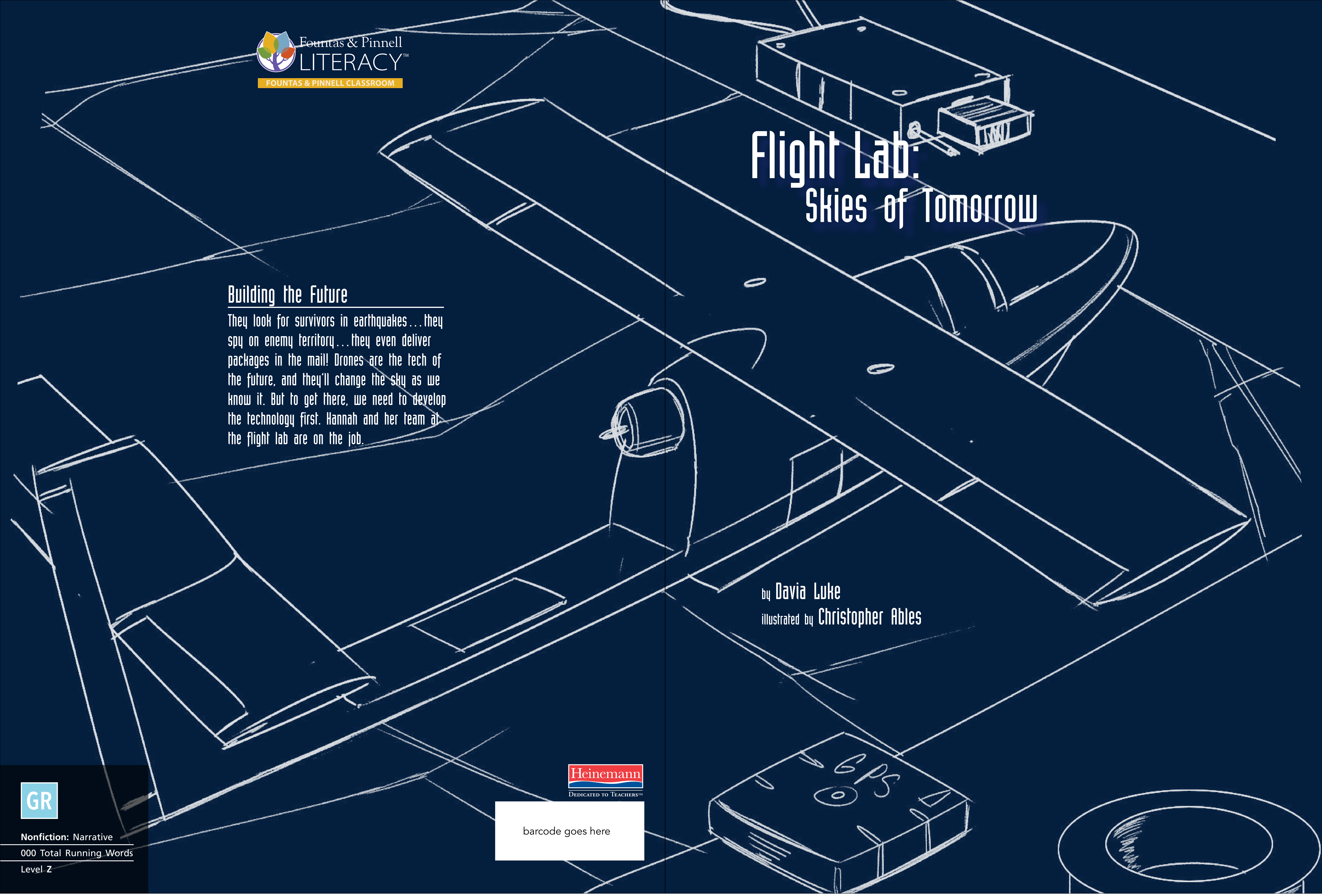

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Building the Future

They look for survivors in earthquakes . . . they spy on enemy territory . . . they even deliver packages in the mail! Drones are the tech of the future, and they'll change the sky as we know it. But to get there, we need to develop the technology first. Hannah and her team at the flight lab are on the job.

GR

Nonfiction: Narrative
000 Total Running Words
Level **Z**

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barcode goes here

Flight Lab:
Skies of Tomorrow

by Davia Luke
illustrated by Christopher Ables

Trim size: 8″ x 10.75″

Text Elements

Genre: Narrative Nonfiction

Form: Graphic

Text Structures
Main: Chronological Sequence
Embedded: Categorical, Temporal Sequence, Cause/Effect

Text Features: table of contents, headings, photos, captions, illustrations, speech balloons, diagrams, sidebars, maps

Flight Lab: Skies of Tomorrow
Author: Davia Luke

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Chris Lum: To help illustrate this point, Hannah recently got a job at Amazon where she will be working on drones for package delivery.

Pioneer Partners

Scientists like the ones featured in this book are pioneers—their discoveries and innovation help companies, governments, and the public adopt new technologies or solve problems. Their work doesn't happen in a vacuum—science, industry, and government often work hand in hand. Many times a company will partner with a science department at a university. The company provides funding for new computers, software, and other materials, and the university leads the work. Students like Hannah get real, hands-on experience, and companies get extra help designing new technology. And many times, students go on to get a job with their company partner. Everybody wins!

Acknowledgments

The author and editors of this book would like to thank Hannah Rotta and Christopher Lum of the Autonomous Flight Systems Laboratory at the University of Washington in Seattle. (The Lab works closely with industry partners and funding agencies that help enable its work.)

The Joint Center for Aerospace Technology Innovation (https://jcati.org/) – Funding Agency

Hood Technology (http://www.hoodtech.com/) – Industry Partner

Advanced Navigation and Positioning Corporation (http://

ED: please note overset text below

www.anpc.com/) – Industry Partner

Sagetech (https://sagetech.com/) – Industry Partner

Insitu (https://insitu.com/) – Industry Partner

Carnation Farms (https://www.carnationfarms.org/)

—*Davia Luke*

Flight Lab:
Skies of Tomorrow

by Davia Luke
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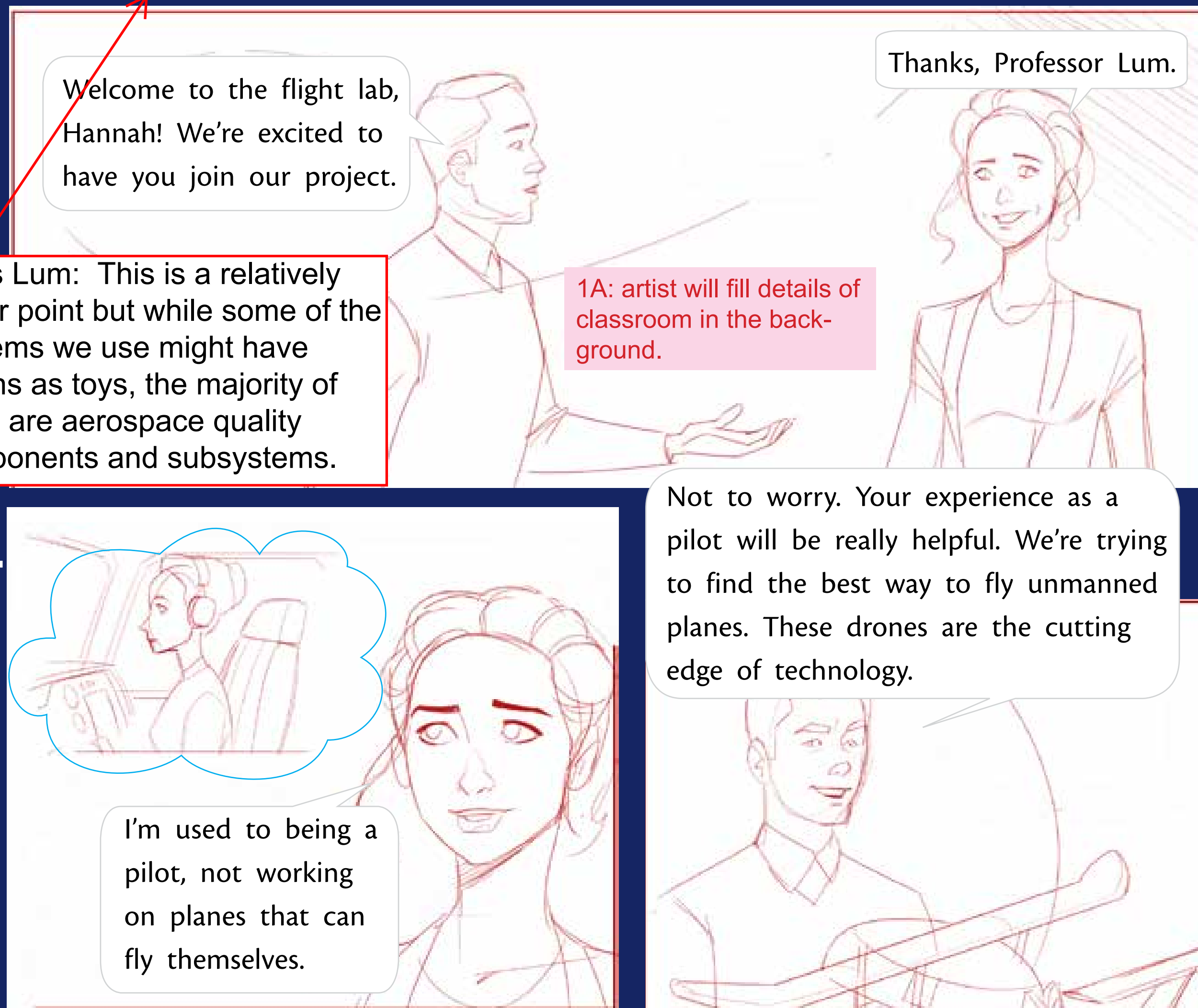
Table of Contents

