NEW AIRBORNE INSTRUMENTATION FOR PHOTOGRAMMETRY

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A photo flight mission for mapping purposes can be regarded as successful if it results in the production of negatives of good quality which cover the required area with a minimum number of models. These two factors clearly have a considerable influence on the costs of producing the photogrammetric plotting.

In obtaining aerial photography for mapping, the crew of a survey aircraft must carry out three specialized operations. There is the piloting operation - that of flying the plane; there is the navigating operation; there is the process of operating the camera. These separate functions, normally performed by a crew of two or three, dove-tail into one another to such an extent that a high degree of coordination is necessary for successful photography as defined above.

On approaching and flying over the terrain to be covered, the flying and navigating aspects are both influenced by the photographic aspect. Flight and navigation get the aircraft to the site; expert piloting and precision navigation are needed during photographic flight for economic photographic cover.

Consideration of the organisational side of the whole problem therefore shows that both the long-range and the precision photo-flight navigation facilities should be centralised in the cockpit, in which the essential camera controls should also be located for obtaining "pointed" or aimed as well as strip photographs. The equipment available commercially up to the present time varies from home-made mechanical sights to sophisticated electronic systems (such as Radan-Doppler) for the navigational requirements, and a gyroscopic platform (the Aeroflex Stabilized Mount) for maintaining the camera axis at near-vertical. The indications are that visual navigation methods using relatively simple equipment will continue to take first place, thus calling for a navigation sight which provides the possibility of viewing both forward to the horizon and down to the nadir. Horizon sighting is particularly desirable, especially when flying over monotonous terrain, because of the greater possibility of finding characteristic topographic features in the line of sight. At the same time, synchronization of the two functions "expert piloting" and "precision navigation" demand that this sight be placed in the cockpit if possible, to permit personal communication between pilot and navigator; while the "precision navigation" and "camera operation" functions call for means of releasing the exposures by the operator of the navigation sight.

In order to meet the need for an instrument combining both navigational functions and essential camera controls, Wild Heerbrugg have developed a navigation telescope called the NF1 Navigation Sight (Fig.1). By means of this instrument, which can be placed in front of the co-pilot's seat, and the control unit of the camera - its plugbox - located within reach, the navigator controls from his seat the camera exposures and the overlap settings, while the

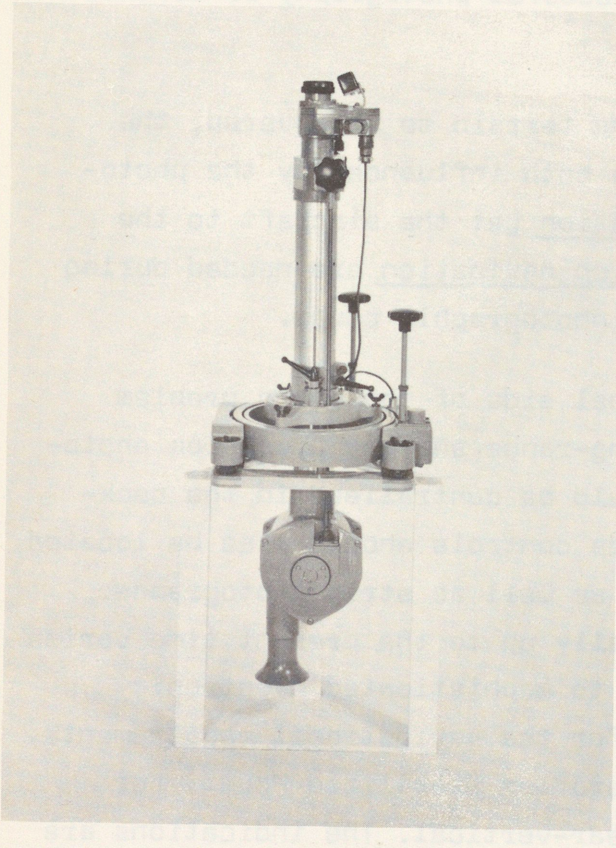

Fig.1 Wild NF1 Navigation Sight, shown here with objective in position for viewing the heading from above the horizon level to within two degrees of the nadir.

