



zipline

We deliver lifesaving medicines precisely where and when they are needed, safely and reliably, every day, across multiple countries

Ryan Oksenhorn
Co-founder, Head of Autonomy

Operating 24/7/365, since 2016

Rain or shine

Over 110,000 commercial deliveries

Dozens (if not hundreds) of drones in flight at any moment



*A Zip recovers by an arresting line, during a storm
Muhanga, Rwanda, 2018*

Today we operate 1:20

Scaled from 1:4 in 2016 → 1:12 in 2018 → 1:20 by 2020

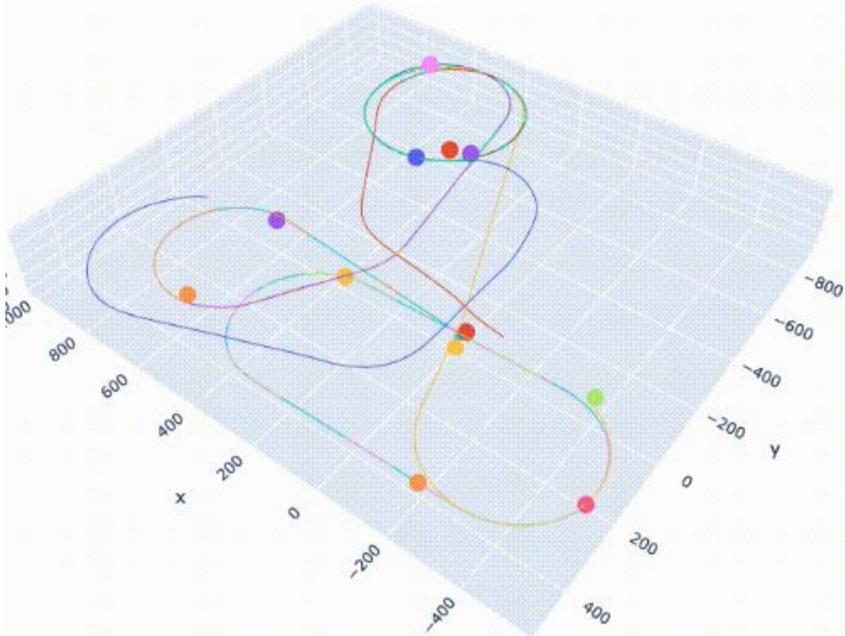
Zero safety incidents



*Our controller (left) with a controller-in-training (right)
Muhanga, Rwanda, 2018*

How our 1:20 works today

Clear responsibility breakdown between the Zip, the Operator, and ATC



Zips are responsible for themselves in flight

- Fully autonomous Zip-to-Zip deconfliction from launch to recovery
- Fully autonomous determination of airworthiness as each flies

ATC responsible for Zip-to-crewed aircraft avoidance

- ATC gives us clearance for each flight plan

Operator responsible for orchestrating the fleet

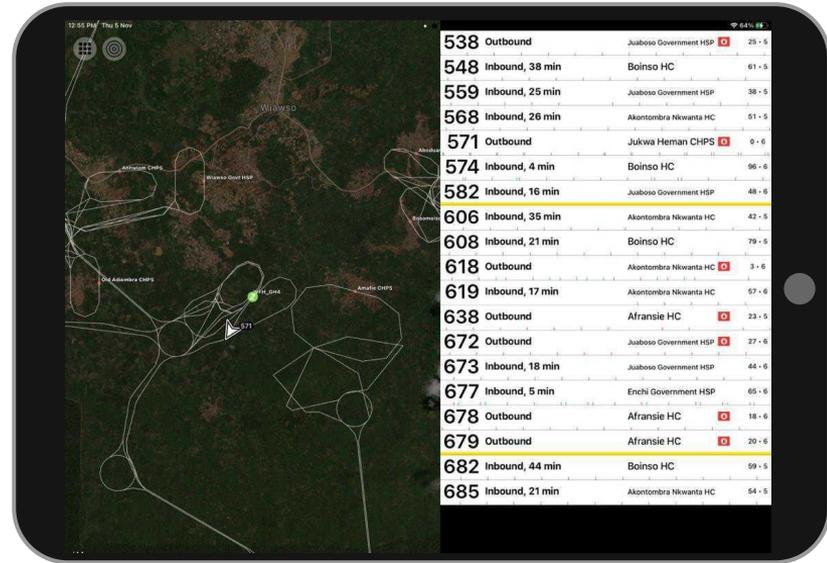
- Pacing launches, monitoring storms, coordinating with ATC
- Issuing area-wide notices

How our 1:20 works today

Tailored user interfaces to make the specified manual tasks very fast

The real world is complicated and could never have been designed for without getting out and flying

Zips fly themselves second-to-second and even minute-to-minute; comms will always be flakey



Custom app for overseeing the fleet at a glance

What comes after 1:20?