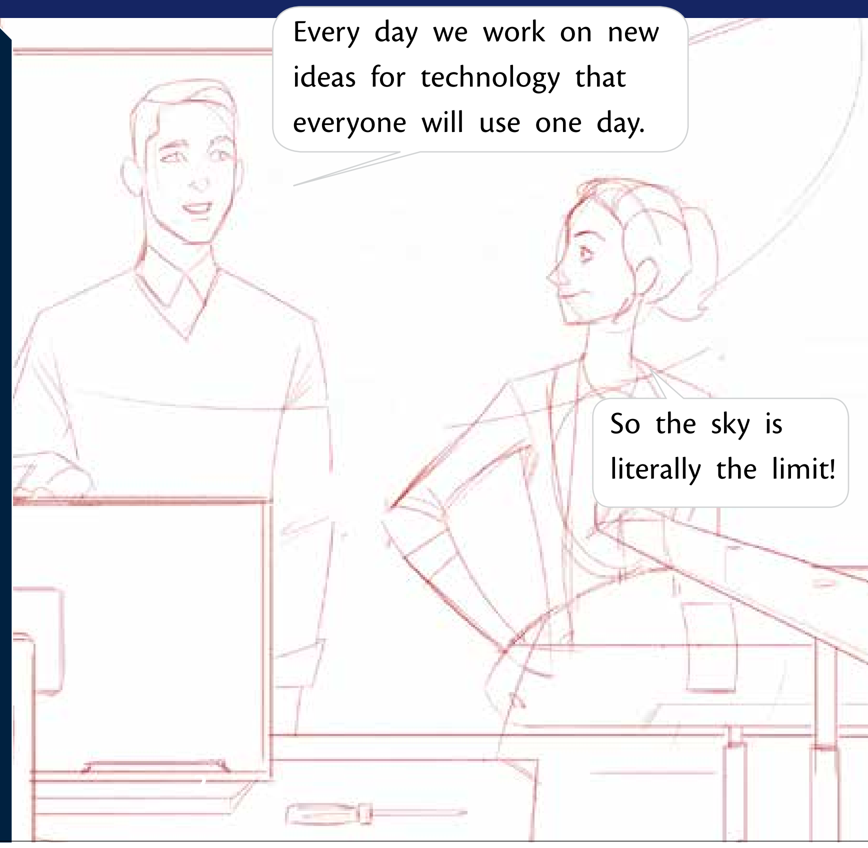
Level: Z
Word count:TK
Genre: Nonfiction
Trim size: 8” x 10.75”
# of Pages: 16

First Day a... t Lab

Hannah Rotta scans this most unusual classroom. Wings, motors, and other parts of what look like toy planes are strewn across the tables. This isn't just any classroom, it's a flight lab.

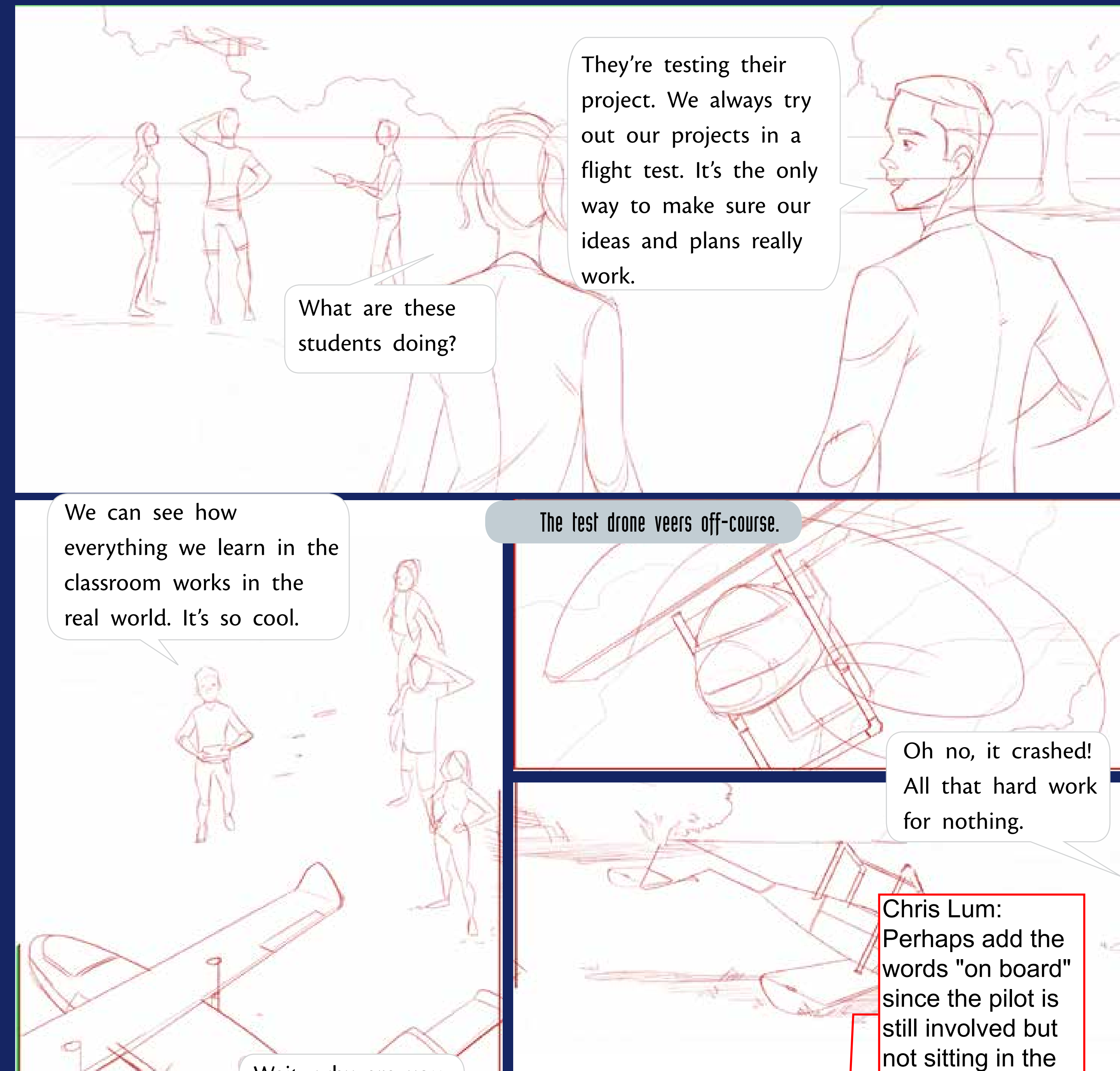
Chris Lum: This is a relatively minor point but while some of the systems we use might have origins as toys, the majority of them are aerospace quality components and subsystems.





Meet Hannah

Hannah comes from a family of pilots, so it was only a matter of time before she got her own pilot's license. She loves everything about planes and flying, so she came to the flight lab to learn about the exciting new technology of drones. Drones don't need onboard pilots to fly them. But Hannah thinks it's great to be on both sides—as a pilot, she understands how planes fly, and she can help shape this exciting new technology.



Chris Lum: Perhaps add the words "on board" since the pilot is still involved but not sitting in the aircraft.

The Sky's Next Big Thing

Drones fly in the sky—but they don't need a pilot. They can be operated by a pilot on the ground, like a remote-control plane, or by an on-board computer via autopilot. Drones can be so tiny they fit in the palm of your hand, or they can be as big as a full-size jet. These unmanned fliers can be very useful for mapping, delivering supplies to remote areas, and more. They can go places humans can't and perform dangerous jobs like search and rescue.

