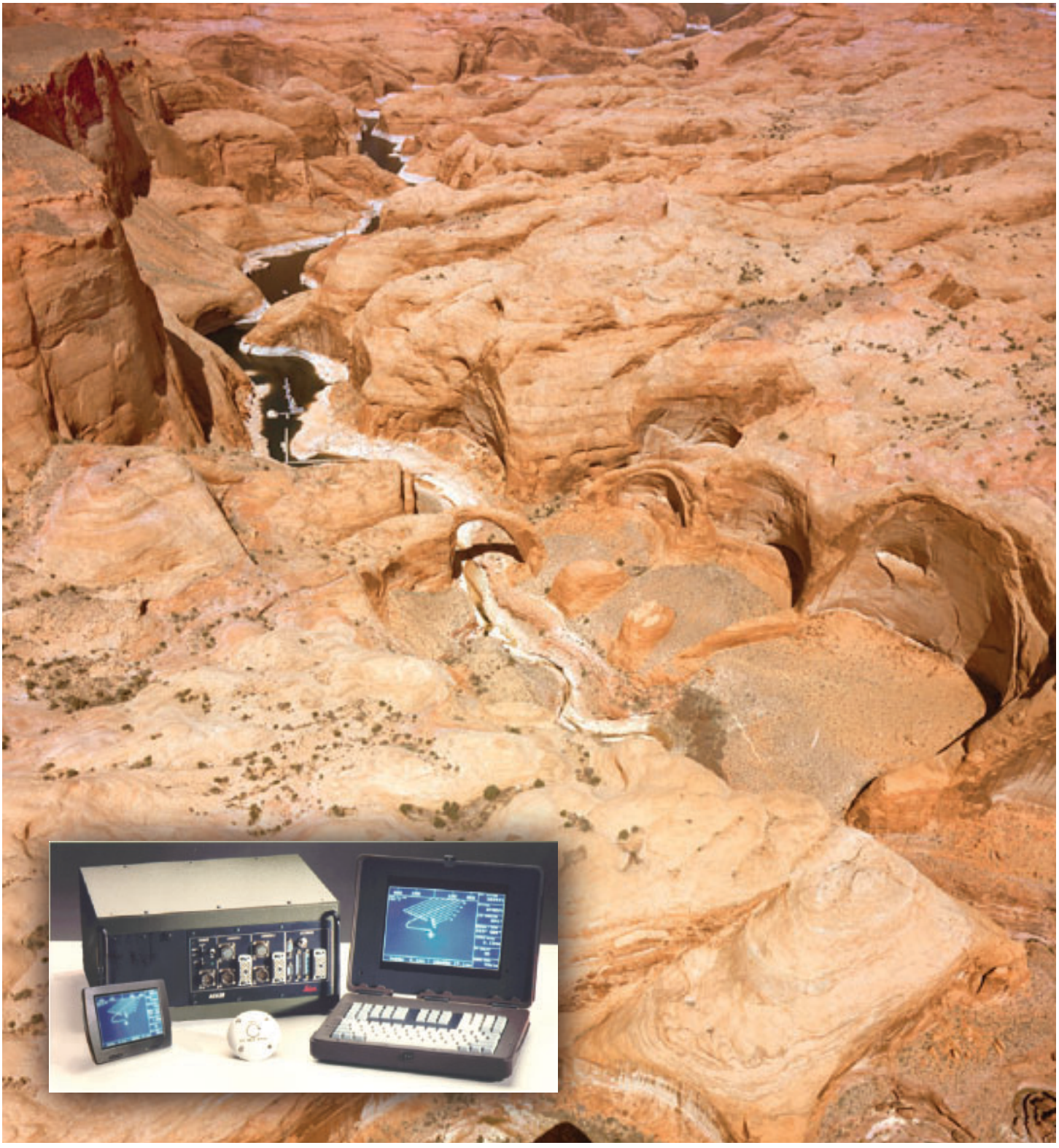
Leica ASCOT (Aerial Survey Control Tool)



Aerial photography of Rainbow Bridge, Utah, USA, captured with Leica RC30. Image courtesy of Aero-Graphics, Inc.

