DESIGN CASE STUDY

PART 1 OF AN ONGOING CASE STUDY

Designing a Drone Console in a Case

Part 1, exploring the requirements for a portable command station

Niki Shu Designs

FINAL DESIGN, FLOCK COMMAND CASE

Rugged case console, lid open, operator view

Product and interaction design case study

October 2026

01 · THE DESIGN CHALLENGE

A command station you can carry

When you fly a small group of drones, the drones are the easy part to carry. Everything that lets one person supervise them safely is not. There are screens to see the flock, a radio and antenna for each drone, beacons so the drones know where they are indoors, batteries, chargers, a computer and the power to run it all. On a workbench that kit spreads across a table and a tangle of cables. Out in the world it has to travel with the operator and work wherever they arrive.

So the idea became a case. Picture the operator walking into a room they have never seen, carrying everything in one hand. They set the case down, open the lid, place a few beacons on the walls, and within minutes the case tells them whether the room is ready. From then on the case is their command station, the screen they glance at, the controls under their hands and the stop they can find without looking.

The case journey

Carry
One person, one hand, through doors and up stairs. Nothing left behind because everything has a place.

Arrive
A room they have never seen, with its own furniture, walls and people. No time to study it.

Open and set up
Lid up, beacons out, power on. The case guides the steps and checks the room.

Ready to fly
A clear go or no go, then a command station that stays calm until it needs them.

> We weren't really designing a box of electronics. We were designing a way for one person to arrive anywhere, be ready quickly and stay oriented while several autonomous machines make decisions around them.

PART 1, WHAT THIS ARTICLE COVERS

This is the first part of an ongoing case study, and it focuses on the case itself. It covers our research, our initial exploration of what the case needs to do, the concepts we sketched and how the design team evaluated them. The on screen interface is part of that story, because the screen is one of the things that has to live in the case, but the case and its requirements are the centre. This is design work, not a field trial. Everything here comes from desk research, sketching, prototyping in software and walkthroughs by the design team. No user testing with real operators has happened yet. Where we describe what we learned, we say how we learned it, and where something still needs testing, we say that too.

Once the lid is open

The situation

Picture a demonstration in a borrowed meeting room. Four palm sized drones lap a course of gates between the tables. An audience stands along one wall. Someone is explaining what is happening while also watching the drones, the people and a screen. Most of the time nothing goes wrong, and that is exactly the problem. When nothing goes wrong for long enough, people stop watching closely, and the first sign of trouble arrives when their attention is somewhere else.

Why a conventional controller is not enough

It assumes one aircraft
A hobby controller is built for one pilot flying one drone with both thumbs. Here there are four, and the person is supervising rather than steering.

It assumes the picture is true
Outdoors, position comes from satellites and is usually good. Indoors it comes from beacons on the walls, and it quietly gets worse behind a shelf or a person.

It hides who is in charge
When software flies and a human can take over, the most dangerous question is whose hands the drone is in. Typical screens answer it in small print, if at all.

> The central tension is autonomy against attention. The more the machines handle, the less the person watches, yet the person is the safety net.

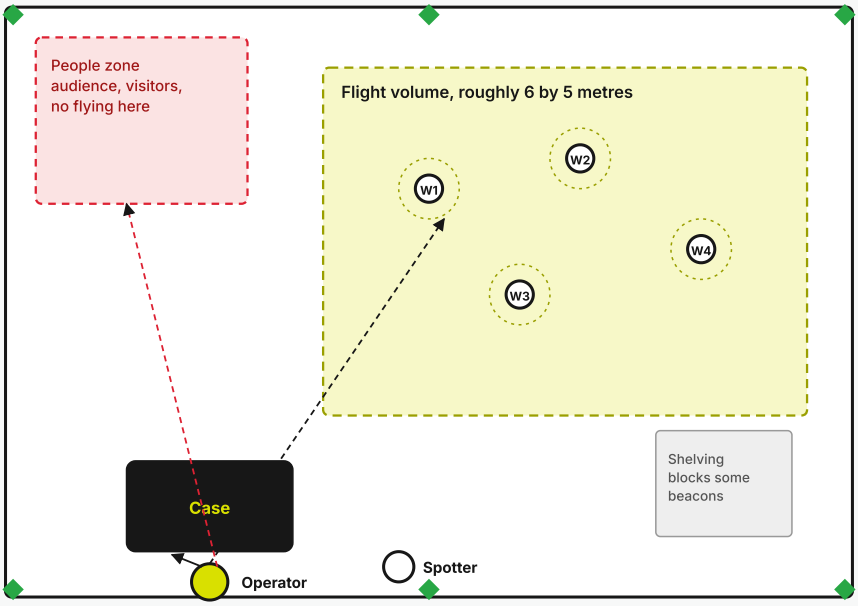
That tension shaped everything that followed. If the design demanded constant attention, it would defeat the point of autonomy. If it asked for none, the operator would not be ready in the few seconds that matter. We needed a case, and a screen inside it, that stays quiet when things are normal, speaks up early and clearly when they are not, and puts the right control under the operator's hand when they have to act.

02 · UNDERSTAND THE CONTEXT

Who stands at the case, and what else they are doing

Before drawing a single screen we tried to understand the place and the person. The context of use changed the problem more than any technical constraint did. The operator is standing, often holding something, talking, and watching a room with people in it. The screen is something they glance at, not something they read.

THE ROOM, SEEN FROM ABOVE



What the operator attends to

- Eyes on the drones in the room
- A glance down at the case
- Ears and peripheral vision on people
- Position beacons on walls

What they are physically doing

Standing, often moving a step or two
One hand holding a grip, one free
Possibly wearing gloves
Talking to an audience or a spotter
Glancing, not reading

Why it matters

Every second spent looking down
is a second not watching the room.
The screen has to be read in a glance,
and safety has to be found by hand.

Context map. The operator's attention is split three ways, between the drones, the case and the people. The design has to respect that split rather than compete with it.

Proto-personas

These are design constructs built from the project brief and our desk research. They are not people we interviewed. We used them to keep three very different levels of experience in view.

PROTO-PERSONA

The builder operator

Knows the system deeply and flies it often. Their risk is trusting it too much on a good day.
Hardest moment a drone behind shelving looks confident on screen but is in the wrong place.

PROTO-PERSONA

The demonstrator

Runs the flock in front of an audience, talking while flying. Attention is always shared.
Hardest moment a visitor walks toward the course mid lap.

PROTO-PERSONA

The safety spotter

Has one job, to stop the flock. May be new to the system and wearing gloves.
Hardest moment cannot find the stop, or is not sure it worked.