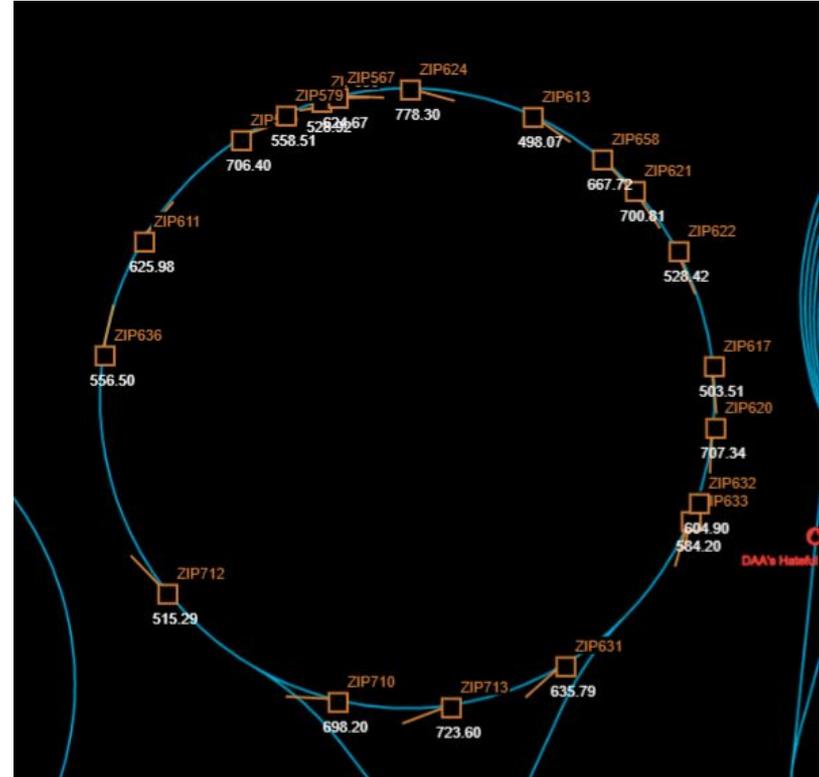
1:∞

1:∞ Operator-to-Zip

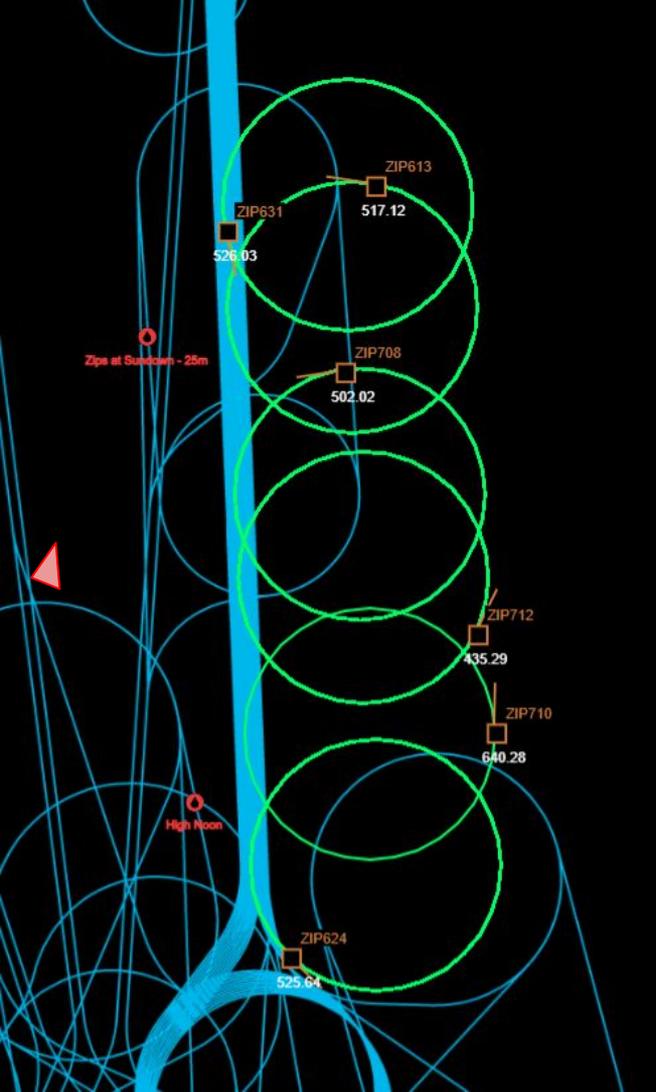
When **N** grows above low-single-digits, no human can maintain situational awareness, responsiveness, and clear-enough judgment to safely **pilot** when things inevitably go wrong.

The tools, processes, and roles we created to get to 1:20 have fully removed the human from any judgment calls on a per-flight basis.

This is effectively no different than 1-to-infinity.



20 Zips managing themselves in close proximity during a simulated failure scenario at a test site in N. California



1:∞ Operator-to-Zip

One-to-many requires full autonomy

Aircraft must be able to get themselves out of tricky situations

It is only realistic that operators oversee and issue blanket notices

e.g. storm warnings, airspace closures

As a crewed aircraft (red) flies by, Zips (orange) autonomously decide to leave their nominal path (blue), with each entering a loiter (green)

One-to-Many in the U.S.

1. Clear responsibility break down for what each party is responsible for
 - a. Embrace proven autonomy (let the drones make decisions)
2. Design dedicated tooling for the roles humans are best suited to play
 - a. Share area-wide information updates
 - b. Not realistic to have context
3. Use real world constraints
 - a. Comms are unreliable
 - b. Scenarios are never as black and white as one might conceive
 - c. Human factors are real (rare scenarios that should be regression tested and built upon)
4. Define overall system safety targets
 - a. And hold drone operations to a very high standard for their safety cases