GPS-Supported Flight Management System for the Acquisition of Aerial Photography

Leica Geosystems

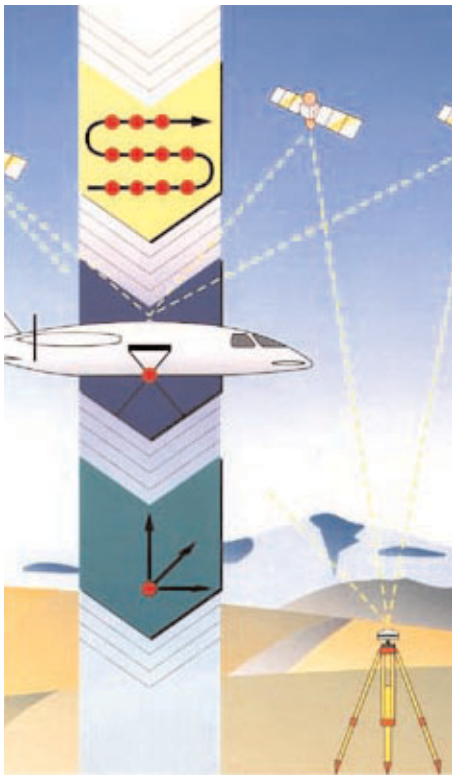
Benefits of Leica ASCOT

Higher Productivity

- Reduced project planning time
- Shorter flights and reduced stress on crew
- Easy flight reporting and photo identification
- Optimal data interfaces to GPS data processing

Lower Costs

- No repetition of photo flights
- Fewer ground control points
- Reduced aircraft maintenance costs



Leica ASCOT — Do It Right the First Time

Survey flight planning, navigation and reporting have always been a challenge for pilots, navigators and photographers. Flight plans had to be prepared manually from map sheets in a painstaking process. Precise overlaps, accurate aircraft guidance and pinpoint photography were difficult to achieve by visual means and flight reporting was done with ruler and pencil.

Fortunately, the advent of the global positioning system (GPS) and the availability of powerful receivers, computer hardware and software have brought convenient flight planning, flight reporting, and precise real-time aircraft positioning within the reach of most camera owners. Flying in accordance with a rigorous plan is no longer a gamble, but a technique.

To provide aerial camera users with all the advantages of GPS-based flight management and an ideal data flow from flight planning to block adjustment, Leica Geosystems has developed the GPS-based photo flight management system ASCOT.

Leica ASCOT Provides:

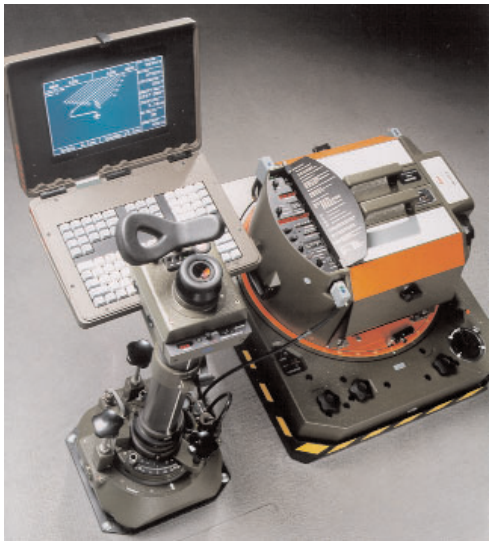
- Rugged and robust hardware, especially suited for the airborne environment
- Easy-to-use, computer-aided interactive graphical flight planning
- Reduced flying time, due to high-precision navigation during all phases of the survey flight
- Photogrammetric flights without stress for the flying crew
- Simple flight reporting and image analysis
- Collection of GPS data and interfaces to post-processing software for a significant reduction of ground control points

These features ensure that your survey flight will be cost-effective, productive, successful, and correct the first time.