A good day, and the hardest moment

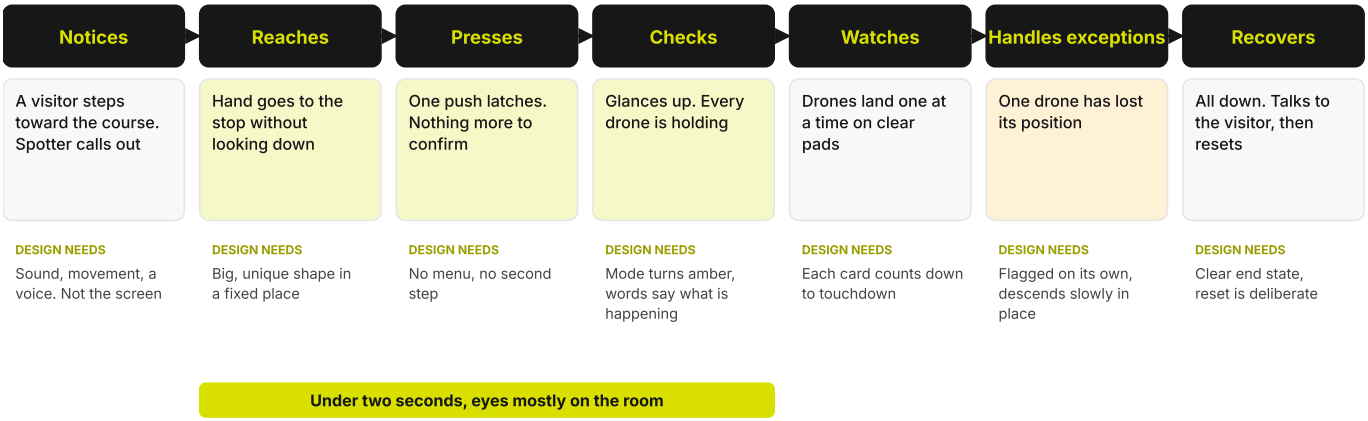
A GOOD DAY

The room is set up, the drones take off, the course runs. One drone runs low on battery and lands itself on schedule. The operator glances down three or four times, answers questions and never touches a control. Success here means the interface was almost invisible.

THE HARDEST MOMENT

A visitor steps toward the course while all four drones are flying. The operator has perhaps a second or two to stop the flock without making things worse. Success here means they did the right thing without having to think about where it was.

THE HARDEST MOMENT, AS A TASK FLOW



Task flow for the hardest moment. Each step shows what happens and what the design must provide. The three highlighted steps have to happen with eyes mostly on the room.

Jobs to be done

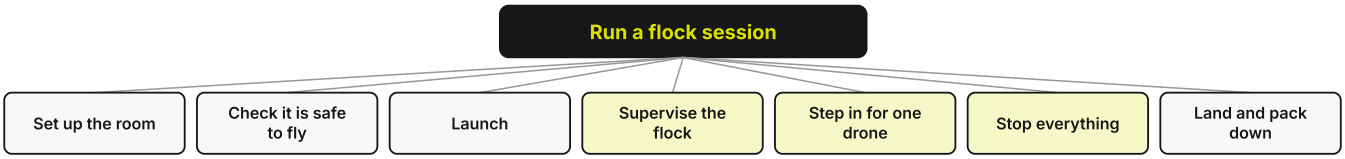
Supervise
When the flock is flying, I want to know at a glance whether anything needs me, so I can keep my attention on the room.

Trust
When a drone looks fine on screen, I want to know whether that picture is reliable, so I am not caught out by a confident mistake.

Step in
When one drone misbehaves, I want to take it over without upsetting the others, so the session can carry on.

Stop
When someone is at risk, I want to stop everything in one movement and see that it worked, so I can deal with the person, not the machine.

Task analysis

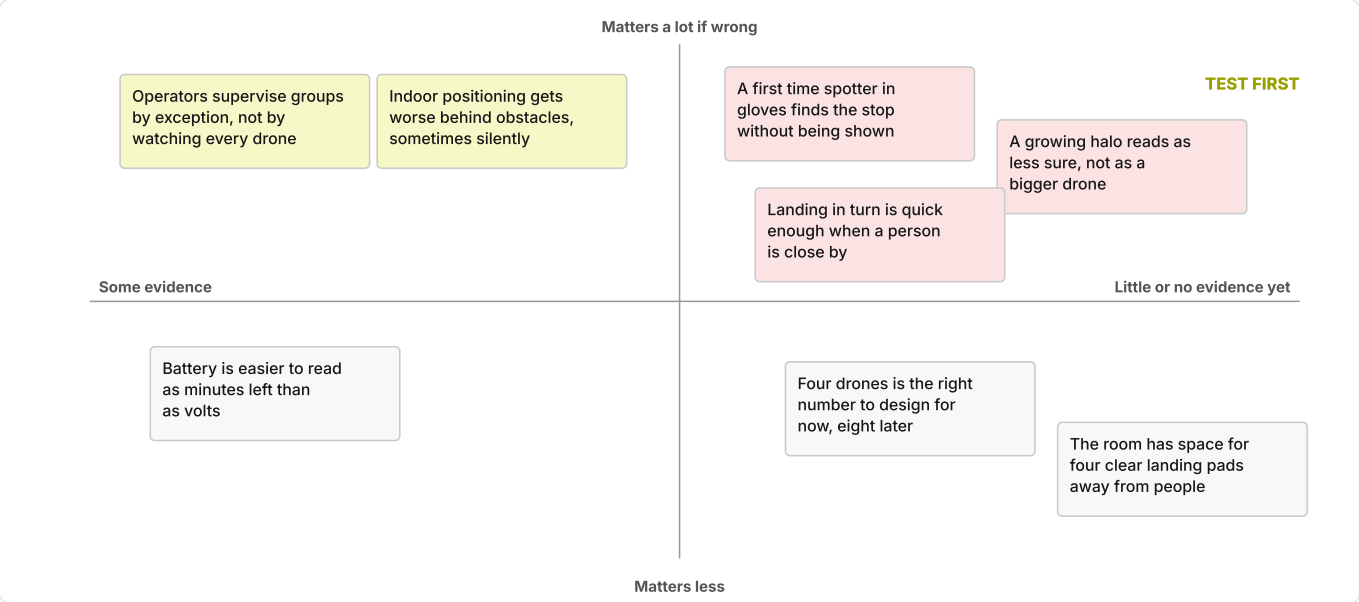


Highlighted tasks happen while the drones are flying, so they carry the most attention cost and became the focus of the design.

Breaking a session into tasks showed us where attention is scarcest. Set up and pack down can ask for focus. The middle three cannot.

What we assumed, and how sure we were

Several of our beliefs were reasonable but untested. Mapping them by how much they matter and how much evidence we had told us where to be careful and what to test first. Assumptions in the top right are the riskiest, because the design leans on them and nobody has checked them with real operators yet.



Assumption map. Pale lime notes are supported by published research we read. Pink notes are high stakes guesses that our proposed tests target first. Grey notes are lower stakes.

How the context changed the problem

From screens to glances

The operator rarely reads. Anything important has to be legible in under a second, by colour, position and shape before words.

From touch to hands

A standing person in gloves will miss small targets. Controls that matter most must be found by feel.

From information to trust

The hard part is not showing where the drones are. It is showing how much to believe it.

03 · DEFINE USER NEEDS

From constraints to needs

Engineering constraints are real, but they are not the brief. For each one we asked what it means for the person at the case, and wrote that down as a need. This kept the technology in its place, as something that shapes the experience rather than something the experience is about.

N1 **Stop the whole flock safely in one obvious action, even as a stranger in gloves**
Because people are close and drones can fall

N2 **Notice when the picture is becoming less trustworthy, before it becomes a problem**
Because indoor positioning degrades quietly

N3 **Never wonder who is in control of each drone**
Because modes change and control moves between human and software

N4 **Understand the state of the group without watching each drone**
Because several vehicles, one pair of eyes

N5 **Find out why a drone is doing something, and what it will do next, only when asked**
Because autonomy makes its own decisions

N6 **Take back one drone without disturbing the rest**
Because problems are usually local

N7 **Be told only what needs attention, in order, with what to do and by when**
Because attention is the scarcest resource

N8 **Know how long each drone can keep flying, in plain time**
Because batteries last minutes, not hours

N9 **Know a new room is safe to fly in before anything takes off**
Because every room is different

N10 **Operate while standing, talking and possibly gloved**
Because the body is busy too

The problem, in one sentence

> A person standing at a portable case needs to supervise several autonomous drones flying close to people, because the software flies but the human stays responsible, and today nothing helps them judge how far to trust the picture, who is in control, or how to step in without making things worse.

