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# From Earth to Image Distribution, Leica Geosystems and ERDAS Advances in Geospatial Solutions

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#### ABSTRACT

Over the past two years since Photogrammetric Week '07, there have been significant changes in photogrammetry technology as well as in the Leica Geosystems Geospatial Solutions Division (GSD) ability to serve this market. GSD now combines the data capture capabilities of Terrestrial Laser Sensors (TLS) with point cloud software, Airborne Sensor (ABS) with the geospatial data production, enterprise data management, geographic information sharing and internet delivery capabilities of its ERDAS business. Future geospatial information technology directions are also presented.

#### **1. TOTAL GEOSPATIAL SOLUTIONS AT LEICA**

In 2001, Leica Geosystems acquired ERDAS and LH Systems, and this division became Leica Geosystems GIS & Mapping (later renamed to Leica Geosystems Geospatial Imaging). ERDAS was a remote sensing and geospatial-imaging software company while LH Systems was a provider of aerial survey and photogrammetry solutions. The combination of these two entities created a comprehensive solution provider, addressing the entire imaging process from capturing raw data to presenting 2D and 3D maps. In essence, Leica Geosystems defined and powered the geospatial imaging chain as the experts in imagery.



Fig. 1: The holistic approach to serve the geospatial market.

Hexagon purchased Leica Geosystems in 2005 and chose to operate the Airborne Sensor business separately from the ERDAS software solutions. At this time, the battle between Microsoft and Google for dominance in the web-served, consumer driven mapping sectors was fully underway. This battle has been the spearhead of higher resolution images, 3D visualization capability and the ability to serve, almost seamlessly, terabytes of images to millions of users. A significant influence of this emerging market segment is that satellite imagery has become less appealing than higher resolution airborne imagery where high-detail visualization is required. Both GSD businesses began to add functionality and performance to their product portfolios and were positioning to bring these same capabilities to "professional" markets.

Today, GSD provides solutions that meet the full spectrum of geospatial information via a unique set of capabilities to capture and transform geospatial data into information useful for decision-making processes. The sensor portfolio of GSD contains a wide range of Terrestrial Laser Scanners and Airborne Sensors. Incorporating standards-based interoperability for authoring, managing, connecting and delivering geospatial information, GSD ensures that data is seamlessly integrated for enterprise, web-based, mobile and desktop clients.

#### 2. AIRBORNE SENSORS (ABS) TECHNOLOGY ADVANCEMENTS

Since 1925, Leica Geosystems has led the industry in analog airborne film camera technology. In 2001, Leica introduced two revolutionary digital systems – the ADS Airborne Digital Sensor and the ALS Airborne Laser Scanner. These sensors, operating subsystems and advanced software workflows still set the industry standard for digital airborne sensor solutions. Since Photogrammetry Week '07, ABS has completely replaced its product portfolio with significant performance advancements and several exciting new products including XPro line sensor workflow and the RCD100 Medium-Format Digital Camera.



Fig. 2: Leica Geosystems Airborne Sensors product portfolio.

# 2.1. Imaging Sensors

The Leica ADS80 Sensor captures all multi-spectral bands simultaneously at the same high resolution. Providing 5-band, truly co-registered and equal resolution imagery right at data acquisition makes the ADS80 the best system for efficient orthophoto production, feature extraction and remote sensing. The Leica ADS80, SH81, and SH82 Sensor Heads increase aerial survey productivity, maximize area coverage performance and minimize mission time.

A key driver in the development of airborne imaging sensors and workflow solutions has been and remains achievement of higher productivity at lower cost. In data acquisition, gains in productivity have been realized by maximizing area coverage to ensure that less flight lines have to be flown to cover more area. Innovative solutions, such as line staggering with pushbroom sensors, allow "high-res acquisition mode" of up to 24000 pixels across swath. According to recently published papers, this can achieve productivity gains of up to 50%.

Further achievements have been made by increasing the data throughput to allow the capture of more pixels per square kilometer at gsd's of less than 5 cm. This allows faster flying times as well as acquisition of data that can be used for photogrammetric applications plus remote sensing applications. Sensors that acquire data in a way that does not require pan-sharpening during post-processing and which can provide good radiometric calibration are delivering superior feature extraction and classification performance.

Leica XPro provides complete and fast ground processing workflow for ADS digital line sensors. The new Leica XPro line sensor workflow software is straightforward to implement and easy to use for those familiar with traditional analog frame processing. Ground processing with Leica XPro covers the entire line sensor workflow - from data download to image generation.

Newly designed area-based analysis tools and automatic interaction using point matching with targeting image point measurements will improve triangulation accuracy. The aerial triangulation from Leica XPro is based on the well-known and proven ORIMA adjustment. Leica XPro delivers stereo-viewable images or high-resolution orthophotos with extreme speed and minimal user interaction. The Radiometric Image Chain implemented throughout the Leica XPro workflow leads to perfect image radiometry. Generated products are ready for further handling by a wide range of digital photogrammetry software packages.