Leica ASCOT Hardware — For the Harsh Airborne Environment

Features of the Leica ASCOT Hardware

- Rugged design
- Fully integrated
- Reliable
- Operator-friendly
- Minimum cables



The Leica ASCOT Navigator Station can be mounted on to the navigation sight. Also pictured above, Leica RC30 aerial camera and Leica PAV30 gyro-stabilized mount (sold separately).

Control Computer

The ASCOT control computer is based on a powerful industrial computer specially suited for operation in the demanding airborne environment. The choice of the computer components and the computer design was influenced by factors such as system and function reliability, safety and electromagnetic tolerance.

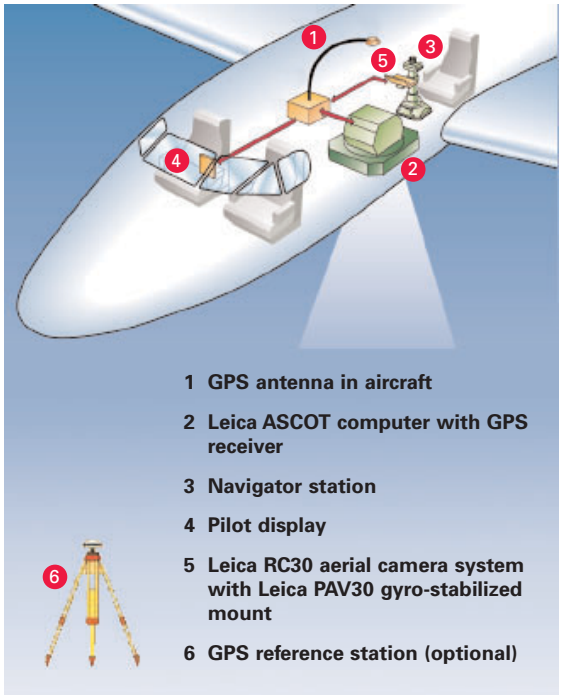
The rugged system housing, with passive electromagnetic shielding, shock- and vibration-protected slots and mounts for the mass storage device, and a silicon disk, allows safe data storage even under turbulent air conditions and in unpressurized aircraft at high altitudes. The ASCOT control computer has communication interfaces for two photogrammetric cameras, two gyro-stabilized mounts, and an external GPS receiver (if desired).

The interface ports give access to all attached sensors in the aircraft directly from the camera operator's seat.

Internal GPS Receiver

The state-of-the-art GPS receiver, which provides high precision navigation information and raw data logging, is directly integrated into the ASCOT control computer. Proprietary carrier phase techniques and patented technology give pseudorange measurements with extremely low noise characteristics.

The receiver can use real-time differential RTCM messages if high-precision applications are desired. The ASCOT software takes control of the receiver during the entire mission, so the camera operator can concentrate on other work, without worrying about GPS.



Leica Geosystems also offers a GPS ground reference station to provide a convenient means of obtaining data for high-precision, differential post-processing. The company can provide ASCOT users with its Flykin Suite+ software product for the estimation of camera stations from the airborne and ground GPS data. Leica Geosystems has designed a particularly effective workflow whereby data progresses from ASCOT (and a ground reference station if provided) to Leica Flykin Suite+ to Leica ORIMA triangulation software.

Operator Terminal

The operator terminal is the interface between the camera operator and the sensors that are handled from the ASCOT system. It can be mounted directly on the NSF3 navigation sight of the Leica RC30 (RC20, RC10A) camera system, and allows supervision and control of the survey flight from the camera operator's seat.

Pilot Display

The pilot display can be mounted in any desired location in the cockpit to give graphic flight guidance information to the pilot.

Leica ASCOT Hardware — For the Harsh Airborne Environment

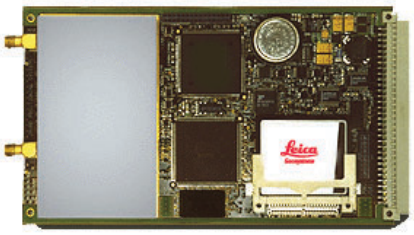
GPS Airborne Receiver for ASCOT

The GPS receiver is a board integrated into the airborne ACU30 computer of the ASCOT system. It features real-time navigation for flight control and phase measurements for subsequent post-processing.

