

Drone Delivery of Blood Products

- Delivery by drone is a futuristic idea that has caught people's imagination
- Amazon, Google, and Domino's Pizza have all given carefully controlled demonstrations of drones delivering their products
- The question is: can a company find a business model that makes drone delivery a sustainable and profitable activity?

https://www.aboutamazon.com/news/transportation/amazon-prime-air-prepares-for-drone-deliveries

Drone Delivery of Blood Products

- Zipline could be that company. It is delivering blood to more than 25 hospitals and clinics across Rwanda every day

- It is betting that delivering lifesaving medical supplies, which are often lightweight and urgently needed, will be the killer app for delivery drones

https://www.newtimes.co.rw/opinions/five-years-later-rwandan-government-zipline-international-have-created-instant-logistics

Drone Delivery of Blood Products

For hospitals in need of critical medical supplies, Rwanda's dirt roads pose a problem

- Blood and blood products have a short shelf life and strict storage requirements
- It is difficult to predict how many packs of each blood type will be needed at a given facility, and when they will be needed

https://www.africanreview.com/

Drone Delivery of Blood Products

On-demand delivery from a central storage location offers a viable solution

- In an emergency, it can take up to 5 hours a blood delivery to arrive via road
- This delay can mean the difference of life and death for the patient

https://www.africanreview.com/

Drone Delivery of Blood Products

On-demand delivery by drones is a viable alternative

Rwanda is the ideal test bed:

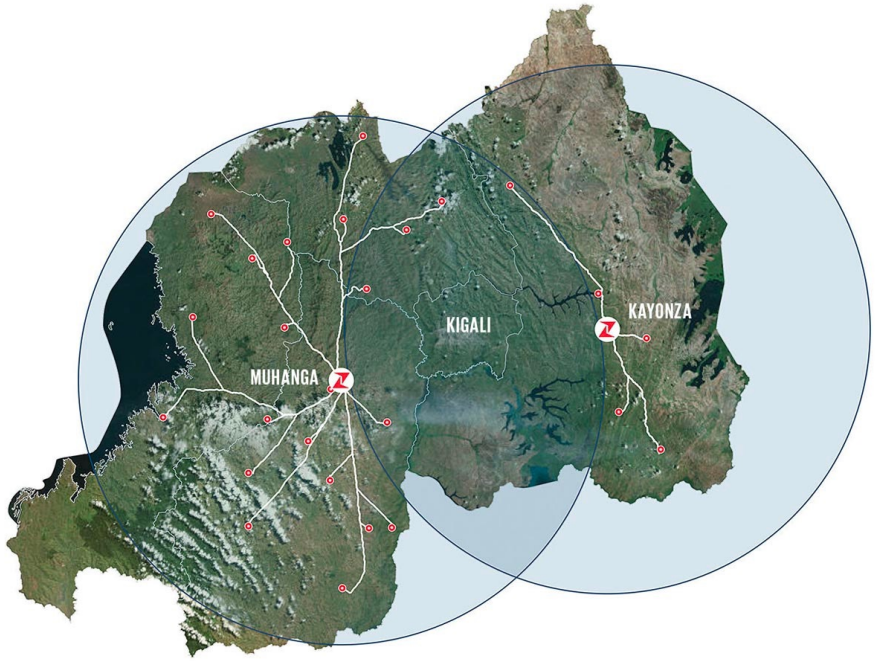
- Challenging terrain
- Relatively small size
- Extensive wireless connectivity
- Receptive government

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

Zipline has two fulfillment centers in Rwanda (which it refers to as “nests”)

- One in Muhanga, about 50 km west of Kigali, the capital of Rwanda
- One in Kayonza, about the same distance to the east of Kigali



(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

When an order comes in from a hospital

- Via phone, website, WhatsApp, or SMS
- A worker wraps the needed packs in padding and
- places the bundle into a bright red box
- which has a wax-paper parachute attached