[panel 2A art: Perhaps full measure view to establish the setting of a bustling classroom/tech lab. Papers and diagrams fill white boards on the walls. There should be a big window with a field outside, as this will appear later as the flight testing space. Groups of students cluster around different tables—some working on a motor, some putting drone pieces together, such as wings and body. Off to one side are a computer or two with students working together while looking at a screen. Should convey bustling activity and students working collaboratively. Should look enough like a classroom to be familiar to readers, but then have these hands-on things happening that might seem surprising in a classroom. Hannah looks like a student, Professor Lum wears a button-down shirt and tie with sleeves rolled up. She is taking in this scene in wonder, and he is welcoming her.v

[panel 2B art: close-up on Hannah. Thought bubble shows her in the pilot seat of a small Cessna type plane smiling. She should clearly be the pilot]

[panel 2C art: close-up on Professor Lum. He's holding a drone/model up in his hand while he talks]

[panel 2D art: Hannah and Professor Lum together. He is showing her around the lab. Perhaps they've paused to look at a cool model]

[panel 3A art: Hannah and Professor Lum have stepped outside the lab into an open field space—open green grass with a distant ring of trees. A group of 2-3 students are testing a drone by flying it with a remote control]

[panel 3B art: Professor Lum and Hannah have come up to the student testing group, and they're all looking up at a drone hovering overhead]

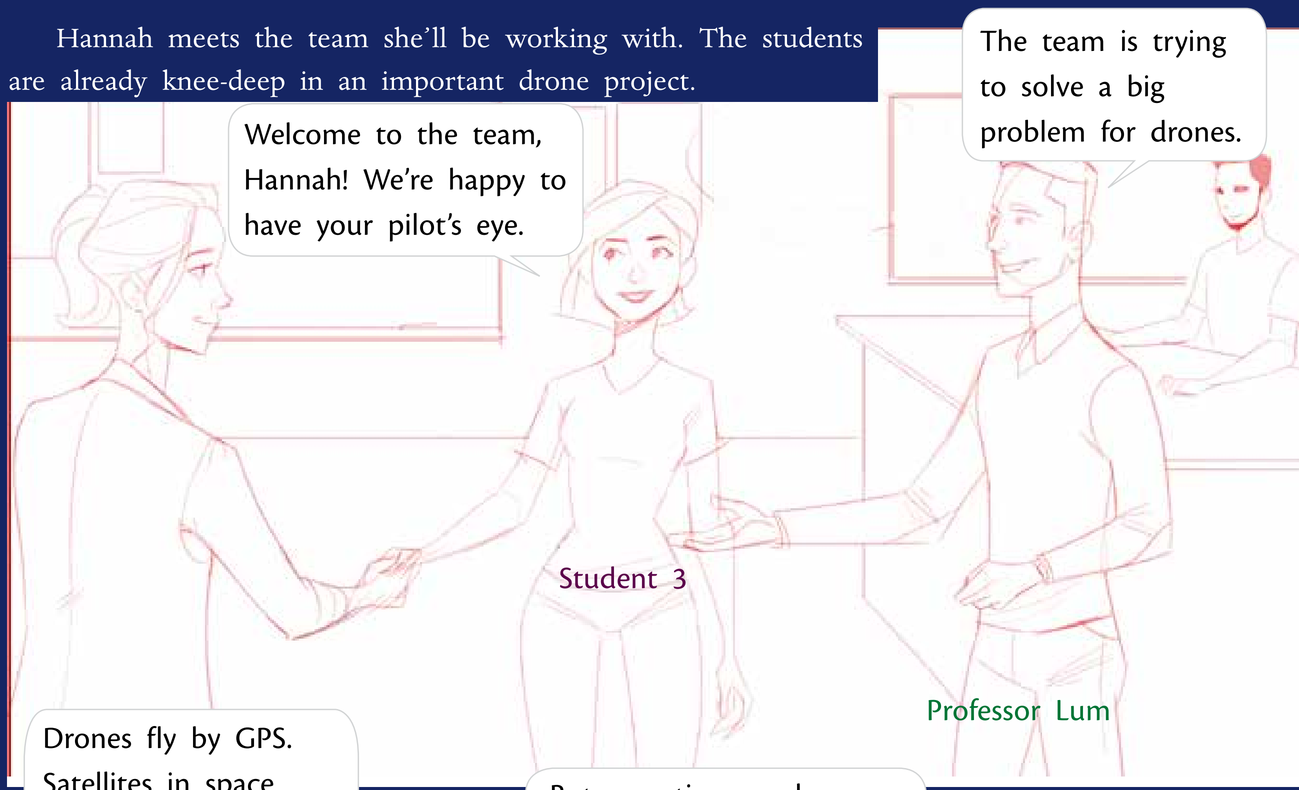
[panel 3C art: Close up on the drone in the air. The drone goes veering off—it should look like it's turning and wobbling—something is clearly amiss. This could be broken up into one or two small panels with no text to show motion. The students are chasing it and/or run over to it where it lands.]

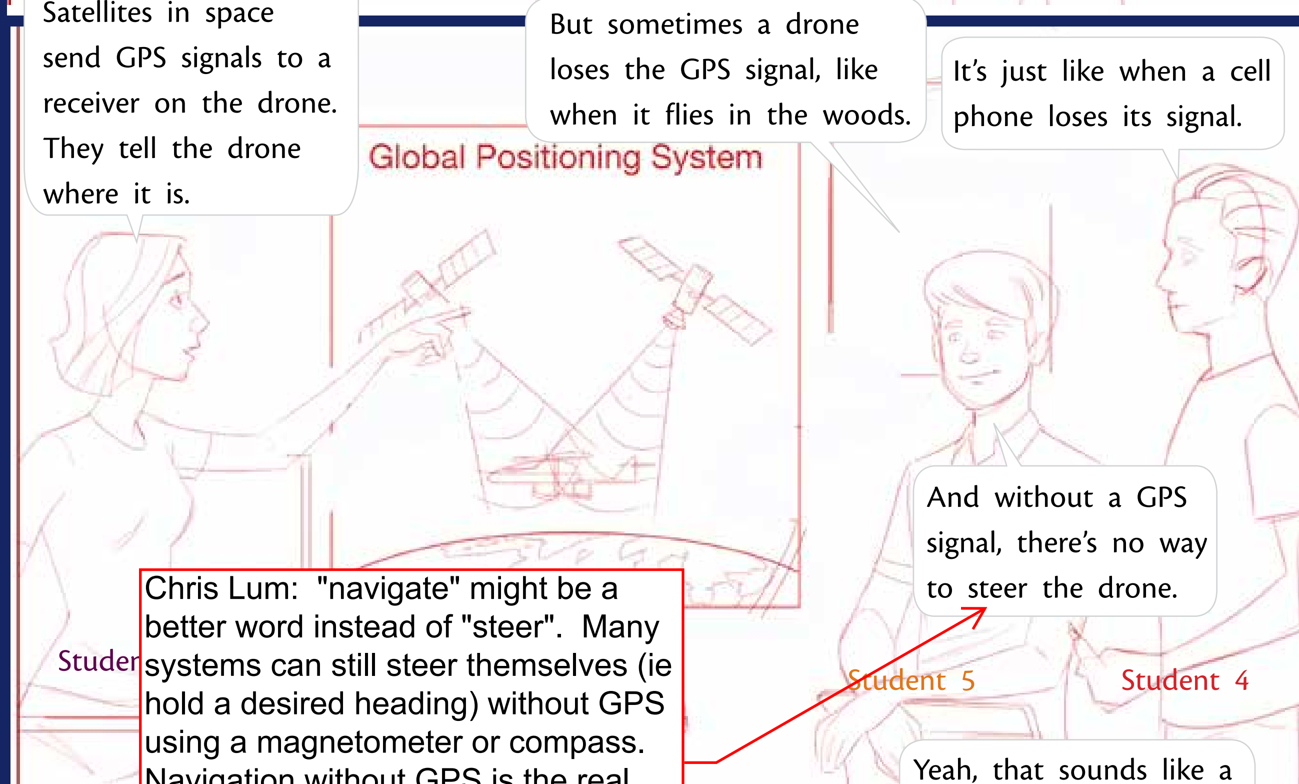
[panel 3D art: the drone has crashed or landed awkwardly (it doesn't look broken).]

[panel 3E art: the students gathered around the drone on the ground, with Hannah and Lum looking on. The students and Professor Lum are smiling and congratulating each other; Hannah looks on confused]

Problem Solvers

Hannah meets the team she'll be working with. The students are already knee-deep in an important drone project.