It is based on current, proven technology. The main feature is its versatility: the same board is used for the most basic or the most high-tech model and can be upgraded without hardware exchange.

Airborne GPS Receiver

FEATURE	BENEFITS
Integrated receiver	No cable, no loose parts; lower cost
Freely customizable	Fits to any customer's requirements
Upgrades available	Evolves with customer's needs
High recording rate	Better accuracy for projection centers
RTCM ready	No additional equipment required



Leica ASCOT airborne GPS receiver

GPS Ground Reference GPS Receiver

Leica Geosystems' ground reference station is a compact, field capable unit. Based on new technology designed and improved during extensive experience, it ensures autonomous and reliable data collection under any conditions. The main feature is its simplicity: there are few cables and a robust design that allow easy measurements after a quick setup.

Ground GPS Receiver

FEATURE	BENEFITS
Compact receiver	Easy to transport
Field and office capable	Fits any conditions
Simple design	Easy to set up, by anyone
Upgrades available	Evolves with customer's needs
Survey equipment	May be used for survey jobs
Established technology	Reliable system and components

Leica SR520 dual frequency GPS receiver

Leica SR510 single frequency GPS receiver

Leica ASCOT Software — Modular and Flexible

The ASCOT software contains modules to cover all phases of typical survey missions:

- **Interactive Mission Planning**
  Computer-aided set up of flight lines, photo centers and frame annotation
- **Flight Execution**
  GPS-supported navigation, recording of raw GPS phase measurements and data annotation on each photograph
- **Post-Flight Analysis**
  Computer-aided documentation and analysis of photo flights
- **Utility Programs**
  Include valuable tools such as RINEX conversion and display of sun elevation angle.

Easy to Learn and Quick to Get Started

The ASCOT software is based on a graphical user interface, which is easy to learn and handle. Any survey flight can be simulated in the office to train pilots and camera operators on the use of the system.

Mission Planning

Interactive, Graphical and Easy to Learn
ASCOT helps the user to plan survey flights in a fast and efficient way. The planning software runs on any personal computer. It may even be used on the airborne ASCOT control computer. If a modification to the flight plan is required during the flight or if a flight plan has to be created in a remote location. In a conventional office environment the flight planning module supports a digitizing tablet.

Project-Oriented and Flexible
ASCOT flight planning is project-oriented. A project may contain the following planning types:

- Blocks defined by border points
- Individual straight lines
- Individual exposures

The number and size of the projects ASCOT can handle are limited only by the capacity of the hardware.

Flight Planning in All Standard Coordinate Systems
Projects can be prepared in local grid coordinates or geographic coordinates. Grid coordinate systems from all over the world are supported and can be defined by the user. Utilities for the transformation of grid coordinates to WGS84 coordinates are a standard feature of the ASCOT system.

Computer-Aided Flight Plan Layout
The projects are computed at the click of a mouse or a key stroke, giving gap-free coverage of the flight area or exposures that fit a given map-sheet layout.

Multi-Sensor Extension
ASCOT Multi-Sensor is an extension to ASCOT. Standard ASCOT flight plans are used during flight execution with ASCOT Multi-Sensor to control dual camera systems as well as to operate another type of sensor in parallel with a frame camera. The main benefit of ASCOT Multi-Sensor is increased productivity of the flight crew, which results in shorter project flying time and cost savings.

Import of Externally Planned Flights
With ASCOT it is also possible to import flight plans from the user's own planning system. A clearly defined, open file structure allows import of either complete or incomplete flight plans as well as coordinates into the flight planning within ASCOT.

Flight Execution

The ASCOT flight execution module is the heart of the ASCOT system. It reduces flying time as it takes over several tasks during the survey flight:

High Precision GPS-Supported Navigation

Navigation and graphical guidance information is displayed during all phases of the survey flight:

- Approach to the mission area
- Along turns
- Across the flight line

Both the camera operator and the pilot can compare their actual position with the desired position on their respective screens.