How might we

- How might we make the operator doubt the map at exactly the moments the map deserves doubt?
- How might we make stopping the flock the easiest thing to find, even for a gloved stranger?
- How might we show the state of a group so one glance is enough?
- How might we let someone take one drone back while the others fly on?
- How might we make a stop that protects people from falling drones as well as from flying ones?

A simple readiness test

We also wrote seven plain questions an operator should be able to answer at any moment. They became our yardstick for every sketch and prototype.

1. What mode is the flock in?
2. Why is this drone doing that, and what will it do next?
3. How sure is the system, and is that changing?
4. Who is responsible for what, the machine or me?
5. How do I take over, and how do I hand back?
6. What needs my attention first?
7. How do I stop it all, and how do I know it worked?

04 · DESIGN PRINCIPLES

Principles drawn from the context

From the context and needs we wrote six principles. They are not decoration. Each one became a test we applied to every later idea, and several sketches were rejected because they broke one.

Make uncertainty visible

Show how sure the system is, not just what it thinks. Doubt should be visible where the eye already is.

Design for the moment of intervention

Optimise for the two seconds when a person must act, not the twenty minutes when they do not.

Show the mission before the machinery

Lead with what the flock is doing and how long it has. Radios and beacons come second.

Safety should have an obvious physical affordance

The stop is found by hand, shaped and coloured so it cannot be mistaken for anything else.

Exceptions deserve attention, normal operation doesn't

A quiet screen is a good screen. Colour and motion are saved for things that need the human.

Always say who is in control

Mode and control are stated in words, in one place, all the time.

COMPANION ARTICLE

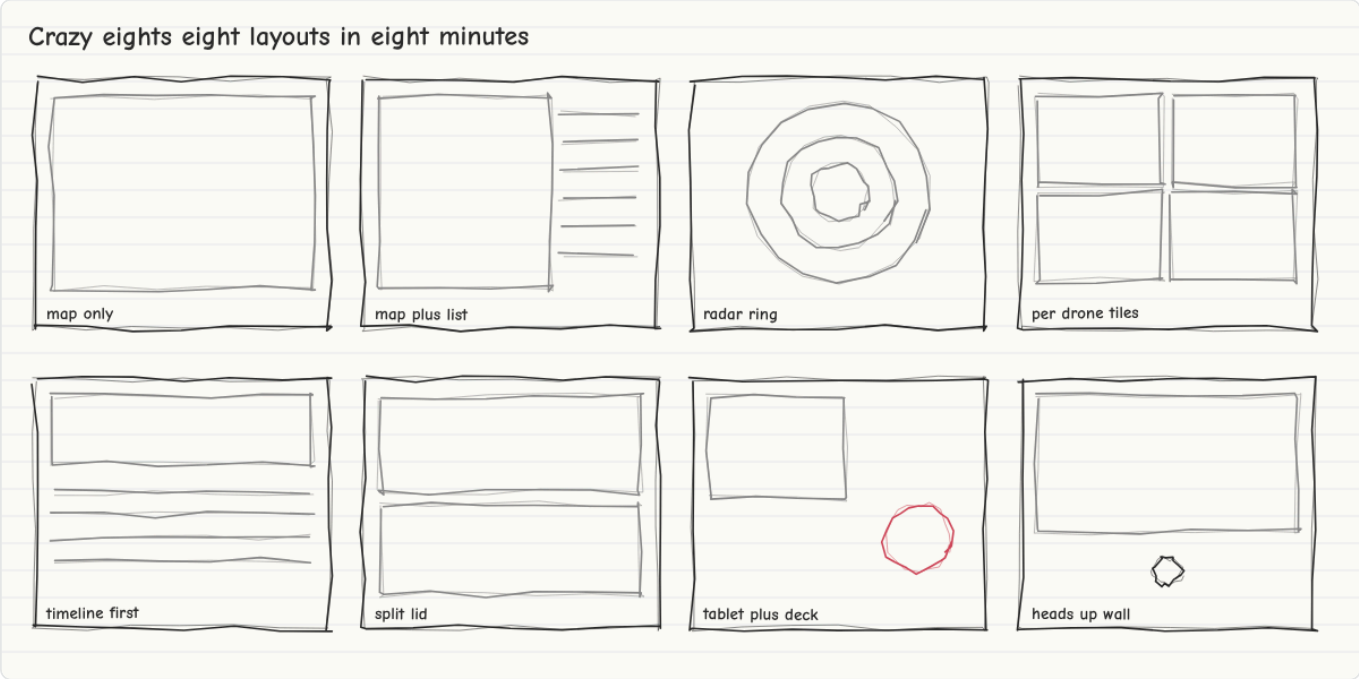
These principles are explored more broadly in the Niki Shu Designs article **Designing Human-Centric Interfaces for Autonomous Systems**, which looks at the same questions beyond drones.

> A quiet screen is a good screen. If everything is highlighted, nothing is.

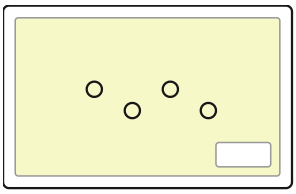
05 · IDEATE WIDELY

Competing ideas, not prettier versions

We started deliberately rough and deliberately wide. A Crazy 8s sheet gave us eight layouts in eight minutes. Then we picked four provocations and pushed each one to an extreme, because an extreme idea fails in a way that teaches you something.



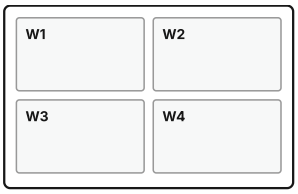
Crazy 8s. Eight layouts in eight minutes, from map only to a heads up wall. Speed was the point, so nobody got attached.



What if the map dominated? Can one spatial picture carry

QUESTION
the whole situation?
Learned, the map is the best way

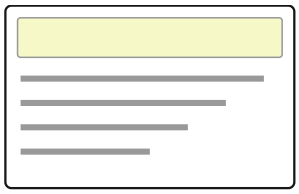
to see where things are, but the worst way to see what state they are in.



What if every drone had equal prominence?

QUESTION
Does a tile per drone help the operator keep track?

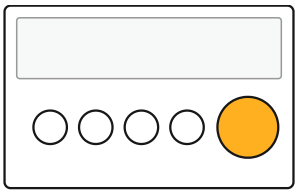
Learned, equal weight means nothing stands out. Four tiles already compete, eight would drown.



What if it were mission based? Does showing the plan and

QUESTION
time left reduce surprise?
Learned, time is the missing

dimension. Battery as minutes and a next handover point survived into the final design.