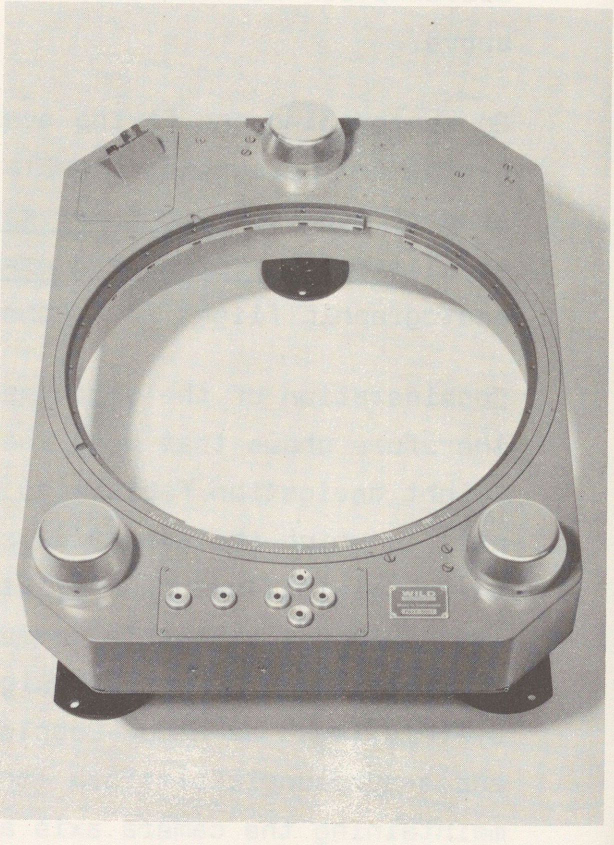

Fig.2 Wild PAV2 Universal Mount, for carrying the RC8 for RC9 aerial cameras and the HC1 Horizon Camera. Push-button control of drift (left) and tip and tilt (right).

elements of drift setting, tip and tilt made with the NF1 are transferred automatically to the aerial camera through a new servo-motor camera mount, the Wild PAV2 Universal Mount (Fig.2).

The Navigation Sight consists essentially of an erect-image telescope supported in a cardanic mount. Its principal optical axis can be plumbed by turning two footscrews to centre a circular bubble. The telescope objective can be swung forward continuously through up to 50°, at which position a view of the heading from horizon almost to nadir is seen. Its field of view is 97° approximately.

Fig.3 shows the reticle of the Navigation Sight and explains the pattern of lines, which are curved to compensate for the barrel distortion of the telescope. Superimposed on this pattern in the

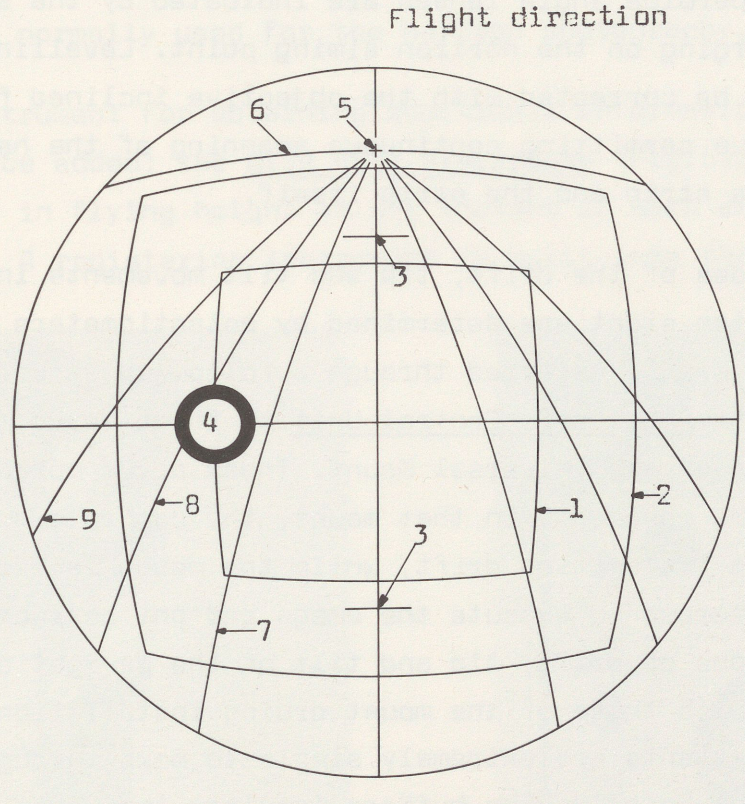

Fig. 3 Reticle of the Wild NF1 Navigation Sight

Vertical position

1. Time interval lines for 60% overlap with super wide angle camera
2. Frame of wide angle photograph
3. Frame of normal angle photograph
4. Circular level