The new Leica RCD100 39-MP Medium Format Digital Camera is a highly productive mapping solution for those who want productivity and efficiency for smaller to medium-sized photogrammetric mapping and orthophoto projects. When used with an existing Leica PAV30 or the new Leica PAV80 Gyro-stabilized Mount, the tight integration with Leica IPAS20 allows the generation of directly georeferenced imagery. The Leica RCD100 offers high photogrammetric accuracy and high data processing efficiency for many airborne mapping and orthophoto applications.

Dual-head operation allows simultaneous image acquisition in RGB and CIR. Further, the Leica RCD100 offers 35mm, 60mm and 100mm exchangeable lenses and the most rigid lens mounting on the market. This ensures flexibility and photogrammetric stability without compromise where true mapping accuracy is needed.



ADS80

Fig. 3: ADS80, RCD100 and ALS60 sample imagery.

#### 2.2. LIDAR Sensors

With leading point density and area coverage, ALS60 and ALS Corridor Mapper are the most versatile and powerful LIDAR (Light Detection and Ranging) systems in the industry. The ALS60 Airborne Laser Scanner has a 200 kHz "on-the-ground" pulse rate, and has a Multiple Pulse in Air (MPiA) capability that effectively doubles available pulse rate under certain conditions. The ALS60 can be operated with the Leica RCD105 39-Megapixel Medium Format Digital Camera.

Major LIDAR system improvements are in point density and accuracy. Today's systems deliver 40 times as many data points per square meter of terrain as systems did 9 or 10 years ago. This allows the capture of finer and finer features in the terrain. If accuracy does not keep pace with point density, the result is "fuzzy looking" data where details are masked by "noise". Advances in how Leica employs various component technologies in its LIDAR product have improved system accuracy from tenths of meters in the late 1990s to current accuracies down to 3-5 cm.

Leica Geosystems also manufactures all critical subsystems and software that enhance the operation of its airborne sensors. The IPAS inertial position and attitude system, PAV sensor mount, FPES flight planning and evaluation system and FCMS flight & sensor control and management system are examples of the complete sensor solution, all from one company. No other company with the product line depth of Leica Geosystems has so much control over the hardware subsystems and software workflow so essential to the total mapping solution.

# **3. ERDAS TECHNOLOGY ADVANCES**

In 2007, ERDAS acquired Acquis, ER Mapper and IONIC, providing the company with new technology and strengthening its global presence. With these acquisitions, the company broadened its offerings, appealing to much larger web and enterprise-wide, non-traditional markets. In 2008, the company became the new ERDAS, expanded to provide the most dynamic geospatial solutions to meet everyday business needs.

Today, ERDAS provides solutions that meet the full spectrum of an organization's requirements, transforming geospatial data into information useful for decision-making processes. Incorporating standards-based interoperability for authoring, managing, connecting and delivering geospatial information, ERDAS ensures that data is seamlessly integrated for enterprise, web-based, mobile and desktop clients.

For over 30 years, ERDAS has been an industry leader in image exploitation, processing, visualization and geospatial data management. With Open Geospatial Consortium (OGC) and International Organization for Standardization (ISO) interoperability, ERDAS develops standards-based solutions with the most advanced service-oriented platform available. Building on the company's rich history and expertise in geospatial imaging, ERDAS is now a leader in the broader geospatial information market.

#### **3.1. Photogrammetry Product Line Advancements**



ERDAS has placed considerable emphasis on improving workflows associated with accurately and efficiently producing stereo-imagery, ortho-mosaics, terrain datasets and 2D/3D feature datasets.

Over the last two years, ERDAS has focused on implementing a new innovative approach for automatically extracting terrain from images captured from a variety of sensors (airborne and satellite).

Fig. 4: High-density terrain dataset automatically produced by LPS eATE using ADS imagery.

This terrain extraction approach:

- Leverages computer science technology, such as multi-threading and distributable processing, so that production can be optimized
- Uses all spectral characteristics of an image. The approach leverages all available bands in an image and performs matching on all spectral bands
- Is intelligent and assesses which bands are most suitable, based on the geography of the area
- Directly outputs LAS files, allowing users down the workflow chain to directly integrate the data in their geospatial applications.

The algorithm is also extensible so that organizations can plug-in custom correlators, blunder detection, interest operators and filters. Output terrain products are RGB encoded; thereby creating a visual information product that establishes a 3D virtual reality within the area of interest. Mass points that have been automatically extracted are also classified on the fly, allowing for the creation of bare earth products as well as vegetation, building and water layers.

#### 3.2. Remote Sensing Product Line Advancements

ERDAS has been an industry leader in remote sensing and image processing for more than 30 years. Over the last several years ERDAS has focused on improving the performance associated with handling large volumes of geospatial data, creating clean and accurate mosaic products, implementing a new graphical user interface to streamline geospatial data exploitation and automating feature extraction and change detection.