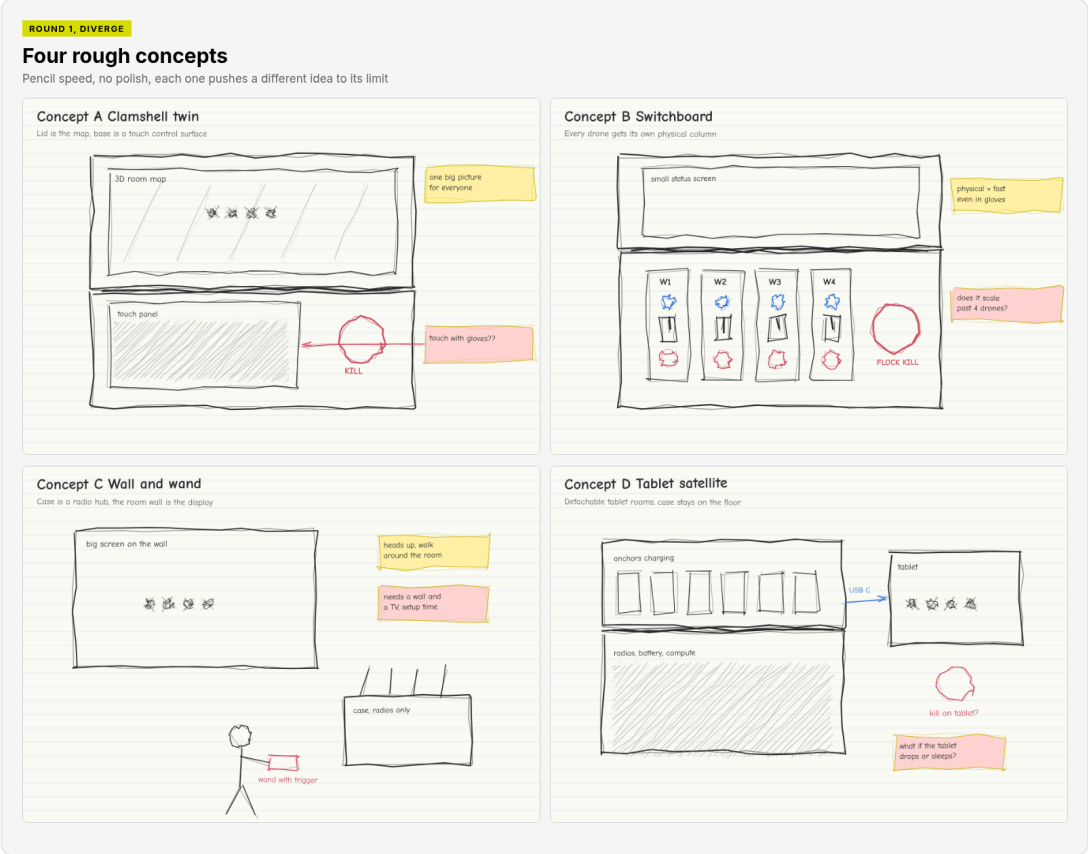
What if critical controls were physical?

QUESTION
Can safety be found by hand without looking down?

Learned, yes for a few things only. Stop, mode and take over earn hardware. Everything else stays on screen.

Four provocations compared. Each asked a different question about the same problem.

Four case concepts, and what each taught us



Round 1. Four physical concepts sketched at pencil speed, with sticky note critiques.

A, clamshell twin

The useful idea here wasn't the layout, it was one large shared picture in the lid that everyone near the case could read. We rejected its touchscreen safety panel straight away.

B, switchboard

This concept helped us discover that physical controls are fast and work in gloves. A column per drone does not scale, so we kept the physical idea and dropped the columns.

C, wall and wand

Heads up and mobile, but it needs a wall and a television, and the stop leaves the case. We parked it.

D, tablet satellite

We rejected this direction because a detachable screen that sleeps or gets dropped would take the stop with it. Its charging bay for beacons survived.

> The stop must never depend on a screen, a sleep timer or a battery that isn't the case's own.

06 · PROTOTYPE TO ANSWER QUESTIONS

Every prototype had a question

We did not prototype to make things look finished. Each sketch, wireframe and software mock up existed to answer a specific design hypothesis. Being honest about which questions we have answered, and how, matters as much as the answers.

	Hypothesis	What we actually did	What we propose next
H1	An operator can read the state of the flock without reading four status panels	Cognitive walkthrough of each sketch round against the readiness test **DONE BY DESIGN TEAM**	Timed glance tests with real operators in a simulator **PROPOSED**
H2	The stop is found without searching, even in gloves	Scenario walkthrough of the hardest moment with paper and software prototypes **DONE BY DESIGN TEAM**	Foam case mock up, first time users in gloves, eyes on the room **PROPOSED**
H3	A growing halo is read as less certain, not as a bigger or closer drone	Heuristic evaluation by the design team **DONE BY DESIGN TEAM**	Comprehension test with people new to the system **PROPOSED**
H4	One drone can be taken over while the others carry on, without confusion about who flies what	Cognitive walkthrough of the take over flow **DONE BY DESIGN TEAM**	Simulator trials with injected faults **PROPOSED**
H5	Landing one at a time is quick enough when a person is close	Not yet tested **NOT DONE**	Simulator timing runs, then a supervised trial **PROPOSED**

Methods we used

Scenario walkthroughs

The design team stepped through five scenarios, including the hardest moment, using each round of sketches.

Heuristic evaluation

We reviewed each round against established usability heuristics and our six principles.

Cognitive walkthrough

For each sketch we asked whether the seven readiness questions could be answered, and how quickly.

AN HONEST LIMIT

All of the observations in this study come from the design team walking through its own prototypes. That is useful for catching obvious problems, but it cannot tell us how a real operator under pressure will behave. The tests marked proposed are the next step, not something we have done.

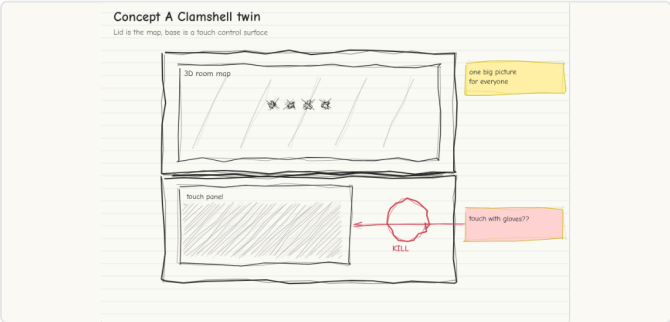
07 · SHOW THE ITERATION

What changed, and why

The observations below come from design team walkthroughs of our own prototypes, not from user testing.

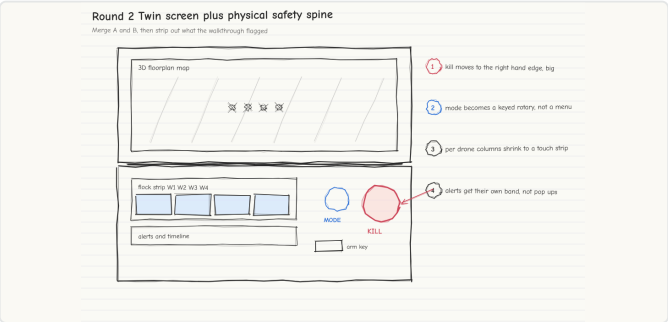
The stop leaves the screen

BEFORE



Round 1, the stop sits beside a touch panel

AFTER



Round 2, a big physical stop on the right edge

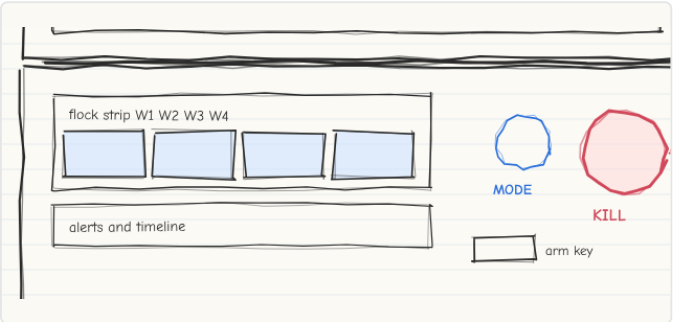
WHAT WE OBSERVED
Walking the hardest moment with concept A, we kept reaching for a panel that might be asleep or covered by a hand.