Objective tilted 50°

5. Horizon vanishing point
6. Horizon
7. Width of super wide angle strip
8. Width of wide angle strip
9. Width of normal angle strip

field of view and not shown in Fig.3 are the spiral lines for setting the overlap regulator by means of a drum on the RC8 control box, to which it is connected, to obtain the desired percentage of overlap from one exposure to the next for narrow angle (60°) and wide angle (90°) photography. For RC9 superwide angle (120°) photography, the passing of a terrain point from the forward to the back line marked "3" is timed in order to determine the exposure interval for setting in the Intervalometer. An image of a circular bubble is displayed in the black ring, in which it is centered for verticalising the principal optical axis by means of two footscrews which tip and tilt the cardanic mount. The drift correction is made after levelling, using the central reticle line and with the objective pointed vertically downwards. In the forward-viewing position, the cover limits of strips of photographs flown with narrow, wide and superwide angle lenses are indicated by the sets of curved lines converging on the horizon aiming point. Levelling can of course also be corrected with the objective inclined for forward viewing, thus permitting continuous scanning of the heading, the edges of the strip and the strip itself.

The magnitudes of the drift, tip and tilt movements introduced at the navigation sight are determined by potentiometers housed in its mount. They are transferred through a follow-up servo control system housed in the PNG1 Servo Control Unit to three servo motors in the sealed frame of the Universal Mount. These servo motors then reproduce the same movements in that mount, the camera supporting ring being driven for setting drift, while the mount is raised or lowered on its footscrews to execute the omega and phi corrections. The zero positions of drift, tip and tilt of the Navigation Sight are correlated with those of the mount druing installation in the aircraft. Adjustments are extremely simple to make through the PNG1 Servo Control Unit. Rubber buffers insulate the mount from aircraft vibrations. Two of the footscrews are hinged to permit change of filters in the aircraft without removing the camera from the mount, after unscrewing the collar holding the third footscrew to its footplate.

The mount can accept both wide and superwide angle cameras. In addition, the Wild HC1 Horizon Camera (Fig.4) can be attached to the mount by means of a mounting bracket which is bolted to the mount. The Horizon Camera, being rigidly fixed to the mount with its principal optical axis parallel to that of the survey camera, will then describe the same movements in omega and phi as the survey camera itself. The drift settings of the RC8 or RC9 and the Horizon Camera are both controlled by the same motor.

The Horizon Camera is designed for taking four photographs of the horizon in four cardinal directions, usually perpendicular to the picture sides. Exposure is synchronised with that of the survey camera. From the horizon photographs, the phi and omega inclinations of the negative plane at its instant of exposure can be determined, given reasonable atmospheric conditions at the time of flying. Infrared film is normally used for the horizon photography.

Another instrument for obtaining additional information on the photo flight can be added: the Wild RST2 Statoscope (Fig.5), with which the differences in flying height at the instant of each exposure can be determined. A registering instrument is built into the instrument

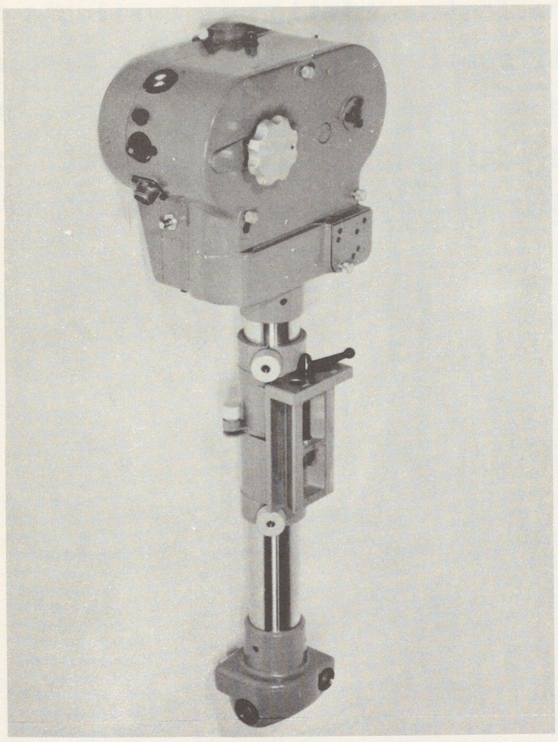

Fig.4 Wild HC1 Horizon Camera

Fig.5

Control panel of the Wild RST2 Recording Statoscope panel of the survey camera and is therefore recorded photographically on each exposure. The range of the statoscope is 80 m (±40 m = ±130 ft) approximately; safety circuits prevent misinterpretation of the results in case the limits should be exceeded. The statoscope would be placed near the navigator.