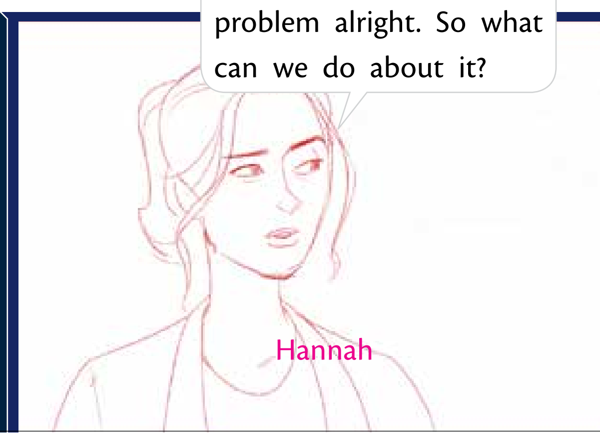


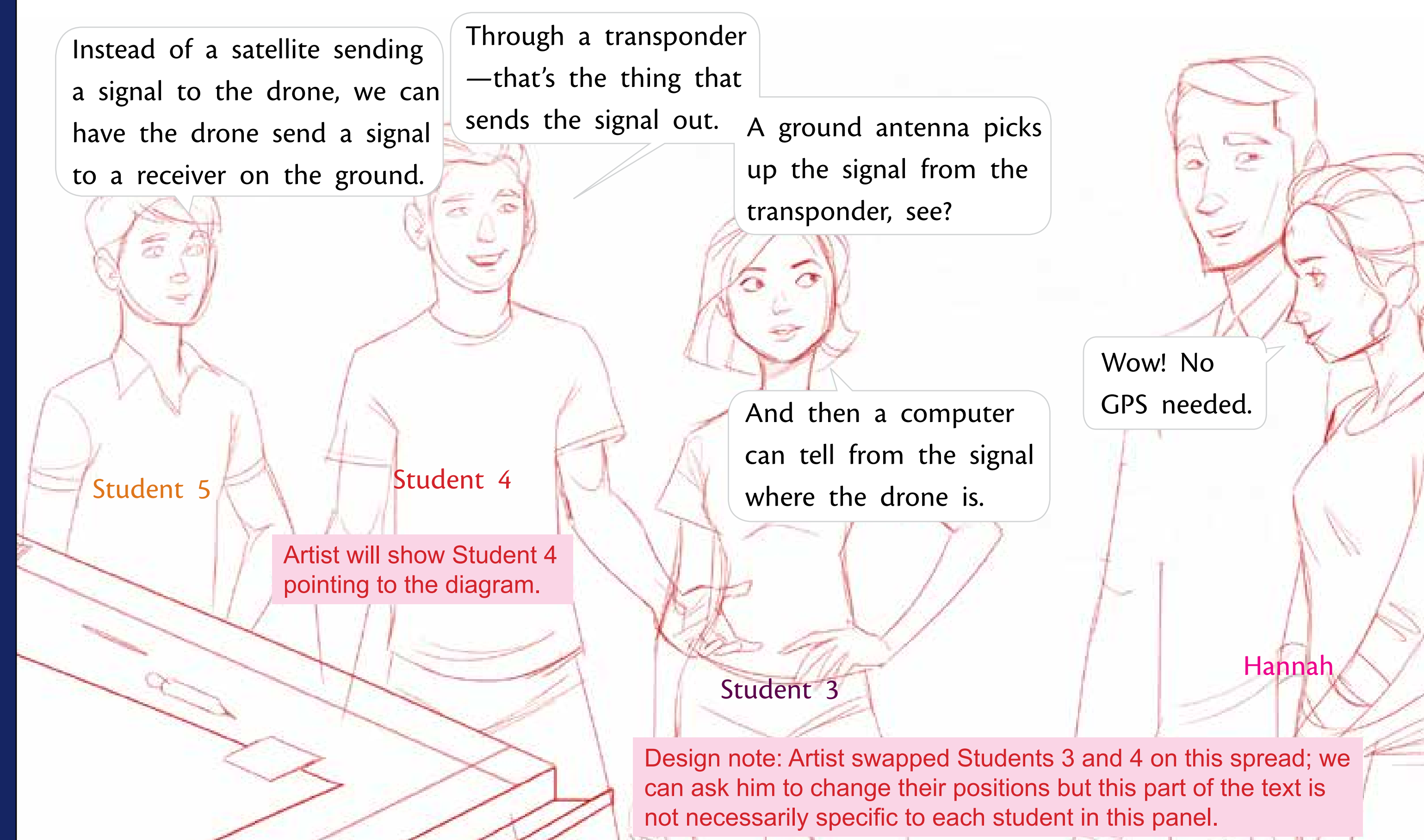


Chris Lum: "navigate" might be a better word instead of "steer". Many systems can still steer themselves (ie hold a desired heading) without GPS using a magnetometer or compass. Navigation without GPS is the real problem. The word "navigate" might line up better with the side panel discussion in the bottom left of the page.

Steering by GPS

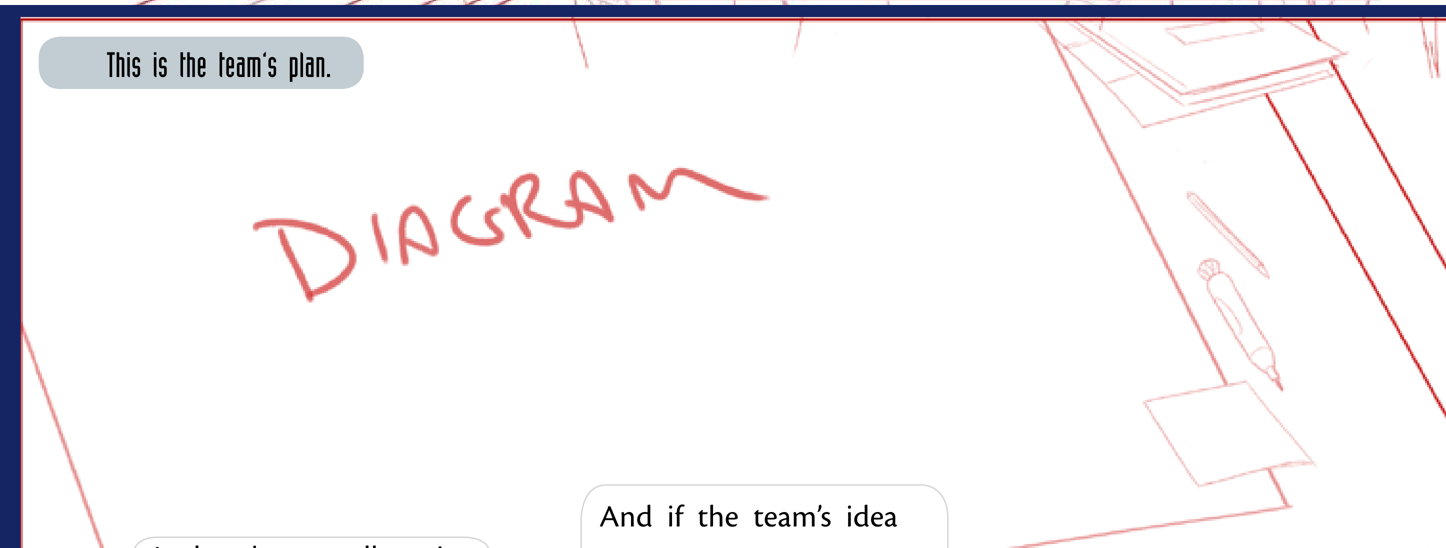
GPS stands for "glot[...] map on a device, yo[...] where you are. That's GPS at work. Satellites in space send signals to a receiver in your device, and that receiver uses the signals to calculate your exact position. It works the same way with drones, and since there's no pilot to navigate it, this location information is critical.

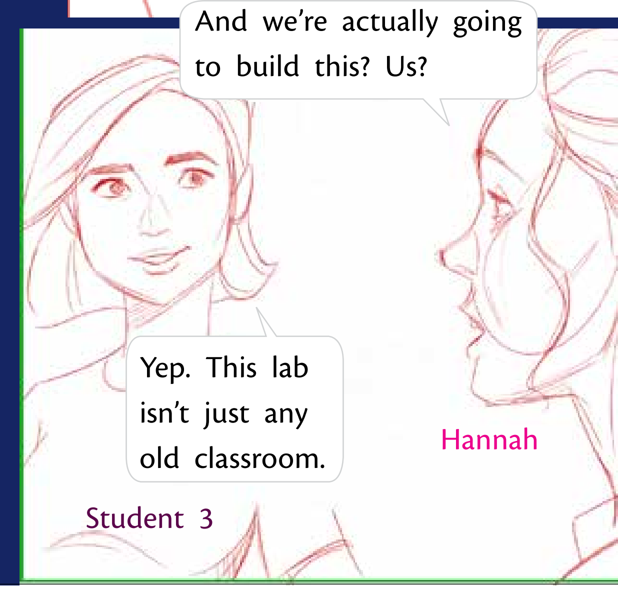


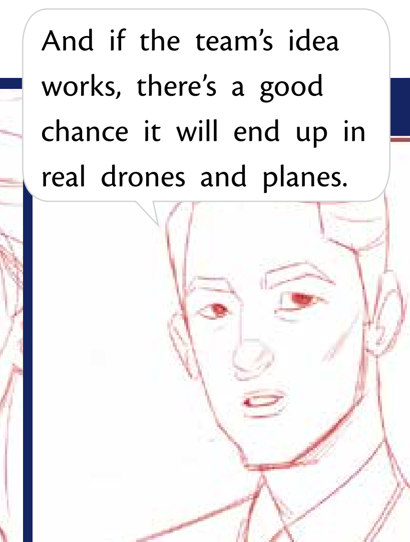


Artist will show Student 4 pointing to the diagram.

