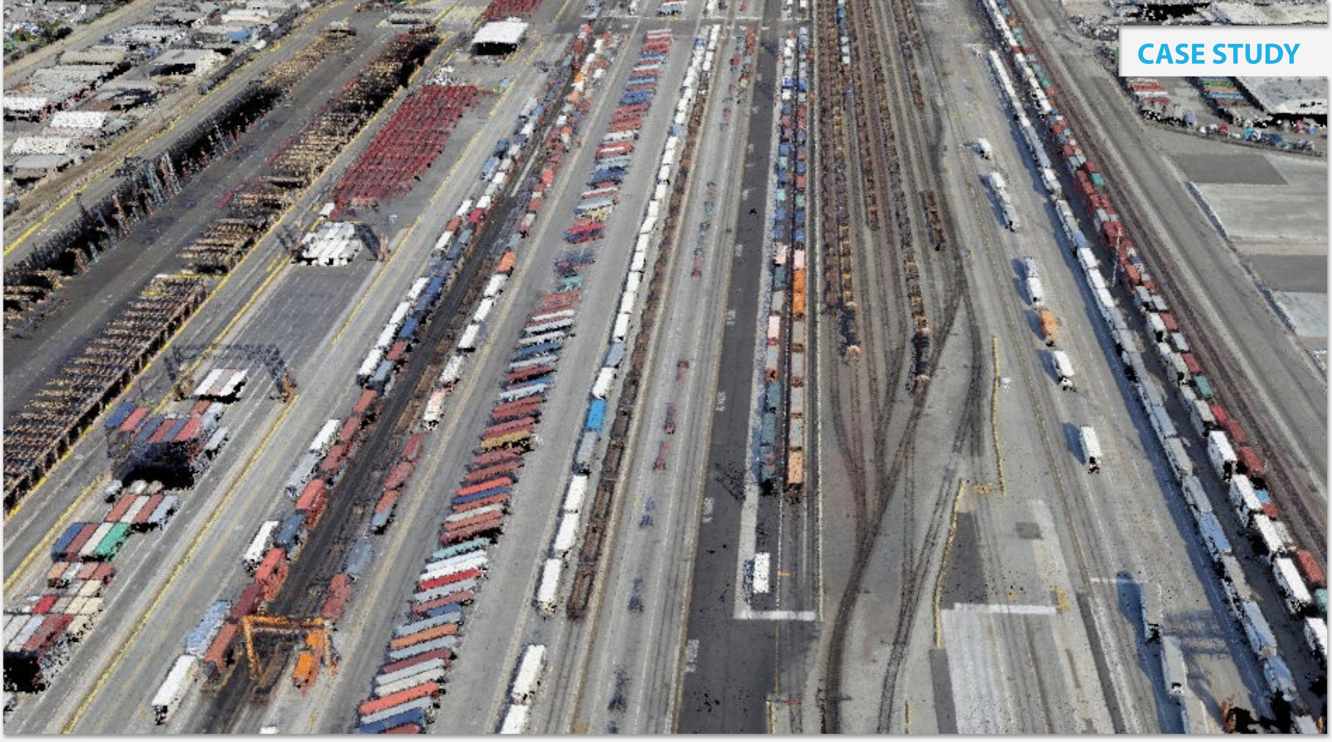

CASE STUDY

Right on track – surveying a Californian high-speed rail route using an eBee RTK

For its first professional drone deployment, transportation engineering company J.L. Patterson & Associates, Inc. (JLP) surveyed a 30-mile rail corridor with an eBee RTK. Its team reported "phenomenal" data accuracy, completed the job in a quarter of the time of terrestrial surveying, and at half the cost of employing manned aerial services.

The California High-Speed Rail Authority is responsible for planning, designing, building and operating the first high-speed rail system in the United States. Due to be completed by 2029, this transportation project will connect the state's so-called 'mega regions', enabling customers to travel from San Francisco to the Los Angeles basin in under three hours at speeds capable of exceeding 200 miles per hour.

In early 2015, the authority selected a consortium of firms to perform environmental and preliminary engineering work for the Burbank-Los Angeles-Anaheim section of the route. As part of this consortium, JL Patterson & Associates (JLP) was tasked with the engineering design work required to support the preparation of the Record of Decision/Notice of Determination (ROD/NOD) with a deadline of December 2017. This means having preliminary engineering work completed by early 2016.