WHAT WE LEARNED
The stop has to be found by hand, with no dependency on software.

WHAT WE CHANGED
A physical safety spine, with the stop at the right hand edge, mode on a keyed dial and an arm key.

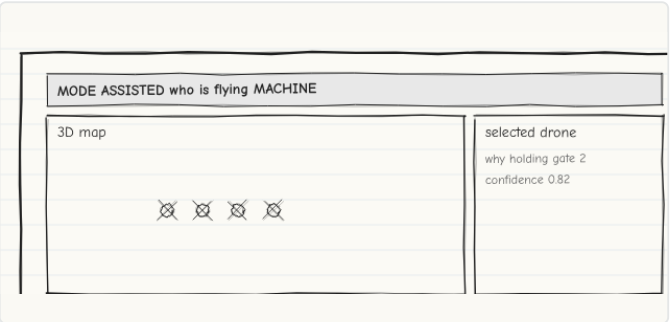
Who is in control, always

BEFORE



Round 2, mode lives on a dial only

AFTER



Round 3, mode and who is flying across the top

WHAT WE OBSERVED
After a simulated take over we could not tell from the sketch who was now flying that drone.

WHAT WE LEARNED
Mode errors are quiet. The state has to be stated, not inferred.

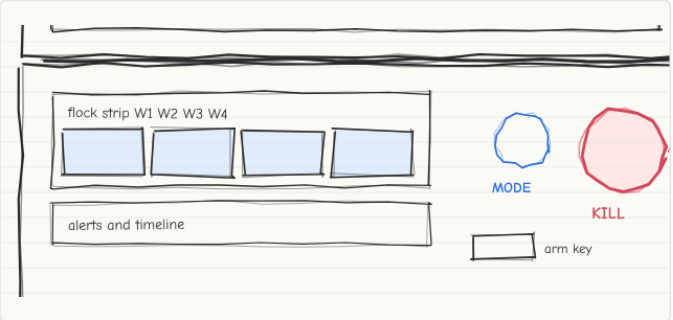
WHAT WE CHANGED
A mode banner and a who is in control panel, in words, always on screen.

07 · SHOW THE ITERATION

What changed, and why, continued

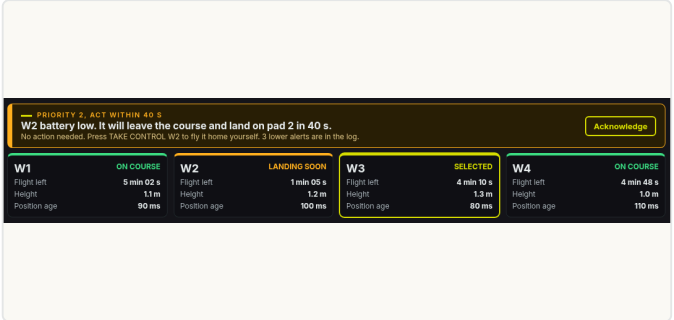
Alerts that wait their turn

BEFORE



Round 2, alerts share a strip with the timeline

AFTER



Final, one alert band with a deadline and an action

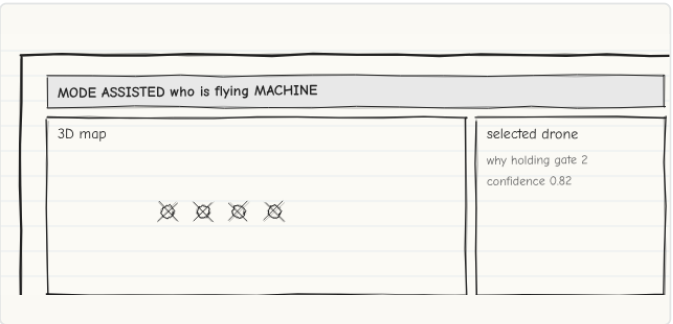
WHAT WE OBSERVED
In the low battery scenario, pop ups covered the map at the moment the operator needed it.

WHAT WE LEARNED
Alerts compete with the picture. Most do not need the human.

WHAT WE CHANGED
One band showing only the top priority alert, with what to do and by when. Everything else goes to a log.

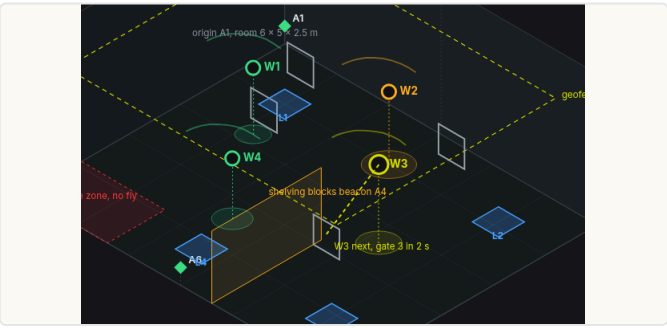
A number became a picture

BEFORE



Round 3, confidence shown as a number

AFTER



Final, a halo that grows with doubt

WHAT WE OBSERVED
In walkthroughs we noticed nobody looked at a number in a side panel while watching the map.

WHAT WE LEARNED
Uncertainty has to live where the eye already is, on the map itself.

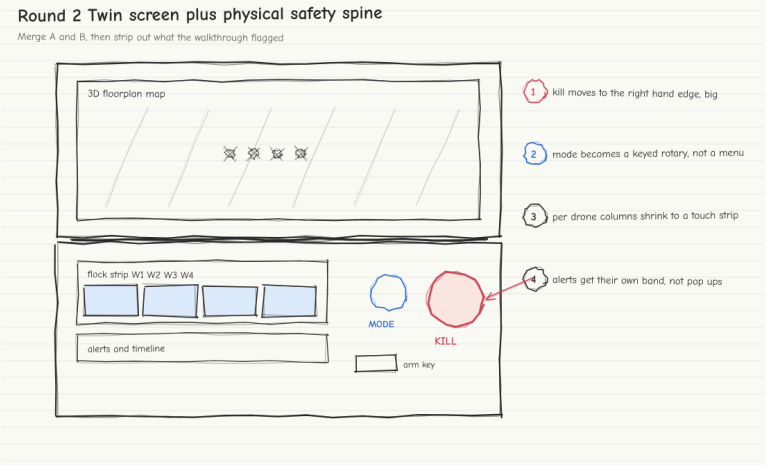
WHAT WE CHANGED
A shaded halo under each drone that grows as the system becomes less sure, backed up by plain words.

07 · SHOW THE ITERATION

The biggest change, how the flock stops

From drop to hold and land

BEFORE



Round 2, a single kill that cuts every motor

AFTER

Round 3, hold and land first, a guarded kill beside it

WHAT WE OBSERVED
Walking the hardest moment again, a kill meant four drones falling near the person who had just walked in.

WHAT WE LEARNED
Stopping the motors moves the risk rather than removing it. A controlled stop protects people better.

WHAT WE CHANGED
The big stop now holds every drone and lands them one at a time on clear pads. A separate kill sits under a cover as a last resort.