Design note: Artist swapped Students 3 and 4 on this spread; we can ask him to change their positions but this part of the text is not necessarily specific to each student in this panel.







Electronic Calling Card

A transponder is a small piece of equipment used on many commercial planes. It sends out a signal broadcasting the exact position and altitude of the aircraft. Air traffic controllers and other pilots can pick up the signal and know exactly where the plane is.

[panel 4A art: Professor Lum is introducing Hannah to her team—a couple of other students who are smiling and taking a break from what they're working on. They are back in the lab]

[panel 4C art: Hannah up close, looking concerned]

[panel 4B art: Hannah's team are gathered around a diagram on a whiteboard or a more formal looking poster on the wall showing how GPS works, called "Global Positioning System." It essentially shows a GPS signal represented by wifi-type lines such as))))) going from a satellite to a drone. Student 3 is pointing to the signal marks. Student 4 or 6 could be expressively gesturing to show this is a problem.]

[panel 5A art: Same group of students and Professor Lum around a drafting table, with a large drawing/diagram spread out on it (representing the diagram shown in panel 5B. Student 3 points to drawing.]

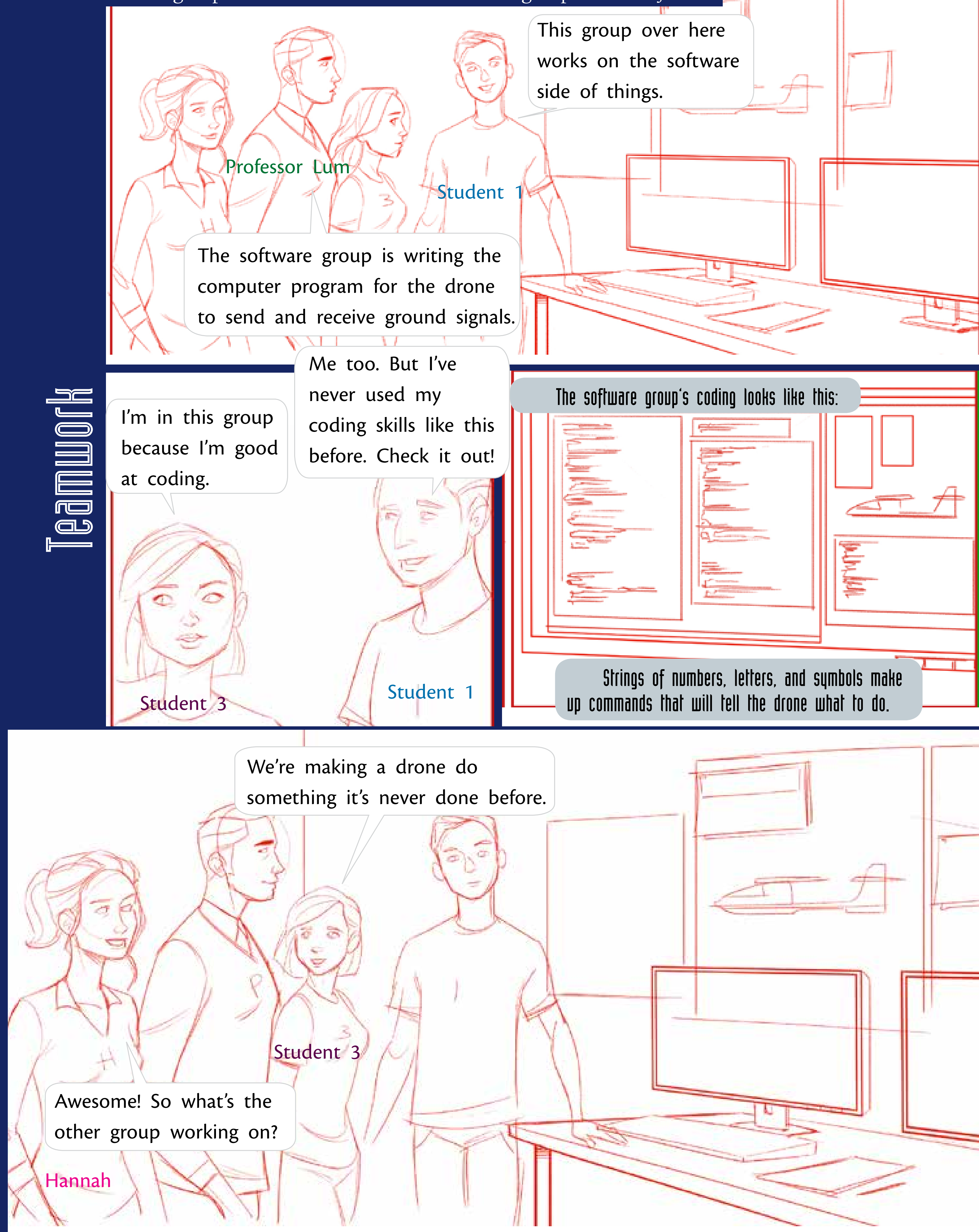
[panel 5B art: close-up of the students' diagram/work plans, which are on the table. This should function like an actual diagram for readers.]

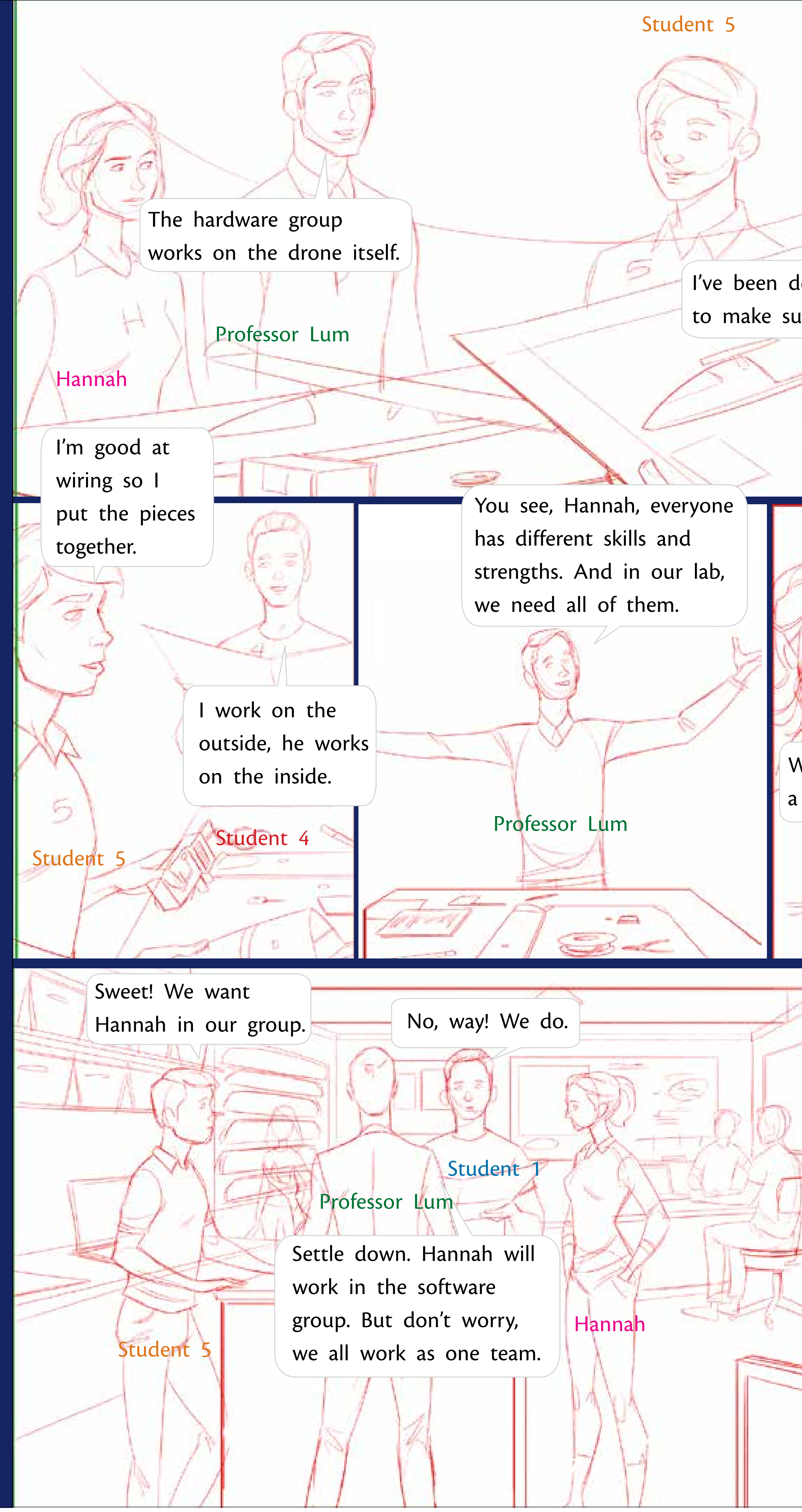
[panel 5C art: close up of Hannah and Student 4. Hannah looks amazed.]