The challenge

For the Los Angeles to Anaheim corridor, there was zero surveying data available. There also exists a host of issues that would make mapping this corridor using ground-based surveying techniques both time-consuming and problematic.

For starters, the corridor in question—measuring 30 miles (48 km) long by 1,500 feet (457 m) wide—is situated in an active railroad corridor that carries up to 100 trains per day.

"Traditional surveying would have required lengthy permits to access the railroad right-of-way and constant interruptions due to train traffic," explains Marc Cañas, the vice president of JLP. "The original plan was actually to use conventional aerial mapping, via a manned flight, however the mapping firm wanted eight to ten weeks to fly and process the data. Since our team didn't have the luxury of time, we turned instead to the eBee RTK."

> "The original plan was to use conventional aerial mapping, via a manned flight, however the mapping firm wanted eight to ten weeks to fly and process the data"

While JLP owns two survey-grade eBee RTK drones, it only flew one at a time to map its Californian rail corridor due to FAA restrictions.

Previous to flying the eBee RTK, JLP had experimented with recreational drones and small scale eBee flights. "We had some very limited experience using the eBee on another railroad project, and a recreational quadcopter, but never with the eBee RTK UAV," says Cañas. "We chose the eBee RTK because it offered the professional quality and survey-grade accuracy we were looking for and it is very compact, making it extremely portable—we can be on site and flying within a matter of minutes, without the need for complicated launching systems. Plus, the safety of the vehicle was important to us, so the software's geo-fencing feature was a must for our projects. With this eMotion program we could plan our missions ahead of time and execute them with confidence."

Trial, plan, execute

Although JLP owns two eBee RTK aircraft, its team was only able to fly one at a time due to FAA regulations.

"We started by conducting several trial and error runs," Cañas explains, "after which we decided to create a series of 1,500 by 5,200 foot flight polygon areas with overlapping areas of approximately 300 feet, which we used to set our set ground control points (GCPs). Our initial trials showed that this approach would fit our corridor objective while allowing us to optimise our time in the field."

JLP's team used the drone's eMotion software to set a 3.6 cm per pixel ground resolution. This figure was chosen to ensure a high-quality ortho aerial while staying below the 400 foot ATO maximum elevation set by the FAA. "We also specified a 69% by 69% image overlap. This yielded enough overlap for our urban environment but still kept flight times within safe battery levels," Cañas adds.

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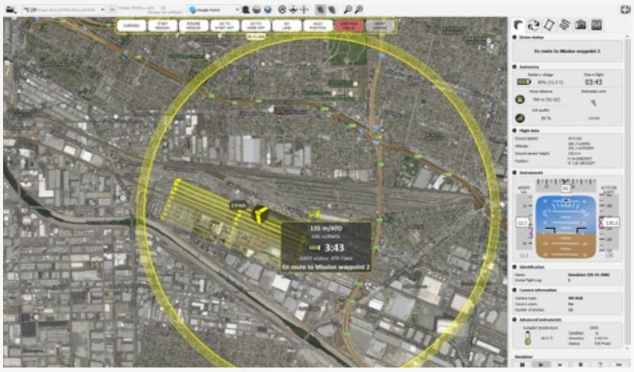
The team's flight planning in eMotion also incorporated elevation data in order to ensure flights remained at a consistent altitude above the ground.

"We used improved SRTM data when planning our missions because we chose to do a series of individual flights and tile them as opposed to merging several flights. We felt this would offer the best results for the change in ground elevation from the beginning to the end of our project limits," Cañas says.



An eMotion 2 screenshot showing one of the project's 41 UAV flights in progress.

"One of our biggest challenges came from finding suitable takeoff and landing sites," says Cañas. "We would plan the flights in the office and what looked to be great sites ended up being obstructed by overhead wires or street lights, or even buildings that were not in the Google Maps image yet but were there when we arrived to the site. 100% of our project lies within a heavily urban environment. That was challenging in itself. We learned to land in areas that you would never think of, except that necessity drove us to make it work and we did!"

The project's overlapping flight zones contained 82 GCPs in all. Why were these control points used if flying an RTK drone? Marc explains that, "In our environment we couldn't solely rely on the virtual RTK network. There were areas where the RTK would drop out so that posed a problem. Additionally, as far as we and the owner knew, RTK UAV technology had not, at the time, been used this scale and for this type of application, so setting GCPs just gave us extra confidence. As we progress with more and more flights and our virtual RTK network, and we further prove the technology onboard the eBee, I can see these GCPs being eliminated."