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

When an order comes in from a hospital

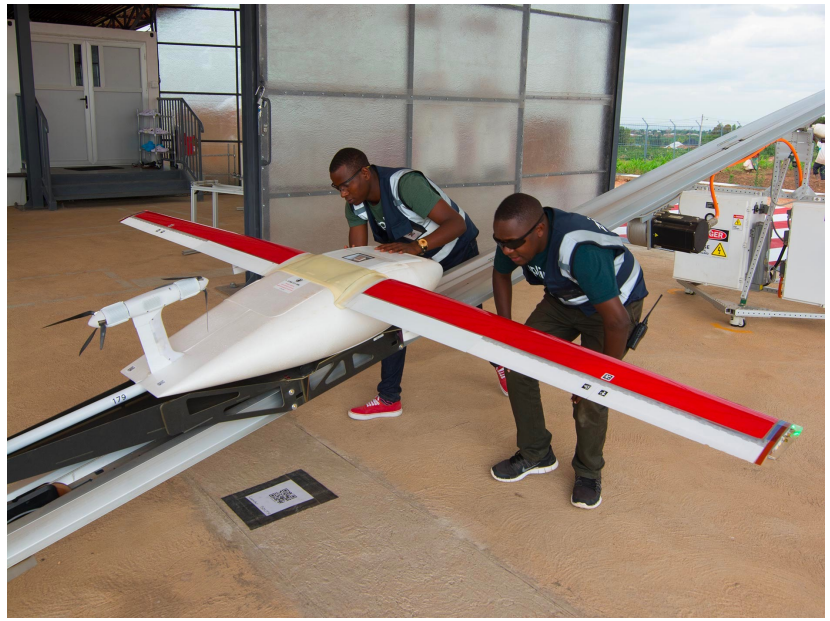
- A technician places the box and parachute in the belly of a drone behind a spring-loaded hatch
- Then snaps a modular battery pack into the drone's nose

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

When an order comes in from a hospital

- Two people carry the drone to a 13-meter-long electric catapult powered by a bank of supercapacitors
- Then run through a preflight checklist with the aid of a smartphone app

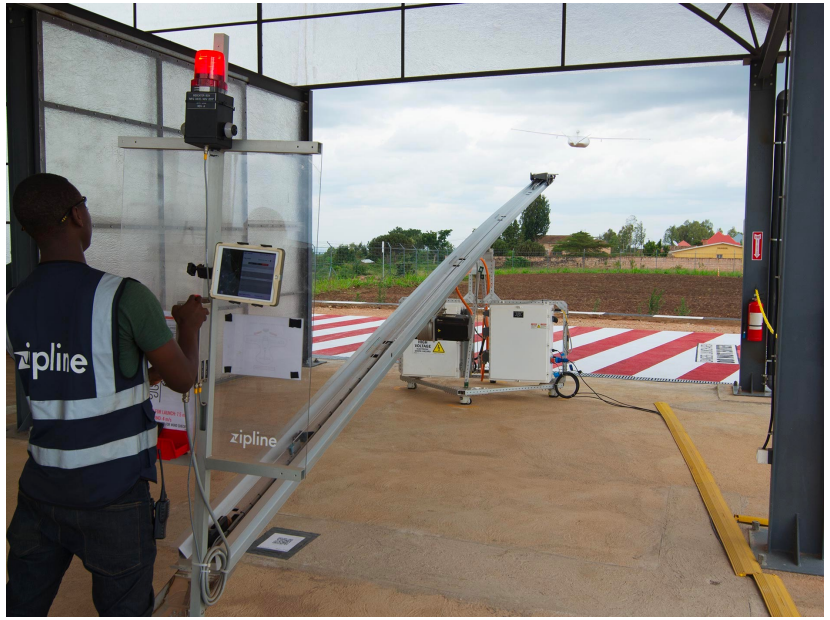


(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

When an order comes in from a hospital

- Zipline confirms the drone's flight plan with the Rwanda Civil Aviation Authority and requests flight clearance
- Finally, the catapult flings the drone skyward, accelerating it to 100 km per hour in half a second
- It swiftly rises over the Rwandan countryside to a cruising altitude of 120 meters



