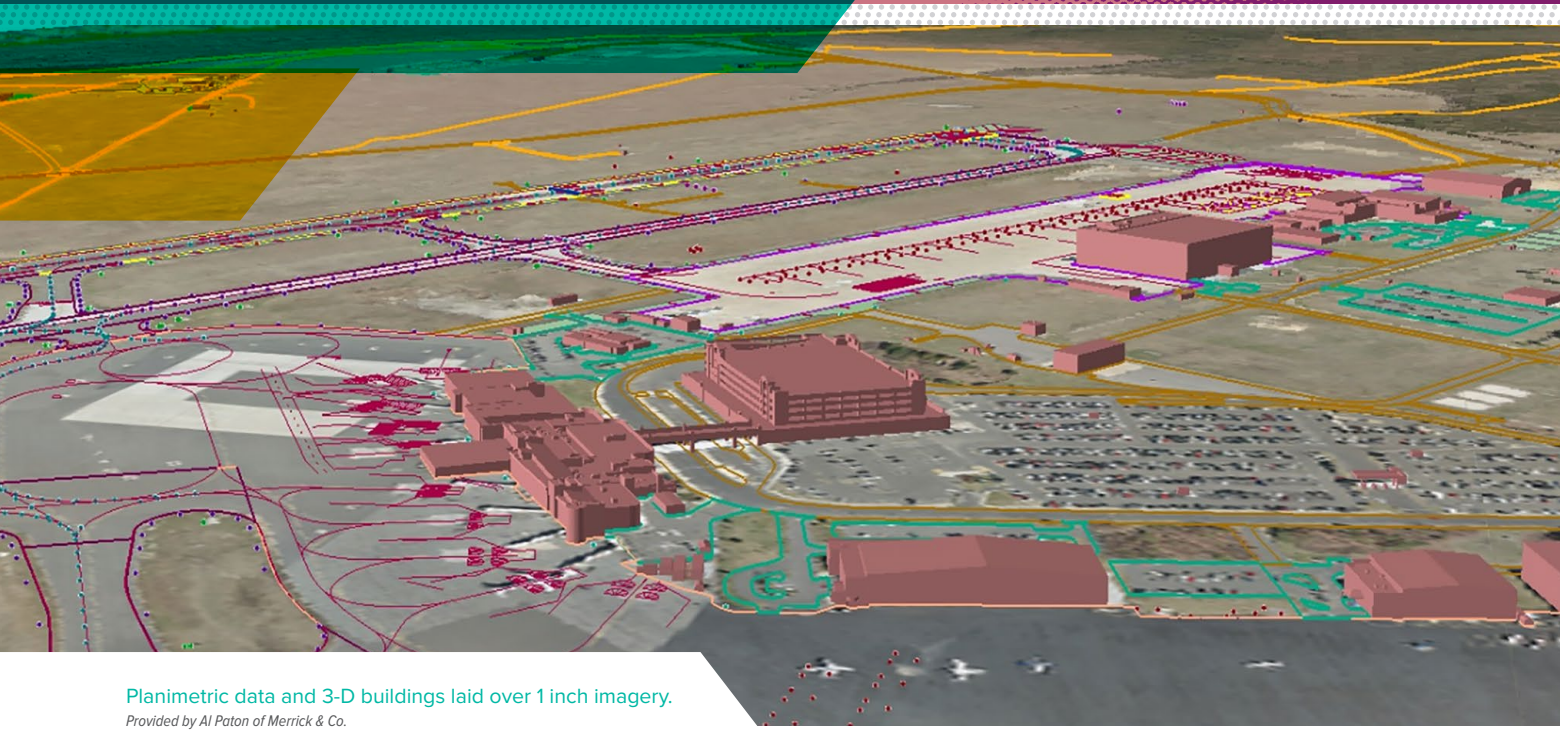


Planimetric data and 3-D buildings laid over 1 inch imagery.
Provided by Al Paton of Merrick & Co.