NEED
Stop the flock without creating a new hazard

EXPLORATION
Drop everything, hold in place, return to launch, hold then land

LEARNING
Holding alone leaves drones over the person. Return to launch crosses the room. Landing nearby on clear pads keeps everything predictable

DECISION
Hold and land as the primary stop, with a guarded kill that still drops everything when it truly must

The case

The final design is a rugged case with two surfaces. The lid carries one large shared picture. The base carries the controls that must work by touch. Placement follows a simple rule, the more urgent an action, the bigger, more physical and more right handed it is.

Final case. The lid screen shows the situation, the base carries the hands. Hold and land is the largest control on the case, and the kill hides under a cover beside it.

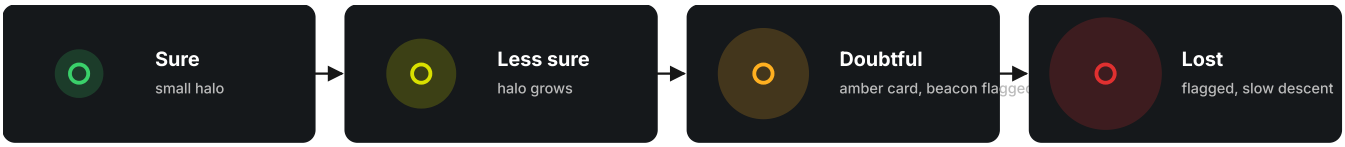
At a glance

1. Mode, in words and colour, readable across the room
2. Who is in control, stated plainly
3. Stop controls, always visible, showing what is ready
4. Map with a halo under each drone that grows with doubt
5. Why and what next, for the selected drone only
6. Position beacons, with any blocked view flagged
7. One alert band, top priority only, with a deadline
8. A card per drone, minutes left, not volts
9. Mission timeline with the next planned handover
10. Automation dial, showing what the machine decides

The information hierarchy reads top to bottom and big to small. The top band answers the first question anyone asks, what is going on and who is in charge. The map takes the most space because spatial awareness is the hardest thing to rebuild after looking away. Detail sits to the right, where it can be ignored until wanted. Everything that might need a decision sits along the bottom, close to the hands.

When something changes, and when more detail is needed

When something changes



No change. The map can be trusted at a glance.

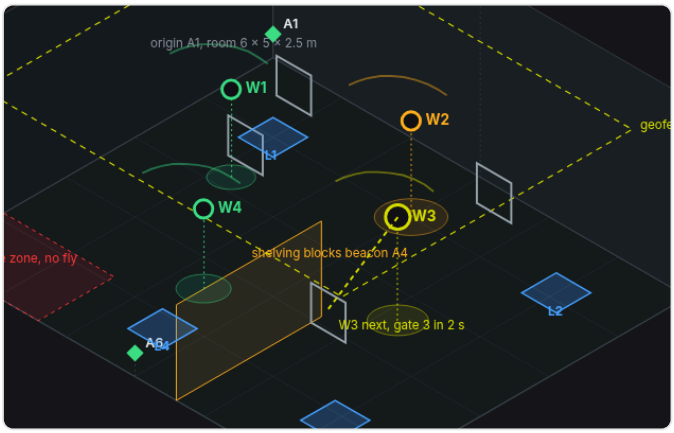
The halo grows before anything else changes. A hint, not an alarm.

The drone card and the blocked beacon turn amber. One line says why.

The drone stops trusting itself and descends slowly where it is.

How doubt about a drone's position escalates. Each step is a little louder than the last, so the operator notices the picture becoming less trustworthy before it becomes a problem.

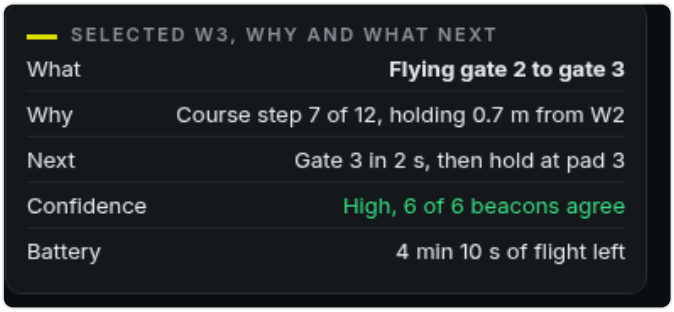
Most interfaces have two states, fine and alarm. We designed for the slope between them. The halo is a gentle, continuous hint that costs no attention when it is small. If doubt keeps growing the drone's card turns amber and the blocked beacon is flagged, so the cause is visible as well as the effect. Only when the drone genuinely cannot trust itself does it act on its own and say so.



The halo lives on the map, where the eye already is.

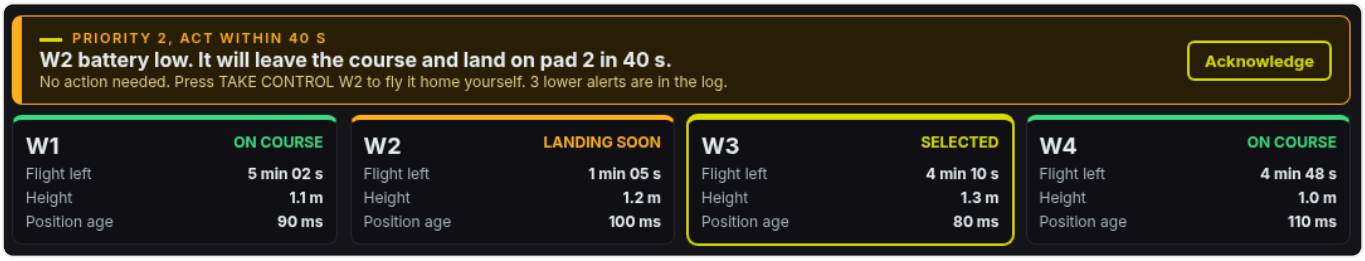
The cause, a beacon with a blocked view, is one glance to the right.

When more detail is needed



Selecting a drone opens a short panel that answers what it is doing, why, what it will do next and how sure it is. This is progressive disclosure. The explanation is there in one tap when the operator wants it, and absent when they do not, so it never competes with the map. Plain sentences replace codes, so the operator can recognise rather than recall.

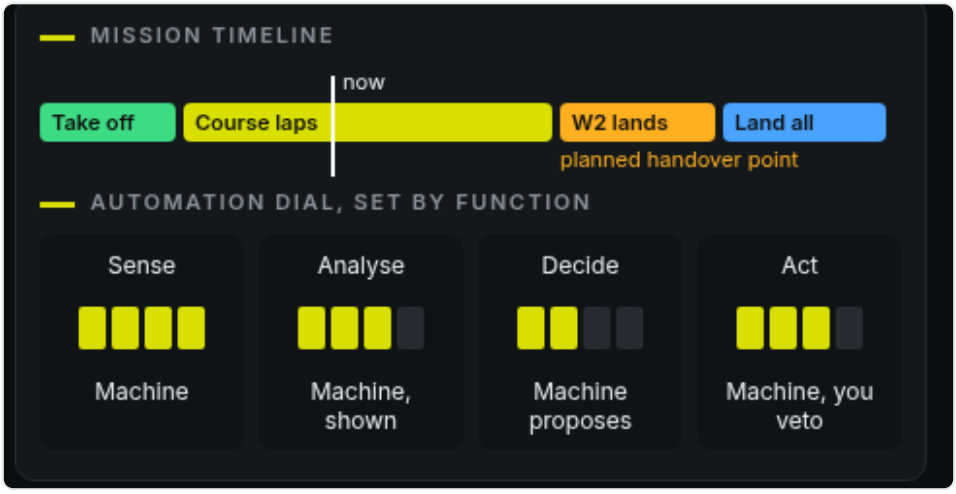
When the human needs to intervene



The alert band and the drone cards sit directly above the take control buttons on the case.