The GCPs were painted in place two weeks before the flights took place, controlled using total stations and tied to the CAHSR control network (State Plane coordinate system) the same week as the flights. “Because the entire project is in a heavily urban environment, almost all the GCPs were painted in the streets,” Cañas says. “That was a benefit as it made them easy to ID, however it was challenging for the field survey team because they had to work in busy traffic.”

To map the 30 mile corridor—an area of 61 square miles—JLP’s three drone staff flew 41 flights. These missions captured 11,800 images, with an average flight time of 28 minutes and average flight altitude of 200 feet.

“Each flight’s images took our other three staff between two and three hours to process in Pix4Dmapper Pro. After several iterations we found that we could queue up five instances of Pix4D and process simultaneously; any more than that would slow our processing computer down and just prolong the process,” Cañas notes.

Project workflow

01 Identify corridor using Google Maps

02 Establish flight model boundaries

03 Plan GCP locations

04 Submit flight plans & project boundaries to land owner for approval

05 Place GCPs

06 Contact local ATC/tower to coordinate flights within controlled airspace

07 Fly eBee RTK at critical locations first (near airports & other controlled airspace)

08 Sequentially fly planned limits

09 Process data in Pix4Dmapper Pro at end of each flight day

10 Create DTM from Pix4D .las file using TopoDOT, MicroStation & Bentley InRail software

11 Deliver DTM & orthophoto to client

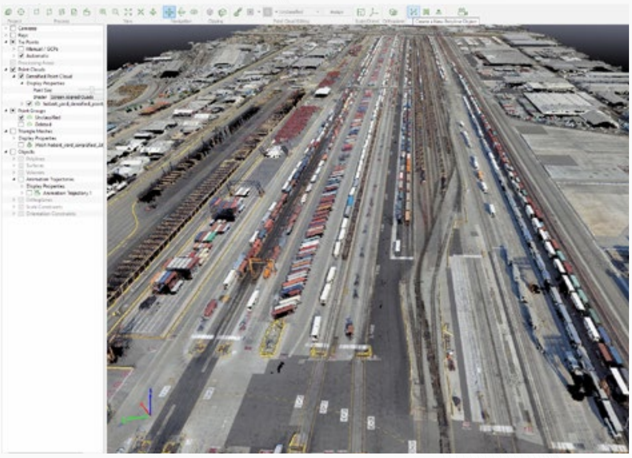
Talking results

The efficiency achieved by JLP’s first ever large-scale UAV project surpassed its team’s expectations. Cañas explains: “We surveyed a dense urban corridor in less than a month. Had we used traditional surveying techniques this would have taken 18 weeks, more than four times as long, and had we used manned aircraft the cost would have been double.”

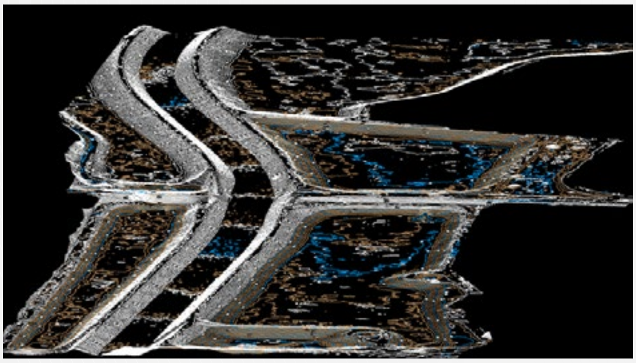
> “Traditional surveying would have taken more than four times as long and had we used manned aircraft the cost would have been double”

Not to mention that the quality and accuracy of the data JLP produced was, as Cañas says, “phenomenal”. “We were able to collect ortho-rectified images at one and a half inches [3.8 cm] per pixel—twice the resolution of even the best manned aerial product—and the data models we produced show accuracies of down to one to two inches [2.5 – 5 cm] for both vertical and horizontal—the kind of accuracies you can only dream of with conventional aerial methods.”

Michelle Boehm, the Southern California Director of High Speed Rail, echoed Cañas’ satisfaction in an interview with a local television station. “Ours is a project for the 21st century, employing 21st century technology, so we want to make sure that we do everything better, faster and more economically. We needed to obtain detailed mapping of our corridor, in quick time, and the eBee provided that for us.”



A Postflight Terra 3D (Pix4D) screenshot showing the project’s densified point cloud of Hobart Yard.