AIRPORTS

LiDAR and Imagery is Now Widely Used for Airport Mapping

In FY 2007, the FAA issued three Advisory Circulars to provide guidance for the collection and submission of aeronautical data and to identify the FAA's GIS data model for airport-related data. The main goal of the Advisory Circulars was to develop satellite-based approach procedures and to better utilize and manage the National Airspace System. This will use GIS data to create electronic Airport Layout Plan (eALP) for airports. The eALP includes the obstruction and approach information for the airport. There are several remote sensing companies that specialize in this type of mapping and so far this approach has been very successful. The FAA was at first reluctant to use LiDAR for this type of mapping but after some work by the mapping profession the FAA has accepted the use of LiDAR for this applications. In turn added benefit, from collecting LiDAR in addition to imagery was realized. There now are hundreds of airports using a combination of remote sensing technology to manage facilities and help operate airports, this is not just for obstruction and approach mapping.

In September 2009, the FAA reached the proof-of concept milestone for completion on a deployable eALP module and then beta testing was

BY JAMIE **YOUNG**

conducted from Airports GIS data gathered from 37 pilot program airports across the county. For more information about Airport GIS and the electronic ALP can be found on the FAA's Airport GIS website (https://airports-gis.faa.gov/public/index.html).

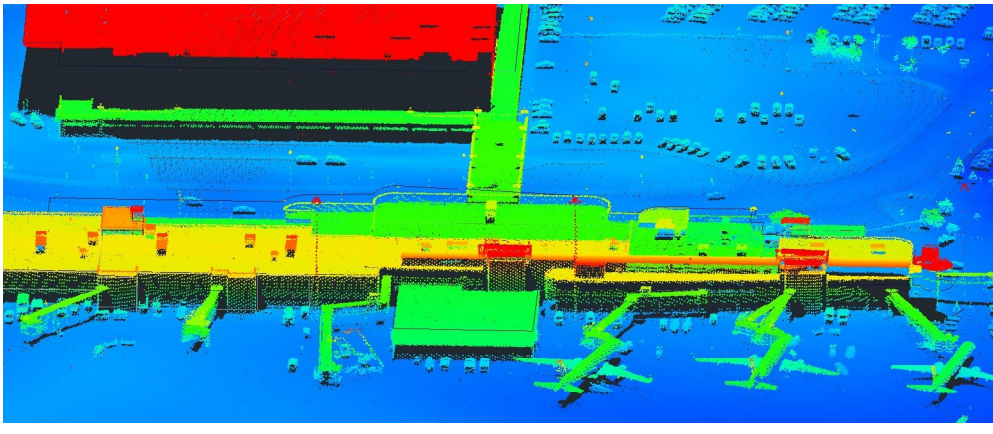
The FAA requires a full spectrum of information of airports because there is so much required to operate an airport and the bigger the airport the harder it is to operate. Detailed information is required for every aspect of an airport from but not limited to the taxiways, runways, traffic lanes for service vehicles, buildings, terminals, and all the signs and assets associated them.

The mapping requirements for these projects are extremely detailed and accurate. Typically, These projects are collected with a high definition mapping system (HDMS) mounted on a helicopter, but based on the image resolution and LiDAR point density, they could be collected with a fixed wing platform but the accuracy may not be achieved. The FAA requires most projects to be collected at a resolution of 2.5 cm pixel resolution, 4-band (RGB and IR bands) with 60% forward and 30% side lap with a sun angle no less than 35 degrees. Additional considerations would be dust, smoke, cloud, haze and snow free with leaf off conditions. The accuracy of the imagery is required to be 2x the pixel resolution or 5cm RMSE both horizontally and vertically. The AT accuracy needs to be equal to the pixel size or 2.5cm and the ground control requirement is required to be half the pixel size or 1.25cm. The orthophotography product will thus have a horizontal accuracy class of 5cm and absolute accuracy of X and Y at less than or equal to 5cm, RMSEr less than or equal to 7.05cm and orthoimagery mosaic seamline mismatch less than or equal to 10cm. The imagery is delivered in GeoTiff format and TIFF with TFW format. Meta data is also required.

> "In September 2009, the FAA reached the proof-of-concept milestone for completion on a deployable eALP module."

The mapping requirement for the topographic data is not always LiDAR but is becoming the preferred data for several reasons based on the extensive use of this data type. The LiDAR is required to be collected at 8ppm or higher. The LiDAR is also used to support the orthophotography production and is more cost effective as a result. The LiDAR is collected at a minimum to support 1 foot contours but given the requirements for 3-D modeling the point sample spacing is increased to support this applications. The LiDAR accuracy is vertical accuracy class of 5cm, with the non-vegetated accuracy tested to be 5.0cm or less. The resulting DTM accuracy will also be equal or less than 5cm and non-vegetated RMSEz will be equal to or less than 5cm, with hard surface within swath repeatability of less than or equal to 3cm, the swath to swath terrain RMSDz of 4cm and maximum difference being less than or equal to 8cm. These projects require the following classifications: 0,1,2,3,4,5,6,7, and 9 as they relate to the LAS 1.2 format. The products extracted from the LiDAR would be but not limited to contour, spot elevations, DTM and product level metadata.