The flight lines to be flown and the direction of approach can be freely selected by the operator, but when required an optimal route-finder algorithm selects the nearest flight line automatically.

Screen during approach and turns: Overview Display

Automatic Camera and Sensor Control

During the survey flight, ASCOT usually takes control over the aerial camera and triggers it at the pre-planned positions. Additional exposures may be made manually and the spiral mode of the camera is also supported by the ASCOT system. Over hilly terrain ASCOT can be switched to constant forward overlap mode. In this mode the v/h value from the camera is used to compute the next release position to ensure constant forward overlap along the flight line.

The whole camera system including the Leica PAV30 gyro-stabilized mount (even on a dual camera system) is fully controlled by ASCOT. This minimizes stress for the camera operator.

Flexible Data Annotation

ASCOT allows free definition of the photo annotation for specific projects with individual text, which can be varied from for flight lines to flight line. Also, data that can only be determined during the flight can be annotated, such as:

- GPS position and navigation data
- Project and flight crew identification
- Flying altitude and ground tracking

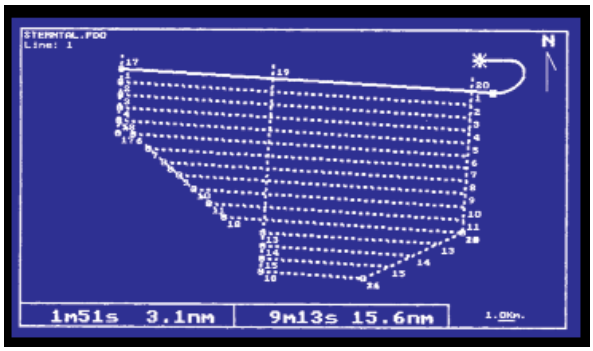
System Hardware and Software Checks

Prior to each flight the optimal interfacing of all on-board components allows a comprehensive, automatic system check, which indicates whether or not the hardware is ready to use. During flight, error and status information from the camera and the gyro-stabilized mount are displayed at the operator terminal.

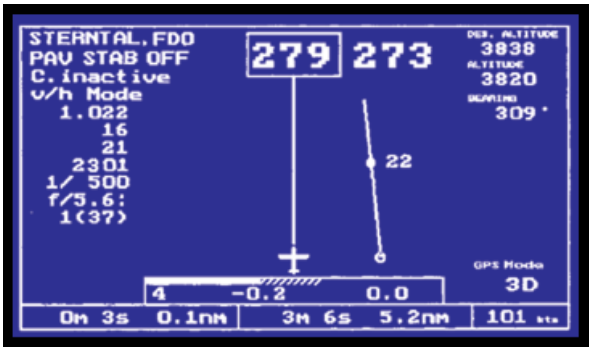
Raw Data Logging

Determination of precise camera coordinates with GPS raw data can reduce the number of required ground control points significantly. For this, it is necessary to store the GPS raw carrier phase and pseudorange data and the exposure event pulse. ASCOT automatically records, for the entire flight: the GPS raw data, the event data as well as the attitude angle of the gyro-stabilized mount at the moment of exposure. This way the data can be processed with Leica Flykin Suite+ and later on with Leica ORIMA-TE/GPS for the block adjustment.

Additionally, for each exposure the coordinates of the antenna phase center are stored on the hard disk, to simplify post-flight analysis and image identification. All data can be downloaded to floppy disk or PC cards or can be transferred to a range of software solutions.



Screen during approach and turns: Map Display



Screen on the photo line: Graphical Guidance Display

Accurate Repetition of Specific Flight Sections

If a specific portion of the flight is missing, for any reason ASCOT will guide the user exactly to the missing lines or points, for a complete coverage of the project area.