When the software wants a decision it says so in one place, with a priority, a deadline and the option the human has. In the example, a drone with low battery will leave the course and land in forty seconds. No action is needed, but the operator can take it home themselves. That framing matters. It tells the operator the machine has a plan, so they are choosing whether to intervene rather than scrambling to.

Taking over is one press on a lit ring button that matches the drone's colour on screen, so the mapping between hand and picture is direct. The others keep flying. After every switch, the who is in control panel confirms the new arrangement in words, so feedback closes the loop.

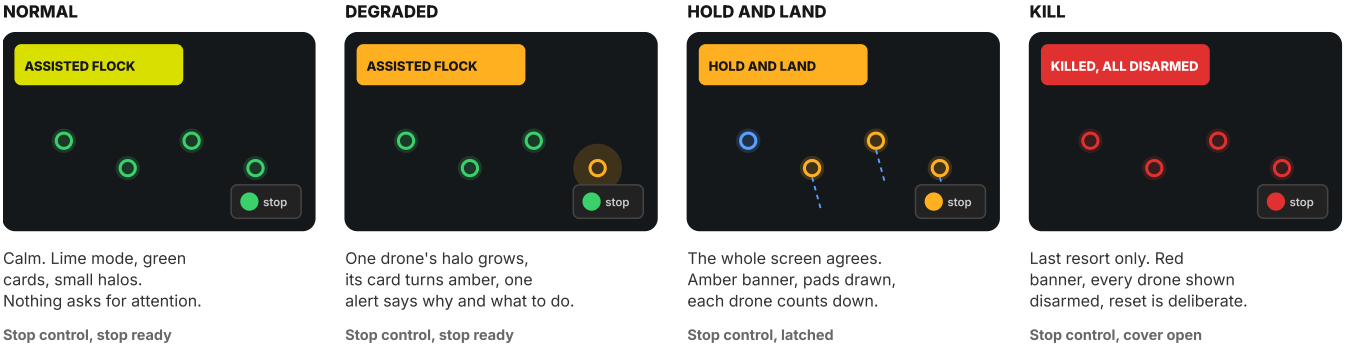


The automation dial shows, function by function, how much the machine decides. It keeps responsibility visible rather than implied.

NEED	EXPLORATION	LEARNING	DECISION
Step in for one drone without disturbing the rest	Take over the whole flock, a menu per drone, a physical button per drone	Whole flock take over punished the three drones doing fine. Menus were too slow in gloves	A lit button per drone, matched by colour, with words on screen confirming who flies

When something goes wrong

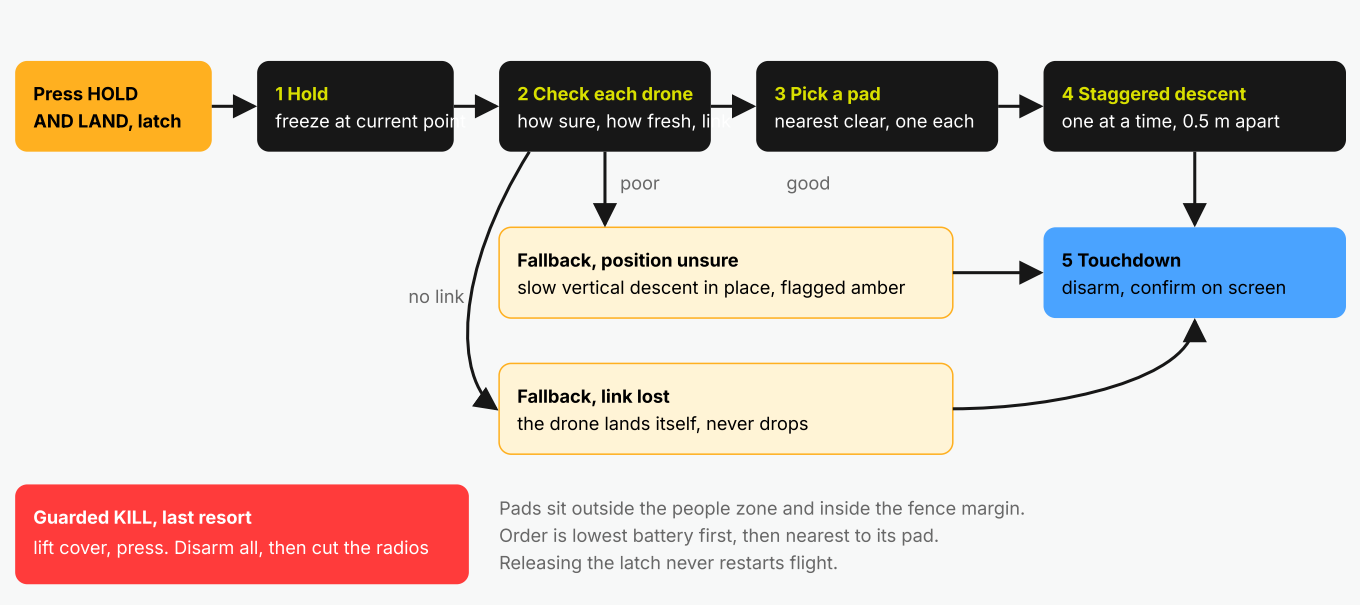
Things go wrong in degrees, so the design responds in degrees. The same four states appear on screen and on the case, so the operator never has to reconcile two different stories.



Interaction states. Normal, degraded, hold and land, and kill. Colour is reserved and consistent, lime for normal, amber for attention, red only for the last resort.