It should also be noted that both the Navigation Sight and the Universal Mount can be operated independently. In this case the Servo Control Unit is not connected. The Mount is operated directly by pushing the buttons shown in Fig.1.

The possible combinations of instruments are, therefore:

1. RC8 or RC9 camera with PAV2 Universal Mount
2. RC8 or RC9 with PAV2 and HC1 Horizon Camera
3. RC8 or RC9 with PAV2 and RST2 Statoscope
4. RC8 or RC9 with PAV2, HC1 and RST2
5. Combinations 1 - 4, with NF1 Navigation Sight. In this case, it is unnecessary to fit the normal viewfinder telescope to the camera.

In Combination 4 with the Navigation Sight a relatively unsophisticated but fully integrated airborne instrumentation is available for the first time for providing simplification of navigational problems, plus information on phi, omega and bz, as well as the essential near-vertical narrow, wide or superwide angle, panchromatic, infrared or colour photography. The whole instrumentation is shown in Figures 6 and 7.

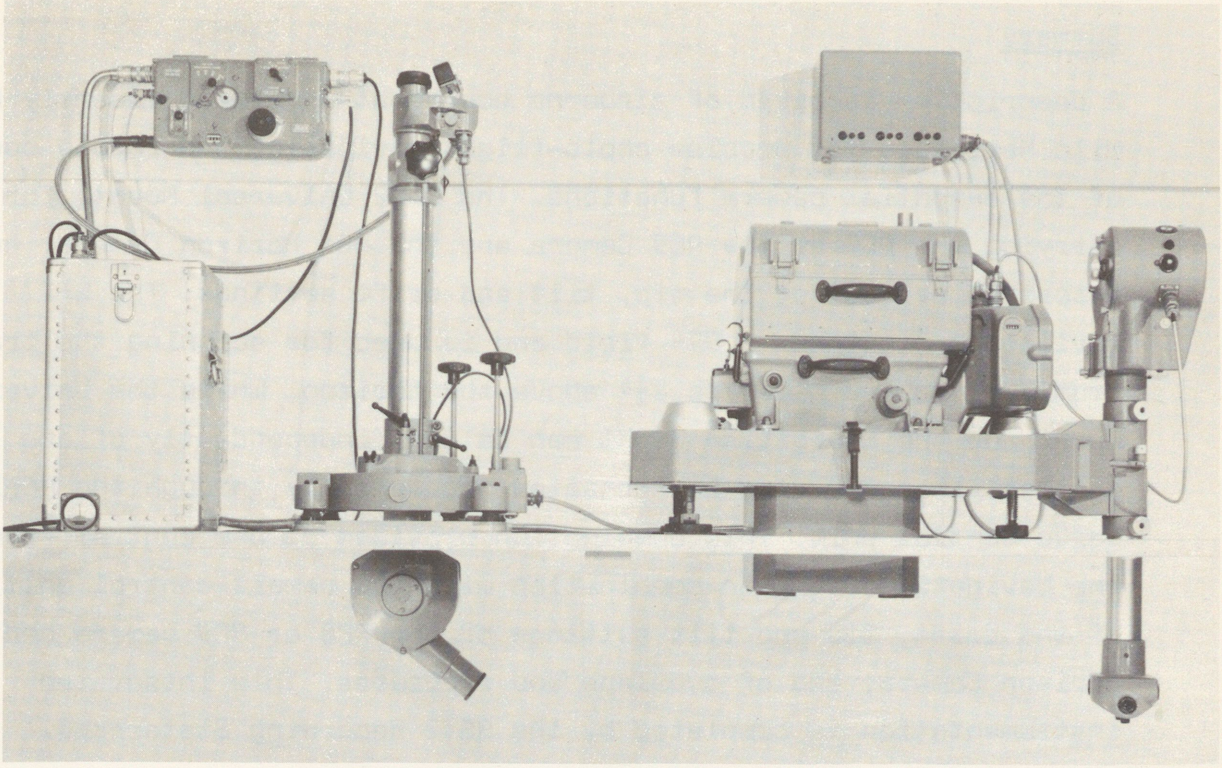

Fig.6 Wild RC8 Automatic Film Camera (shown here with the 6" Universal Aviogon cone) with auxiliary instrumentation. From left to right: RST2 Statoscope, RC8 plugbox, NF1 Navigation Sight, RC8 Camera in PAV2 Universal Mount with HC1 Horizon Camera; above camera: the PNG1 Servo Control Unit.