Post-Flight Analysis and Data Export

Post-flight mission analysis with ASCOT is possible in different ways:

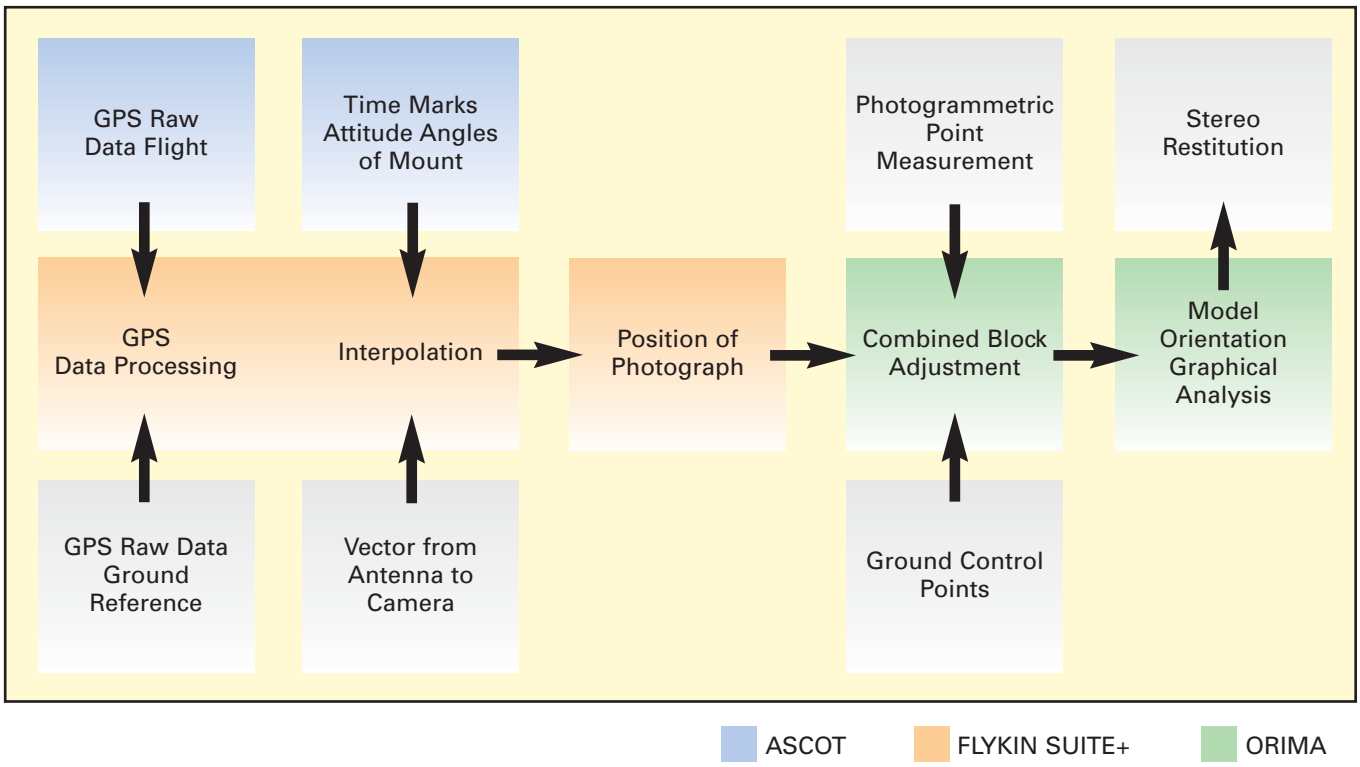
- Display the project graphically with the overlaid flight path
- Keep multiple flight missions; these missions can be treated jointly by ASCOT analysis
- Print flight parameters and verify the deviation between the planned exposure and the actual location of the exposure
- Generate DXF files for export into any CAD or presentation package
- Export mission data in a file and analyze it with a spreadsheet program or database

Leica ASCOT, the Optimal Interface for Post-Processing

The results of the ASCOT system are ideally suited for GPS-based photogrammetric triangulation of aerial images. ASCOT's raw GPS data and the time tags of the exposure events can be read into the Leica Flykin Suite+ program, which computes a high-precision aircraft trajectory and interpolates the coordinates for each camera exposure station. These coordinates are then exported to Leica ORIMA-TE/GPS.

The Combined Block Adjustment (CBA) of GPS and image data is the key to a significant reduction of ground control points.

Data Flow of the Leica Geosystems Solution



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