[panel 5D art: close up of Professor Lum talking]

It's time for Hannah to get down to business. The team works in two groups: software and hardware. Which group will she join?

Teamwork





Mad Skills

Students of all ages and backgrounds come to the flight lab. They all have different skills and experiences, so they approach a problem from different angles. But they all have something in common: dedication and determination. They're not afraid to make mistakes, learn from them, and try again.

[panel 6A art: Hannah, Professor Lum, and Students 1 and 3 gather around a computer or row of computers. The screens are full of code, and there are papers strewn everywhere, in a deep-in-work kind of way, perhaps with drone drawings and notes pinned to the wall]

[panel 6B art: close up of the two students]

[panel 6C art: close up of a computer screen full of programming code]

[panel 6D art: back to the group from 6A]

[panel 7A art: Hannah, Professor Lum, and Students 4 and 5 stand with a test drone on a table. Student 4 is holding or pointing to papers including a schematic drawing of the drone on top, needs to looks like a drawing or blueprint, with some indistinguishable notations or arrows, but it should be based on a Skywalker 1900 drone.]

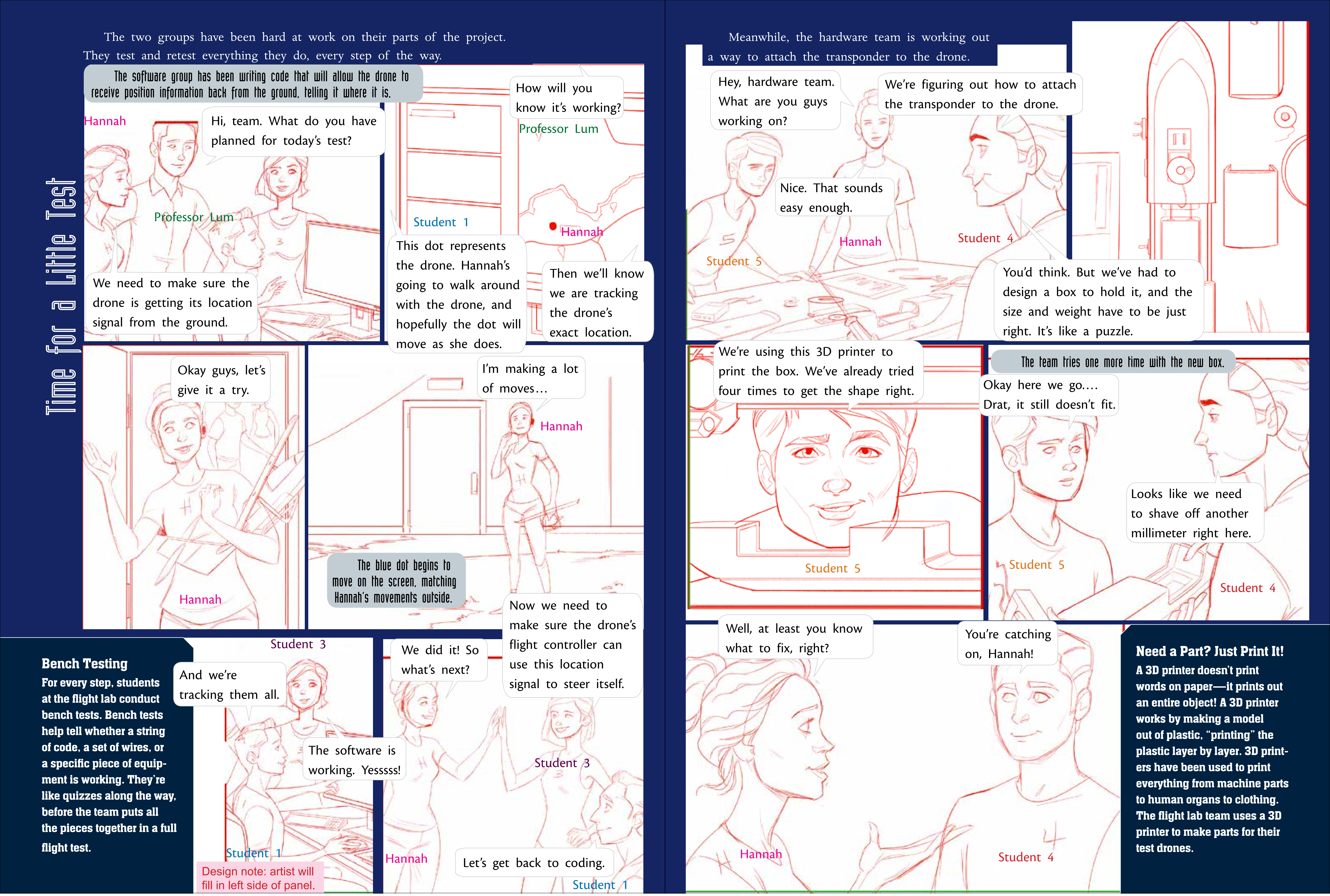
[panel 7B art: same as previous, or a focus on elsewhere on the same tabletop, with Student 5 pointing to or holding a device that goes inside the drone, with associated wiring. See reference images. Could look like the transponder]

[panel 7C art: close up of Professor Lum speaking a spreading his arms wide, as if to indicate the whole lab]

[panel 7D art: close up of Student 4 and Hannah. Perhaps now she has a poster behind her showing a plane in the sky]

[panel 7E art: wide shot of the lab and whole group of Hannah, Professor Lum, and several students from this spread]

Time for a Little Test



Bench Testing

For every step, students at the flight lab conduct bench tests. Bench tests help tell whether a string of code, a set of wires, or a specific piece of equipment is working. They're like quizzes along the way, before the team puts all the pieces together in a full flight test.

Need a Part? Just Print It!

A 3D printer doesn't print words on paper—it prints out an entire object! A 3D printer works by making a model out of plastic, "printing" the plastic layer by layer. 3D printers have been used to print everything from machine parts to human organs to clothing. The flight lab team uses a 3D printer to make parts for their test drones.

[panel 8A art: Hannah, Students 1 and 3, and Professor Lum gathered around a computer (note all should be wearing different clothing to indicate a different day). Not much focus on the computer yet, but if the screen is visible it should show the mapping program described below]

[panel 8B art: close up of Professr Lum, Hannah and Student 1 looking at the computer screen. On-screen, we see Google Maps-like software with a blinking/glowing blue dot that will move around. The "map" it's moving around on should be fairly abstract but loosely represent the lab classroom with the testing field just outside. Focus should be on the dot, not the map. Student 1 is pointing to the dot.]

8B art spec calls for Hannah, Professor Lum, and students in front of detailed screen. Artist rendered only the screen. To maximize space, we could have the voices coming from outside the scene, or combine panels 8A and 8B, or rever to original spec.

[panel 8C art: Hannah wearing a headset and heading out the door to outside, with the test drone in hand and maybe waving back to the group]

[panel 8D art: Hannah walks/runs around outside while holding the drone. She talks into the headset—could b holding the microphone piece to emphasize this]

[panel 8E art: Students 1 and 3 are gathered around the computer with the blue dot moving around on-screen, perhaps with dashed lines indicating its path. The students look excited/triumphant]

[panel 8F art: Hannah back inside with the other two students. They are high-fiving each other triumphantly]