(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

https://www.youtube.com/watch?v=jEbRVNxL44c

Drone Delivery of Blood Products

- As soon as a drone leaves the catapult, it's fully autonomous
- Both Zipline and the Rwanda Civil Aviation Authority track the drone and can redirect it at any time
- In practice, the Zips are mostly forgotten about until they return home, mission complete

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

- The Zip follows a predetermined flight plan, relaying data on its position and status through Rwanda's wireless network
- It also stores sensor data from all its control instruments: approximately 1GB of data per hour of flight
- This is subsequently analyzed to identify ways of improving the Zip's performance

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

- About 5 minutes before the drone arrives, hospital staff members get an automatic text alert telling them to send someone outside to await the delivery

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

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- The pack parachutes safely to the landing point

(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

- About 5 minutes before the drone arrives, hospital staff members get an automatic text alert telling them to send someone outside to await the delivery
- The pack parachutes safely to the landing point
- It is picked up by staff at the clinic or hospital, as the Zip returns safely back to base

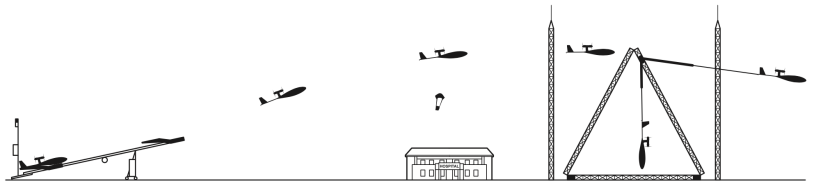
(Ackerman and Koziol, 2019)

Drone Delivery of Blood Products

Landing a Zip safely is a challenge

- The Zipline solution is a system comprising two 10-meter-high truss towers, each with a vertically rotating arm, and a cable is strung between the arms

- As a returning Zip flies between these two towers, the arms rotate quickly upward, so that a metal hook below the Zip's tail snags the cable, bringing the Zip to a stop, and allowing it to drop safely to a suspended position



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Drone Delivery of Blood Products

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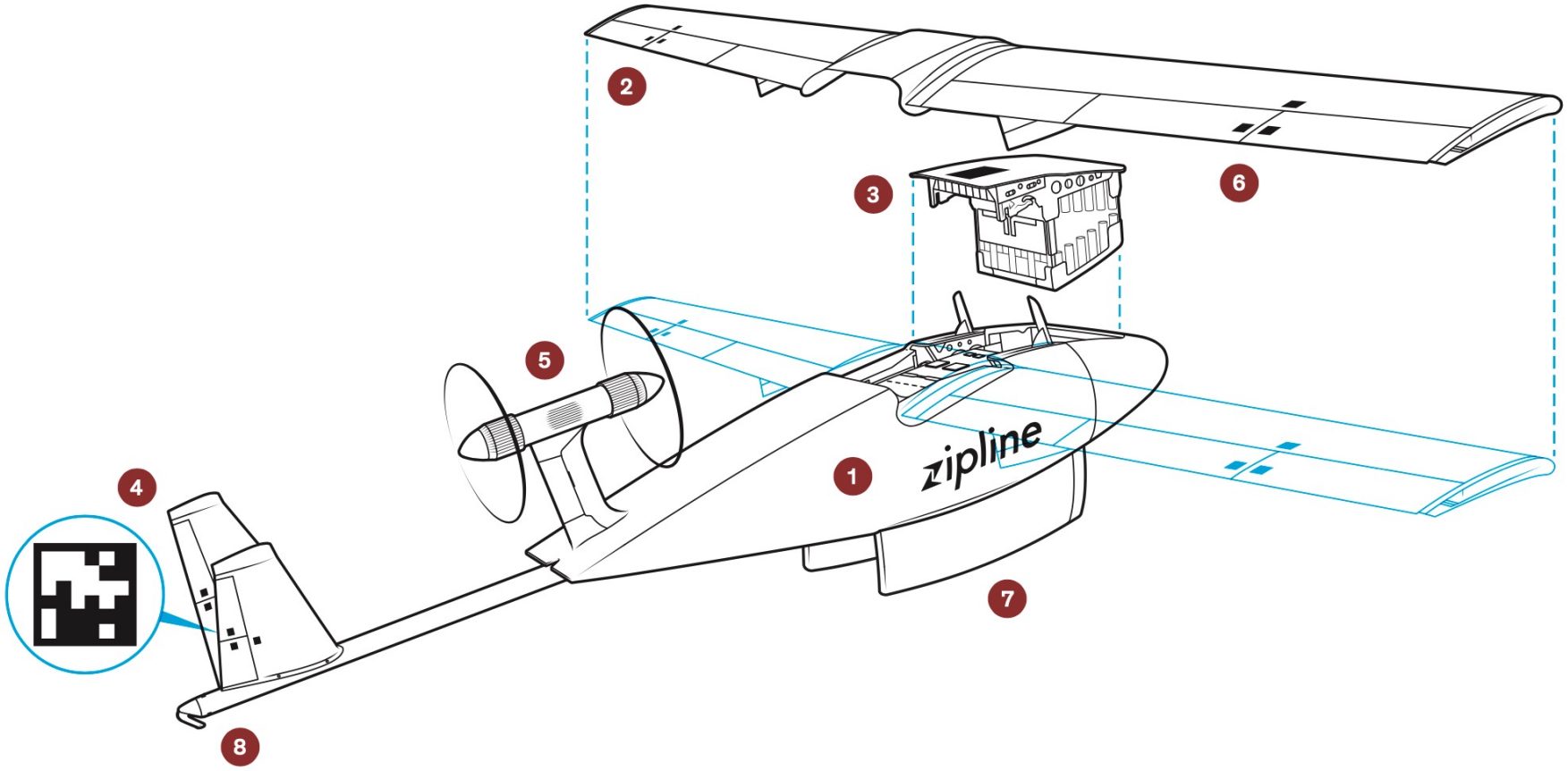
The Zip Drone