The Imagery and LiDAR are only one component of theses airport projects. Obviously, there is ground control required for these projects and typically the survey work requires training and needs to be supervised by a licensed



LiDAR collected at 8 to12 ppm of an airport terminal.
Provided by Al Paton of Merrick & Co.

Planimetric data and 3-D buildings laid over 1 inch imagery.
Provided by Al Paton of Merrick & Co.

surveyor. Additionally, extensive planimetric vector mapping and 3-D modeling is required using the ortho-photography and LiDAR source data. The horizontal accuracy class RMSEx and RMSEy is 5cm and RMSEr of 7.1 cm. This data is required but not limited to be delivered in Geodatabase format and AutoCAD format with project level metadata. In some cases existing planimetric data is available but it in most cases this existing data should be used as a reference for a full plan update, especially if the existing plan doesn't meet the accuracy requirements.

The planimetric extraction or update includes an extensive amount of information. Buildings and structure include extracting roof lines and footprint polygons and 3D building polygons. All roadways and transportation surfaces will be extracted including road area polygons, road bridge polygons, road centerlines, road feature points (signs, traffic lights etc.), curb lines, parking lot polygons and drive way polygons, guard rails, roadway parking surface markings, airfield surface polygons, airfield surface marking lines, pedestrian sidewalks, trail centerlines, foot bridges, and all rail roads. All Hydrography features including waterbodies, streams, stream centerlines, storm sewer inlets (catch basins), storm sewer culvert lines, fire hydrants and aqueduct centerlines. The forest stands and land vegetation areas are also collected. The geodetic information will be collected and represented in the planimetric map including control points and image area. The photo-identifiable infrastructure including fence lines, gates, utility poles, light poles and manholes will be collected. All communication antenna points and any other photo-identifiable undefined features points, lines and polygons will be required as required. The data tolerance for this information or cluster tolerance will be 0.001 feet. The mapping standards for the project data developed will follow the ASPRS positional Accuracy Standards for Digital Geospatial data.

There are several challenges to collecting and processing airport projects. The collection of control and access to the project area can be difficult but working with the FAA makes this exercise much easier but escorts are required for all activities if the proper training is not in place prior to execution of the project. Also, depending on the size and location of the airport detailed information must be provided to air traffic control prior to collection. This access to the airspace needs to correspond with the acceptable weather conditions but again since the project is typically for the FAA the

access is much easier. Additionally, at times it makes sense to collect the LiDAR at night or independent of the imagery collection because the LIDAR collection can be performed during the day or night. Typically, the collection of the imagery is the most challenging aspect of these projects as you have to have access to airspace, favorable ground and atmospheric conditions and acceptable sun angle conditions all at the same time. The FAA has very strict acceptance criteria for the production of planimetric data so it is imperative that the imagery data and LiDAR data is collected and checked to insure that the resulting plan data is going to meet accuracy requirements. Additionally, the planimetric capture has to be meticulously done for all the detail that is required. Typically, the combination of very high resolution imagery and LiDAR provides very detailed information for this process. Most airports have existing plan data from previous projects. Ninety-nine percent of the time the project will have some type of update clause to try and use this existing data to facilitate the plan extraction of update but it would be discouraged in doing this unless the existing data meets the accuracy standards outlined in the new project. Typically, the process of making old data better and more accurate and combining with new data cause more work in the end.

Over the past twenty years a significant amount of technology that was developed from the defense industry such as GPS has made its way into the aviation and mapping professions. The use of LiDAR was met with much resistance from the aviation industry but they are starting to understand the value of this information in combination of traditional imagery and other remote sensing information for developing very accurate GIS databases for eALP and other uses at airports. As LiDAR technology continues to improve and we find innovated solutions from this data as it applies to airport and other applications. The resulting data will only get more powerful and accurate to improve operations and safety for airports and all.

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Planimetric data overlaid on 1 inch imagery
Provided by Al Paton of Merrick & Co.