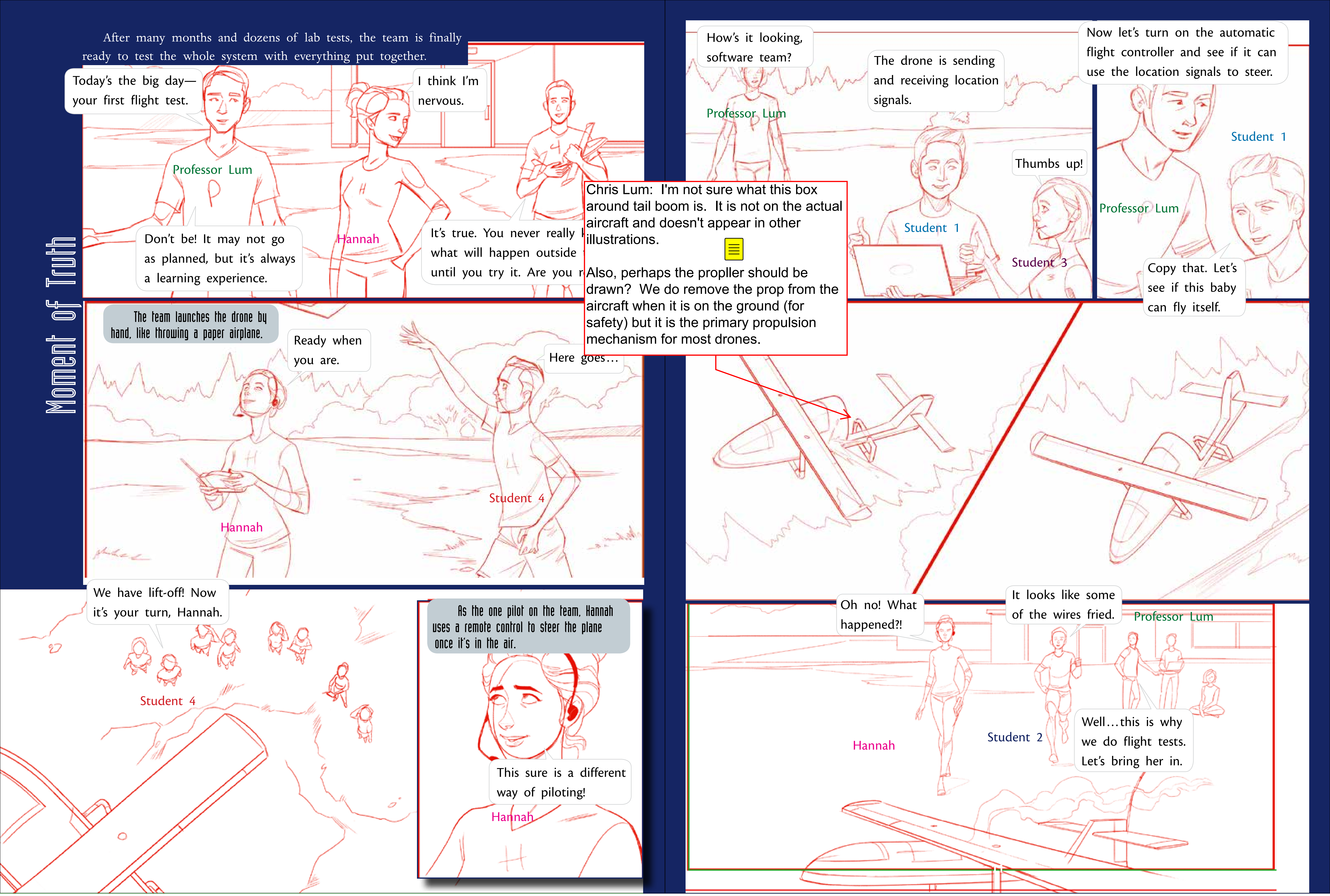
[panel 9A art: Students 4 and 5 working on a drone on a table. Paper/plans, screwdriver/screws, bits of wire, a wrench, etc. are on the table to suggest work in progress. See photos for location of exposed parts (transponder, radio), tape, wires and such that show this is a test/active project. Hannah approaches the team from one side.]

[panel 9B art: Close up of top-down view of drone, with a hole where the plastic cradle holding the transponder will go (see reference image). On the table next to the drone we see a black electronic looking box representing the transponder, and next to that a plastic cradle with a hole the shape of the transponder. It should be clear that the transponder will go in the plastic cradle, and then the plastic cradle will go in the drone. The student speaking is pointing to the cradle.]

[panel 9C art: 3D printer finishing printing another plastic cradle. Perhaps Student 5 is leaning down, at eye level with the printer, looking on]

[panel 9D art: Similar to first scene. Student A is holding the cradle with the transponder inserted, and is inserting it into the hole in the drone. It's stuck halfway because it doesn't fit. Student 5 is pointing to one corner/edge. Both look mildly frustrated. Hannah looks on. Transponder/payload is black box labeled "Pixhawk" as well as the unmarked black box beneath it. These fit inside the payload bay of the aircraft. The antenna is mounted to the tail.]

[panel 9E art: Close up of Hannah and Student 4. Hannah looks like she's encouraging the student.]



[panel 10A art: Hannah and Professor Lum on the test field next to the classroom. Perhaps students in the background are gathered around the drone. Student 4 approaches holding the drone, and conversation expands to include him/her. NOTE: different day; months have passed, maybe clothing shows a change of seasons?]

[panel 10B art: Hannah stands with Student 4. She is wearing a headset and holding a remote control. Student 4 is throwing the drone into the air to launch it. See reference images.]

[panel 10C art: Wider shot of the field with drone flying overhead. Hannah and Student 4 stand together, and all the other students and Professor Lum look on. Everyone is looking up, maybe some are shielding their eyes. To one side are two students from the software team, one holding an open laptop]

[panel 10D art: close up of Hannah flying the drone by remote control]

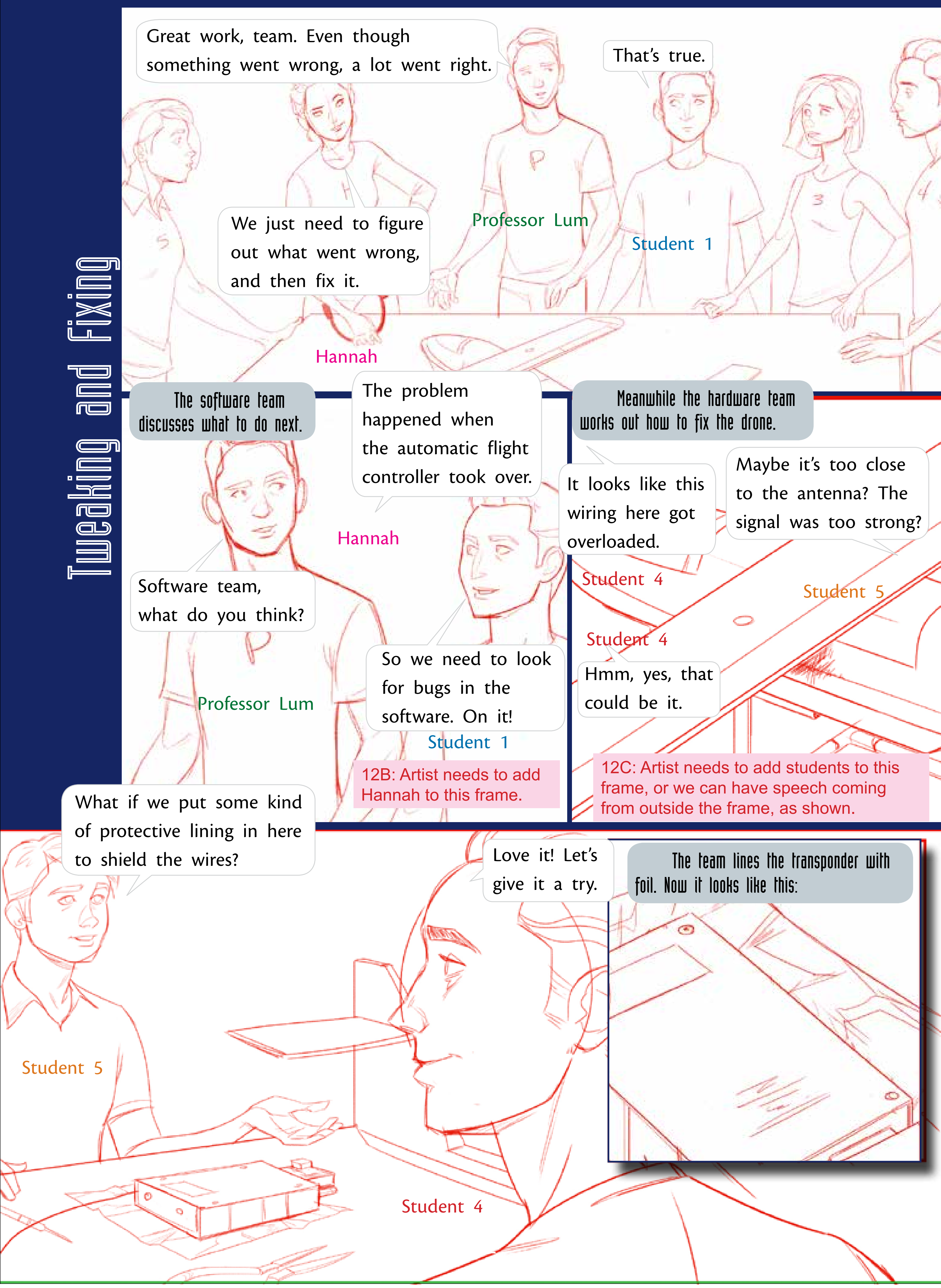
[panel 11A art: scene continues from previous page. Focus is now on the students with the laptop, and Professor Lum calling over or walking up. Student 1 is looking at the screen and Student 3 is flashing two thumbs up; both are grinning]

[panel 11B art: close up of Professor Lum bending down/ looking over the shoulder of Student 1, both looking at the laptop screen as they speak]

[panel 11C-D art: we see a small spark and a thin string of smoke. The drone flips upside down and then plummets straight into the ground. These can be shown over a series of frames as needed to convey motion and drama]

[panel 11E art: Hannah, Professor Lum, and a few other students crowd around the drone on the ground, with a burn mark around the antenna and looking a bit beat up but not broken]

Tweaking and Fixing



[panel 12A art: Wide shot of the group of students, Professor Lum, and Hannah around a big work table in the lab, with the damaged drone in the middle of the table, as if they're examining it]

[panel 12B art: Perhaps half the previous shot, showing Professor Lum and software team students. Or they can be grouped around a computer as in previous spreads.]