The ERDAS mosaicking capability has been expanded in capacity and performance to handle more than 10,000 images and more than 2.5 tera-pixels of data, all within a 32-bit operating system environment. A new radiometric correction tool that corrects illumination artifacts across images has been implemented. A next generation of ERDAS IMAGINE has begun with the development of a new graphical user interface that streamlines commonly used tasks for geospatial data exploitation. Users have the ability to customize workflows to meet their production needs. Improving the performance of handling large datasets (raster, vector, tabular) has also been a focus, including the efficient reading and writing of all geospatial data types.

Automated feature extraction and change detection has also seen much development. In the past, users have used images from multiple time periods to quantify what has changed. However, many users have existing feature datasets that are out of date. The new ERDAS approach fuses the old feature datasets and the new imagery to automatically detect change and map new features. With IMAGINE Objective, ERDAS has developed automated feature extraction capabilities for extracting buildings, roads and other geographic information from imagery. This is done by fusing ancillary geospatial data to facilitate the feature extraction process. As a result, the map of the future truly is an intelligent image.

#### **3.3. Enterprise Product Line Advancements**

Over the last two years, ERDAS has developed and released enterprise solutions for managing, sharing and delivering geographic information over the web. ERDAS APOLLO securely manages data within an organization, including discovering, describing, cataloging and serving data into a variety of web and rich client applications throughout the enterprise. ERDAS TITAN is a powerful geospatial data-sharing infrastructure. ERDAS TITAN enables users to publish datasets stored locally on desktop systems with other users in the organization. These datasets can be fused with data and web services that are centrally managed by ERDAS APOLLO. ERDAS Image Web Server is a high-speed, specialized application that efficiently delivers massive amounts of geospatial imagery to thousands of users, all on a single server. Solving the infrastructure congestion problems traditionally associated with deploying large amounts of image data, users quickly access the information they need. With ERDAS Image Web Server, individuals may access imagery using CAD, GIS, mobile, and web applications.



ERDAS has concentrated on extending the utilization of geographic data and web services across an organization by introducing on-demand geo-processing. ERDAS IMAGINE users producing geography spatial models for earth analysis can extend use of a model to other non-traditional users through an open and interoperable OGC Web Processing Service (WPS). Web processing services introduce a dynamic approach for delivering information based on a variety of input data products.

Fig. 5: On-demand geo-processing of geographic information using spatial models published by ERDAS IMAGINE.

# 4. AIRBORNE SENSORS AND ERDAS TECHNOLOGY DIRECTIONS

Since Photogrammetric Week '07, Leica Geosystems has continued hardware, software and workflow developments to maintain its leadership in geospatial information technology. All of these applications will ultimately move toward utilization of point cloud technology to accurately measure and model in a 3D environment.

Airborne sensor development is proceeding in four major areas: performance, features, workflow, and data fusion. As a market leader in high-end digital imaging and scanning sensors and geospatial imaging software, Leica is in a unique position to assess market needs for technology and workflow improvements. Leica continues to push the performance and feature envelope in areas such as ADS80 radiometric calibration and ALS60 point density and data smoothness, resulting in higher quality image products.

ERDAS has solidified its position in the market by continuing to build upon its remote sensing and photogrammetric solutions. ERDAS is focusing on improving the performance, quality and usability of its products for geospatial data production, mapping and analysis. The next generation of ERDAS IMAGINE will include a new user experience with a modern graphical user experience and leveraging ribbon interfaces, workflow toolbars and custom user templates. ERDAS IMAGINE will be the desktop authoring platform on which remote sensing, photogrammetry, GIS and mapping workflows will be built. LPS will continue to focus on streamlining the production of ortho-rectified images and terrain datasets using modern IT standards and distributed processing. The photogrammetric workflows contained with LPS will 'fuse' with ERDAS IMAGINE for the creation of a one-stop geospatial desktop authoring platform. ERDAS IMAGINE and LPS will also connect directly to the enterprise geospatial data management capabilities of ERDAS APOLLO.

The enterprise geospatial products will focus on web enabled geo-processing and extending the ability of enterprise geospatial data management. ERDAS APOLLO will support the automatic discovery and cataloging of imagery from a variety of sensors, point clouds, GIS databases and survey observations. High performance serving and delivery of point cloud data will allow GIS and CAD users to directly consume and integrate point cloud data in their workflows.

# 5. SUMMARY

The marketplace for high-quality imagery is evolving almost as fast as the technology serving it. Plus, as more quality imagery is delivered to end users – commercial, government and now even consumer – a greater demand is placed on receiving a high quality and consistent data product.

Leica Geosystems has demonstrated a clear, continued commitment to the photogrammetric technologies that capture, author and distribute geospatial information for the market. With its broad array of sensor, workflow, software and information solutions, Leica Geosystems will remain a leader in photogrammetric science application to geospatial information.