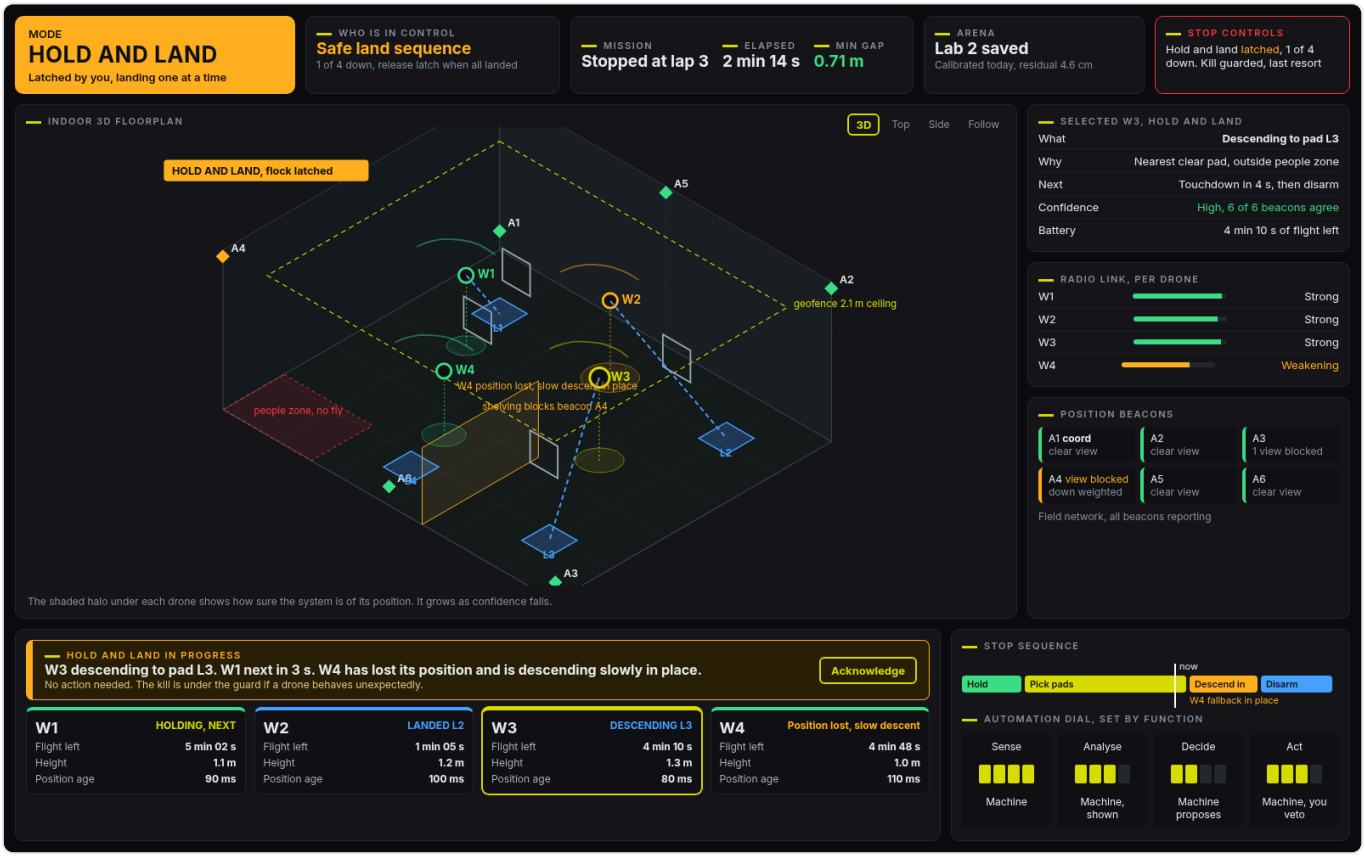
Hold and safe land

Pressing the big amber control latches the whole flock into hold and land. Every drone stops where it is. Each one is given its own clear landing pad away from people, and they come down one at a time, so nothing collides on the way. If a drone is not sure where it is, it does not guess, it descends slowly on the spot and is flagged. If a drone loses its radio link, it lands itself rather than falling.



How the stop behaves. The main path, the two fallbacks and the guarded kill.

What the operator sees during hold and land



During hold and land the whole screen agrees. The mode turns amber, the map draws each drone's path to its pad, the cards count down and the timeline becomes a stop sequence.

WHY AMBER, NOT RED

Red would say emergency. Hold and land is the system doing the safe thing on purpose. Amber says attention, things are under control, keep watching.

WHY THE KILL HIDES

A kill drops every drone. That can be right, for example if a drone is behaving dangerously, but it should never be pressed by accident. A flip cover adds one deliberate step, and the red on yellow stripes make it unmistakable once uncovered.

> Safety should have an obvious physical affordance. The most important control is the biggest, the most distinctive and always in the same place.

User need to design response

Every element in the final design exists because of a need. If we could not point to one, it did not make the cut.

User need	Design response
N1 Stop safely in one obvious action	Large amber latching hold and land control, clear pads, landing in turn, guarded kill under a flip cover
N2 Notice when the picture is less trustworthy	A halo that grows with doubt, amber cards, flagged beacons, plain words in the detail panel
N3 Never wonder who is in control	Mode banner in words, who is in control panel, keyed mode dial on the case
N4 Understand the group at a glance	Drone cards with one status word each, a single flock gap number, colour only on exceptions
N5 Find out why, only when asked	One tap detail panel with what, why, next and how sure
N6 Take back one drone	A lit take control button per drone, colour matched to the screen, confirmation in words
N7 Only what needs attention	One alert band with priority, deadline and the human option, the rest in a log
N8 How long each can fly	Minutes left on every card, planned landings on the mission timeline
N9 A new room is safe	Guided beacon placement and a clear go or no go before take off is allowed
N10 Operate while busy	Hand sized physical controls, a deadman grip, big touch targets, glance first layout

Against the principles

Principle	Where it shows up
Make uncertainty visible	Halo, amber escalation, beacon flags
Design for the moment of intervention	Hold and land placement, take control buttons, alert deadlines
Show the mission before the machinery	Mode, mission and minutes up front, radio and beacon detail secondary
Obvious physical affordance for safety	Amber mushroom, guarded kill, keyed mode dial
Exceptions deserve attention	Calm default, one alert band, colour reserved
Always say who is in control	Who is in control panel, confirmation after every switch

APPENDIX

Technical traceability, in brief

For readers who want to connect the design back to the engineering. The full technical requirements and their sources are in the earlier design paper for this project.

Need	Engineering requirement	Why it matters to the experience
N1	Two tier stop, hold and land first, guarded kill last	Hold and land relies on each drone's flight software landing rather than dropping when its link is lost. The kill therefore disarms each drone over its link before cutting radio power, so it still works as a true drop.
N2	Position confidence always visible	Indoor positioning uses radio beacons, which lose accuracy when walls, shelves or people block their view.
N3	Unmistakable mode and control	Mode is set by a keyed dial, mirrored on screen.
N4	Group supervision with drill down	Flock state is summarised, detail on selection.
N6	Rehearsed handover per drone	Each drone has its own radio, so one can be taken over alone.
N7	Few, prioritised alerts	A weakening radio link is warned about before the drone acts on its own.
N8	Battery as minutes	Flights last roughly ten minutes.
N9	Fast set up	Beacons, chargers, radios and computer travel in the case, and the room is checked before arming.
N10	Glove ready controls	Safety, mode and take over live in hardware.

10 · REFLECT

What we take away

What surprised us

How little of the hard work was about drones. The difficult questions were about attention, trust and responsibility, and they would look familiar to anyone who has designed for a control room or a hospital ward.

The assumption that changed

We began believing the stop should cut power, because that is what emergency stops usually do. Walking through the hardest moment showed that dropping four drones near a person just moves the risk. Hold and land became the primary stop, and the kill became the exception.

The early idea that survived

The single shared picture in the lid, from the very first clamshell sketch. Everything else changed around it.

What sketching revealed

Rough sketches made us talk about behaviour rather than style. Nobody argued about colours on a pencil drawing. They argued about where a hand would go.

What remains unresolved

- Whether a growing halo is read as doubt by people new to it
- How quickly landing in turn completes in a crowded room
- How the design scales from four drones to eight
- Whether a first time spotter in gloves finds the stop without being shown

What we would test next

- A foam mock up of the case with gloved first time users
- Simulator sessions with injected faults and timed responses
- Usability tests with real operators running a short course

> At the beginning we were designing a ground station that showed four drones. By the end we were designing an interface that helped one person understand when four autonomous machines needed them.

THE NEXT DESIGN QUESTION

If the flock grows to eight or twelve, attention will not grow with it. How do we help one person stay oriented when there are more machines than they can count at a glance?

WHAT COMES IN PART 2

We will return to this project once the initial CAD design of the case is in and after the upcoming round of user feedback, which will be the first time real operators see the design. Part 2 will show what changed as a result.

Niki Shu Designs, design case study, Part 1, October 2026.