The Business Model Challenge

- The Zipline technology is impressive, but innovation requires adoption and a viable business model
- Zipline currently receives subsidies from the Government of Rwanda to make its service affordable for hospitals
- Costs more than routine deliveries by ground vehicle, such as motor bikes, partly because ground vehicles can carry a much bigger load
- But this doesn't matter in the case of emergencies

The Business Model Challenge

- Nevertheless, cost and sustainability are the key issues as Zipline seeks to expand its delivery services to more African countries
  - Its first expansion effort, in Tanzania in 2018, fell through during contract negotiations with the government
  - At the end of 2018, the government of Ghana approved a four-year contract to deliver blood and other medical supplies by drone, worth an estimated US $12.5 million for Zipline
  - The plan for Ghana calls for four fulfillment centers that will make between 100 and 150 deliveries per day, at an estimated per-delivery cost of $17

The Business Model Challenge

Zipline makes the case that, in the long run, minimizing waste in the medical system will help the drones pay for themselves

- In Rwanda, the cost to collect, test, and store a unit of blood is about $80
- Before Zipline began operations, about 7 percent of blood packs expired without being used, costing the Rwandan government more than $1 million annually
- In 2018, the hospitals that Zipline serves wasted no blood packs at all

The Business Model Challenge

"In the distance, we can hear the faint buzz of another Zip returning home after making its delivery of blood. Anywhere else on Earth, it would be futuristic. In rural Rwanda, it's just routine."

(Ackerman and Koziol, 2019)

Lecture Summary

1. The article demonstrates that unmanned aerial vehicles – drones – can play an important role in timely delivery of critical medical supplies to remote rural locations

2. It highlights the many engineering accomplishments necessary to realize an effective service

3. It also highlights the importance of a viable business model to complement the engineering innovation

Recommended Reading

Ackerman E, and Koziol M (2019) The blood is here. IEEE Spectrum 56(5): 24–31, May.

Ackerman E, and Koziol M (2019) In the air with Zipline's medical delivery drones. IEEE Spectrum online, April.
hthttps://spectrum.ieee.org/in-the-air-with-ziplines-medical-delivery-drones

Recommended Reading

How Rwanda Built A Drone Delivery Service

https://www.youtube.com/watch?v=jEbRVNxL44c