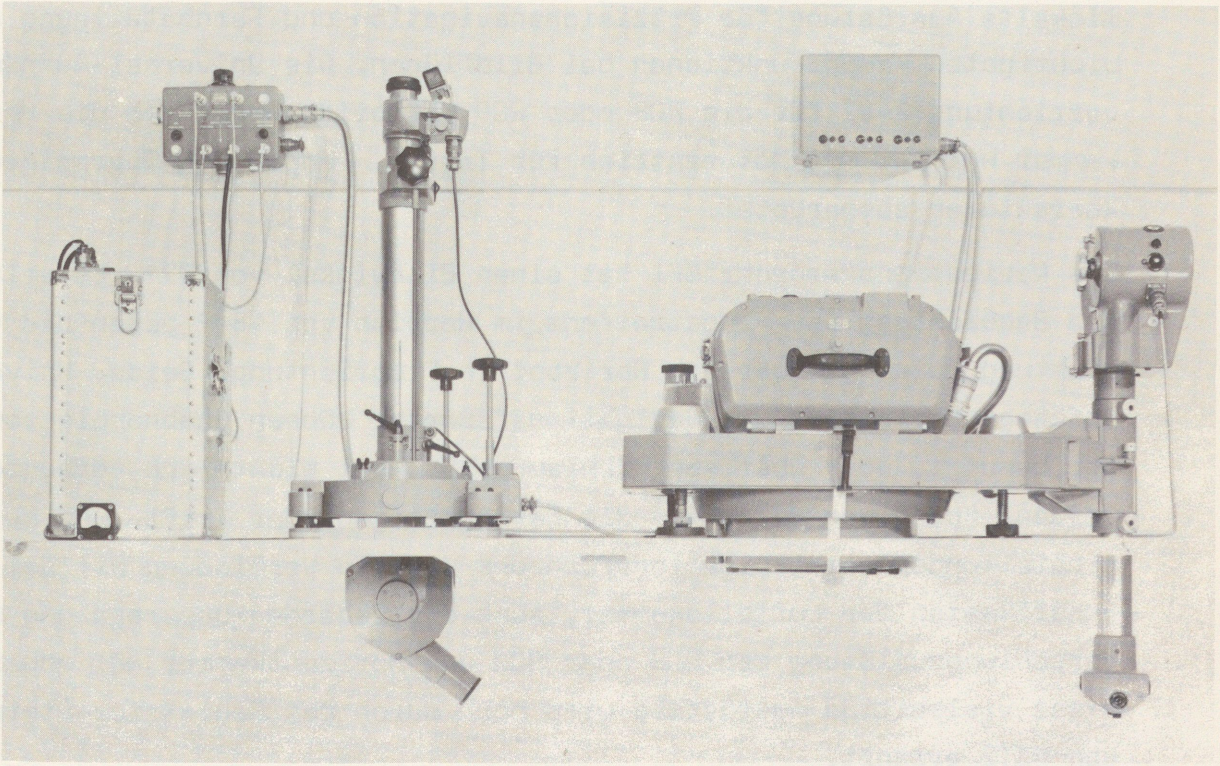

Fig.7 Wild RC9 Superwide Angle Camera with auxiliary instrumentation. From left to right: RST2 Statoscope, RC9 plugbox with Abrams Intervalometer, NF1 Navigation Sight, RC9 Camera in PAV2 Universal Mount with HC1 Horizon Camera. PNG1 Servo Control Unit above camera.

Summary

A description is given of airborne equipment developed recently by Wild Heerbrugg for precise photo-flight navigation and remote control of the essential camera functions. The PAV2 Universal Mount, for carrying the RC8 or the RC9 Camera and the HC1 Horizon Camera, has motorized drives for the tip, tilt and drift settings. The NF1 Navigation Sight has a 97° field and is used for scanning the track from 48½° behind nadir to 8½° above the horizon. While the Universal Mount and the Navigation Sight can be used independently of one another, they can also be connected electrically through the PNG1 Servo Control Unit. This combination provides remote control from the Navigation Sight in combination with the camera control unit of the drift, tip and tilt settings of the RC8 or RC9 camera and the Horizon Camera, and of overlaps and exposures. This integrated instrumentation is completed by the RST2 Recording Statoscope.