A section of contour map showing the Rio Hondo river, situated within the rail project's limits.

Since mapping its first rail corridor, JLP has put its eBee RTKs to work on a range of subsequent projects, achieving similarly impressive outcomes. "For example, we've flown two rail yards for CSX Railroad and five miles of coastal right-of-way for Southern California's Commuter Rail System," Cañas reports. "All these projects yielded the accuracy we were looking for and for a fraction of the cost of employing traditional methods."

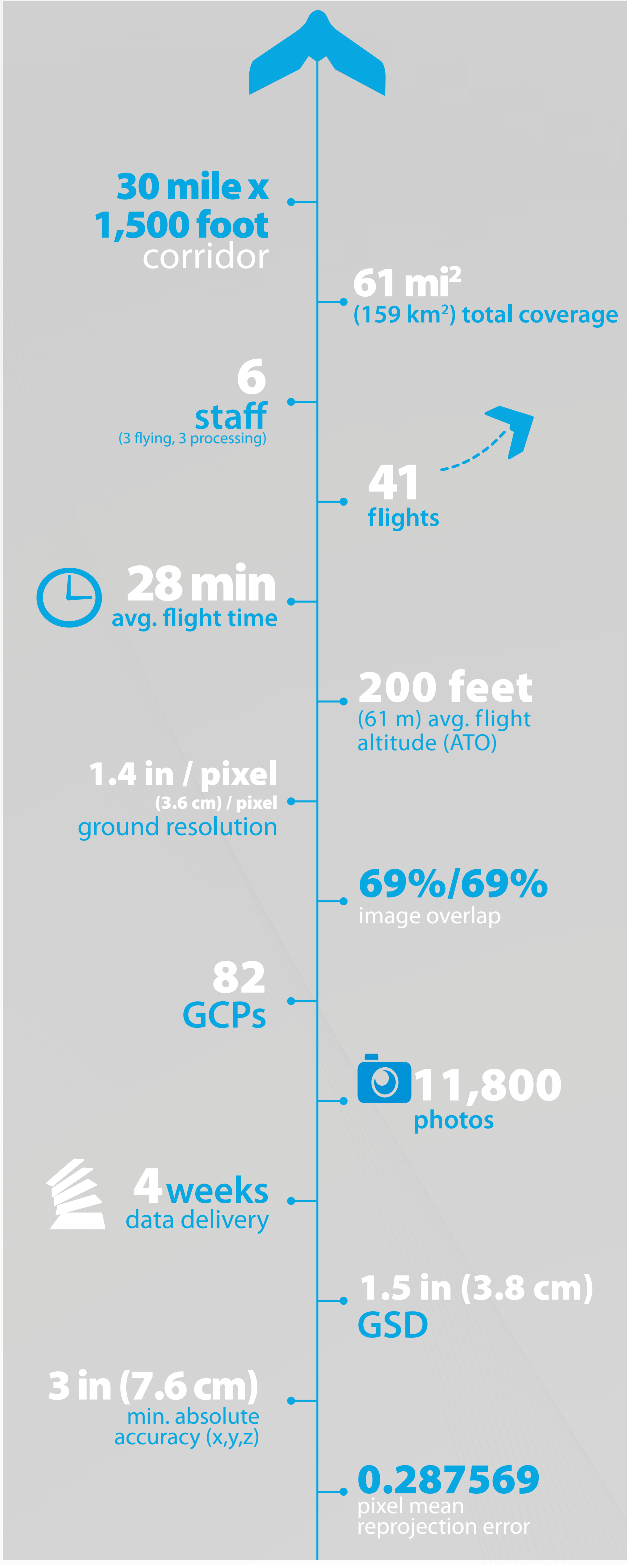
About JL Patterson & Associates

Founded in Orange, California in 1990, J.L. Patterson & Associates, Inc. (www.jlpatterson.com) is a transportation-engineering firm, which provides engineering design, construction management, and staff augmentation services for public and private sector clientele. JLP's assets were acquired by Jacobs Engineering Group Inc. in December 2015. However, those assets excluded the company's UAV program, which was transferred to a new dedicated UAS service company named Zephyr UAS (www.zephyruas.com).

Watch a U.S. TV interview about this project:
https://goo.gl/JH0q3e

Watch California High-Speed Rail Authority's UAV video (feat. Marc Cañas): https://goo.gl/0hMWL9

PROJECT STATISTICS



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