[panel 12C art: close up of the damaged drone on a table with a couple of students from the hardware team]

[panel 12D: close up of the student with the transponder open on the table, pointing inside. Transponder box is white, as in photos.]

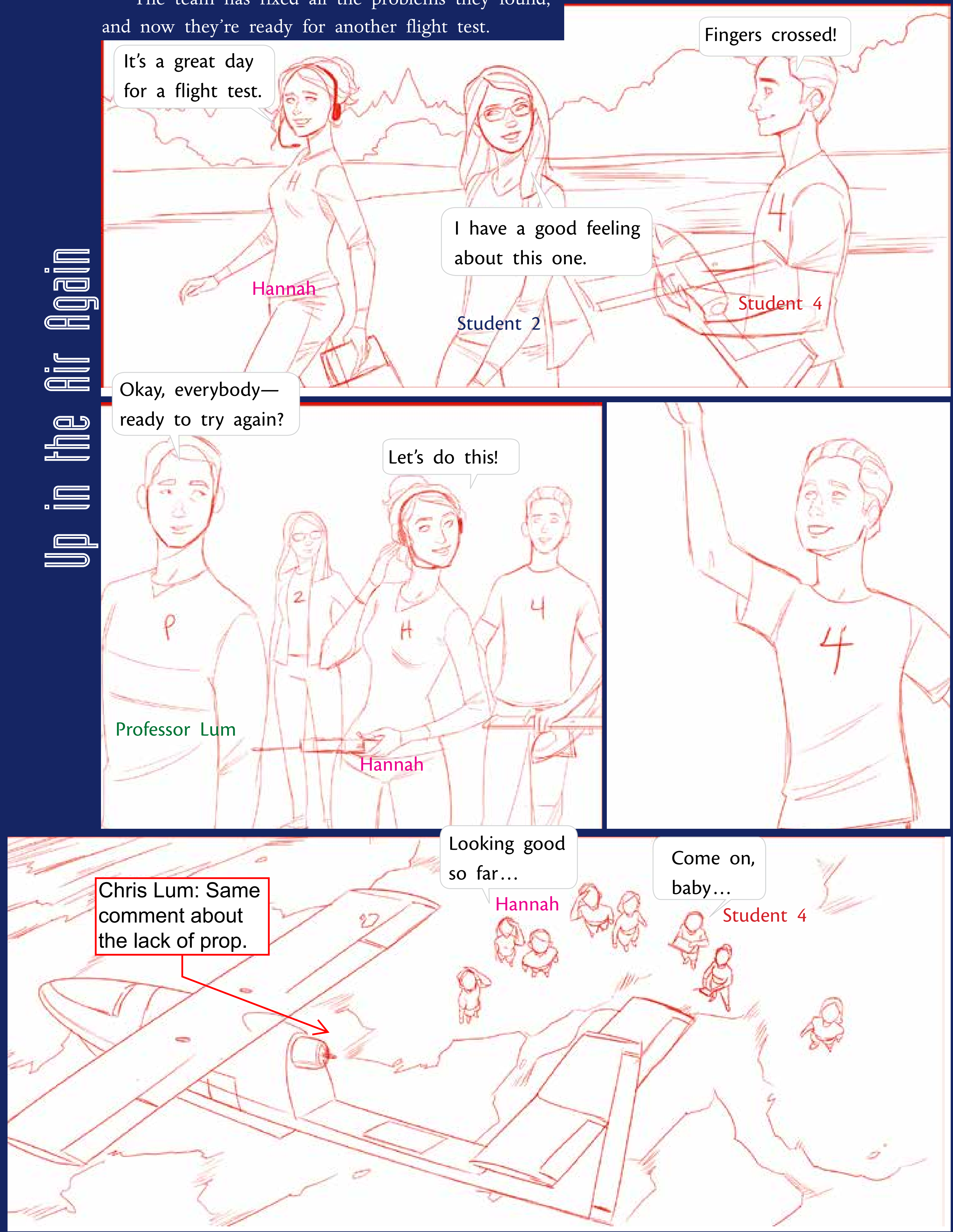
[panel 12E: close up of same transponder, only now the interior/ edges look covered in silver foil, rather than white]

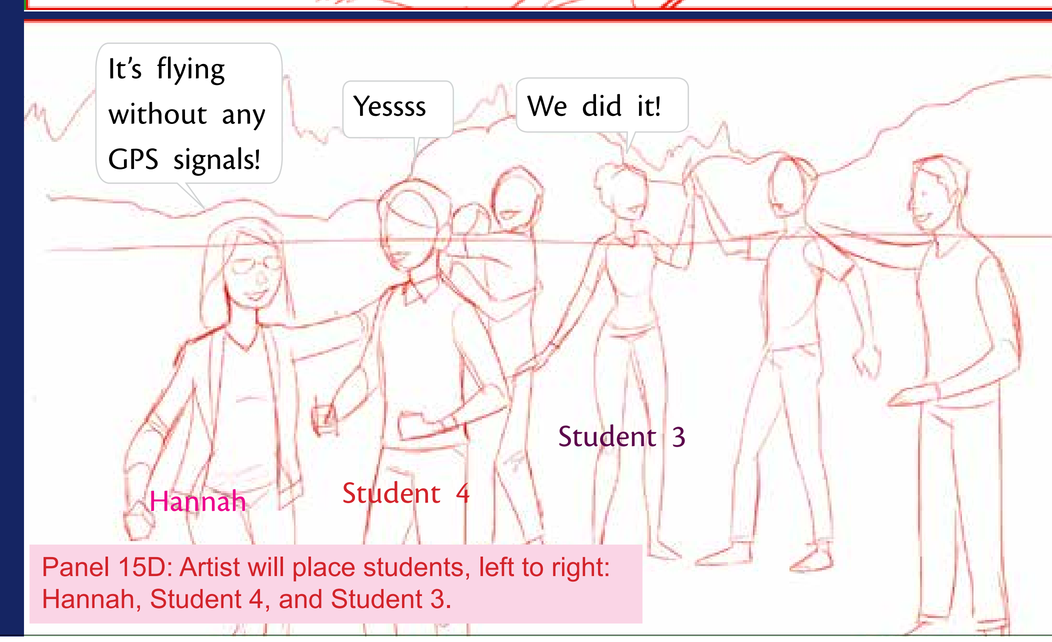
[panel 13A art: Wide shot similar to 12A, only now the drone looks fixed and un-damaged. It's two months later so clothing should be seasonally appropriate, based on earlier clothing.]

[panel 13B art: large panel showing a close-up of the drone on the table, with the parts labeled as in the reference photos. Have dialogue associated with each part, without showing the speaker. The goal here is to show all the parts of the drone]

Up in the Air Again

The team has fixed all the problems they found, and now they're ready for another flight test.





Time to Get It Right

At the real flight lab, Hannah's team spent more than three years developing a drone that can fly itself without needing GPS signals. They ran hundreds of bench tests and dozens of flight tests to get everything working just right.

[panel 14A art: Wide shot of the students, Hannah, and Professor Lum on the field, similar to previous flight test scene]

[panel 14B art: Professor Lum, Hannah and Student 4 as they prepare to launch. Hannah holds the remote with headset and Student holds the drone, as in 10C]

[panel 14C art: Close up as student launches the drone like a paper airplane; no text]

[panel 14D art: The drone sails overhead as students look up. Perhaps show a the drone in the sky wiht voice coming from outside panel, or show sides of two faces in lower part of the panel with the perspective looking up.]

[panel 15A art: close up of software students with computer showing map and tracking dot, similar to 11A and B]

[panel 15B art: close up of Professor Lum, maybe talking as he's looking up at the drone and shading his eyes]

[panel 15C art: wide shot of drone circling above the students, similar to 14D]

[panel 15D art: focus back on the students. They're jumping up and down, cheering, high-fiving each other]

This isn't just a story. Hannah, Professor Lum, and the team at the flight lab have been working for many years on their project. Students like Hannah get hands-on experience that will help them land internships and jobs in the aerospace industry. And the industry—companies that build drones for things like search and rescue—will benefit from the technology that Hannah's team develops.

Hannah and the team know that more flight tests and more failures are to come. But every setback is also a step forward; every problem is an opportunity for improvement. And every flight test will one day enable drones to keep flying when they lose a GPS signal. The team is helping to shape the future of this exciting new world in the sky.

[PHOTO TK showing Hannah, Professor Lum, and their real test drone (other students are ok too)]

[CAPTION TK but should identify Hannah and Professor Lum, and state that today Hannah is in charge of flight operations for the lab]

[PHOTO: if possible also show a commercial or real-world drone that might one day have the type of tech the flight lab is developing. May need to ask them for a reference]

Christopher Ables