THE AEROPLANE AS A CAMERA

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Abstract:/Sommaire:/Zusammenfassung:
Present day methods of aerial photography are little different from those of the early 1950's. The aerial camera is installed in available aircraft as a totally separate system, the adaptation more often designed with economy rather than efficiency in mind. With the advent of modern navigation systems, an integral aircraft/camera system is possible in which a single crew member operates a fully automated survey system. Such an aircraft/camera combination ULSAC (Ultra Light Survey Aircraft system) is under development at ITC, using normal 23 cm photogrammetric cameras designed into a revolutionary new light aircraft, and will be described.

Aerial survey basic data acquisition can be said to be approaching a watershed. For many years manufacturers of advanced navigational aids have been offering what they saw as various versions of"the perfect system" but the aerial photographer has been reluctant to commit himself to total reliance on electronic aids. With good reason if we consider that the amount of money the manufacturers can afford to spend on research and development for such a small, low budget sector of the overall market can only, in itself, be small.
No matter how devoted the practitioners in this field are, we have to accept that aerial survey has long been the "poor relation" of the aviation industry, the "loss leader" of the mapping industry and an uninspiring, production line branch of the photographic industry. We can also safely predict that this image is about to change.
Important new developments in aircraft, navigational aids and photographic systems are poised to enter our industry to make possible, at long last, an accurate and economic aerial survey system designed with the technician in mind.
If we look at each of these three areas in present day terms, and then to the forthcoming developments and work being done toward this next generation of survey systems, a good picture of tomorrows potential will become apparent.

Aircraft. Adaptation has been the norm since the birth of aerial photography. Almost every aircraft ever designed has, at some time or other been used for some form of air photography. Most of us are using conventional air taxi or commuter aircraft modified for photography, with scant attention being paid to pilot or navigator visibility, ergonomic needs in crew positions, or range/payload ideals for the task in hand.
It is not so long since we sold off our wartime C47s, B17s, Avro Ansons and De Havilland Rapides - mostly to museums - to exchange for other less tired veterans.
Very few aircraft have been designed purely with air survey in mind - even less have actually reached the market.
Designing and producing aircraft from scratch is an expensive business and unless the market can be guaranteed prohibitive. Aircraft sales even of the popular models have slumped drastically in recent years and the chances of a major manufacturer paying any attention

to such specialist users is even more remote now than ever.
This however, is true only if we are speaking of conventional, metal aircraft. Recent developments in composite materials have made possible the design and production of several 'survey size' aircraft. Single, prototype aircraft are easily produced with these new material combinations and small production runs of specially designed machines more practical. One company has even been formed specifically to build flying prototypes at convenient scales prior to actual manufacture. The exotic moving-wing Ames AD 1 (1) and the superb Beech-Rutan Starship 1 are examples of this new technology, produced at a fraction of the cost of similar metal-formed prototypes.
Several single- and twin-engined aircraft made from composite plastics are under development and the major manufacturers are studying this challenge closely. Structural changes from aircraft to aircraft are possible with this material thus making internal and external design changes at any stage before, and after completion possible.
The aerial photographer can now start to create a specification for a specialist aircraft to suit his particular need with the knowledge that it may not be just a 'pipe dream'.

Navigation aids. We have listened at length in various seminars and congresses, and read in trade and professional journals to the claims and prophecies of systems manufacturers and their champions of many combinations of navigational aids and survey systems. That no single sustem came forward as the industry standard is probably significant. In buying such systems, brochures and price lists abound but examples of actual products or recommendations of satisfied customers are thin on the ground. It is understandable that survey managers are reluctant to commit themselves to high investment in new equipment, with few guarantees of higher performance accuracy, when their competitors in the market place are staying with tried and proven visual methods.
This state of affairs is also about to change. Although systems manufacturers were a little premature with all-purpose nav-systems, other specialist producers have now demonstrated micro-computer controlled interface units specifically for aerial survey with accuracies in the order of 16-38 m of predicted photo centres in medium and large scale aerial photography [2]. Using, in this case, ground based DME stations around the survey blocks the airborne receiver/computer transfers the data to a CRT display guiding the pilot along the survey line and operating the camera automatically. (This particular system, the IGI-CPNS unit is the subject of another paper to be presented at this congress).
Such an interface can accept other basic navigational inputs and the next generation GPS-NAVSTAR must offer the best possibilities in this field with its predicted x, y accuracy of 33 m and z of 7 m. This system is planned to be available from 1988 for civilian users at a price well within the scope of most survey users.
Having sat for several days behind a pilot using such an automatic system and monitored the monotonously accurate passage of pps. through my redundant navigation telescope, I have no hesitation in predicting that this also will be the the way we must go.

Photography. Our aircraft cameras have kept pace with modern technology and most can now be equipped with automatic exposure reading and setting, auxiliary data recording of navigational data directly from nav-systems as well as pulse inputs from a variety of sources.

Due to the needs of such cameras to be interchangeable between aircraft and used by all experience-levels of user, the obvious penalty of robustness and weight is still being paid. Already the need for a separate crew member to operate such a simplified camera system has virtually gone, most companies flying their aircraft with a two-crew system.

Reviewing the present position then, we now have the potential to obtain a custom-built survey aircraft, to incorporate extremely accurate, programmeable navigation equipment and to add to them a nav-system-operated air camera - all of which can be operated by a single crew member.

In 1978 a series of predictions was made in this direction and in 1980 a paper published by ITC [3] which suggested a question:- "How will the aerial survey industry react when a totally automated aircraft/camera system becomes available?" It was felt by many at that time that such innovations were still many years away. The feasibility study emphasized the necessity of having available in the mid-'80s a blue print of requirements and a outline design of such a system, rather than start to bring together systems on the day after they become available.

The ULSAC project - or ULTRA LIGHT SURVEY AIRCRAFT CONCEPT set out to do, in fact, just that. In order to demonstrate the potential of such a system in a dramatic way, it was suggested to package the whole system in the smallest possible airframe, not as a definitive design but to emphasise its flexibility. Obviously if other systems or space were needed larger aircraft could be used.

Looking for an aircraft design in 1980 capable of such installation led us to a study of various, very unconventional composite aircraft by Burt Rutan, the Long-EZ single engine two seat aircraft and the twin-engine Defiant five seat aircraft. Various spin offs of these two extremely efficient designs have since been produced and confirm the potential of composite materials to produce 'individual' need aircraft.

As a result of this study the basic Long-EZ became the datum, and dimensional and performance data of this aircraft incorporated in the planning. Using a cruising speed of 150 kts, an endurance of 7 hrs , and a maximum altitude in excess of 20 000 ft as an initial survey specification, we were able to outline various areas of study.

In designing a single crew survey system it is obviously important that the working environment for the pilot/technician must be conducive to long mission programmes. The ergonomic considerations in pilot seating and accessibility of flight, nav-system and camera controls must contribute to reducing the overall workload and not impair the level of safety needed. Obviously outside factors influencing the workload such as air traffic intensity or high/versus low-level targets require different approaches.

The present designs of electronic flight instrument systems and those used in existing survey interface systems make it possible to reduce the complexity of the instrument panel and this, allied with the extremely simple flying control inputs of such simple aircraft make the actual pilot workload minimal.

The VDU presentation of navigational information to the pilot is offered in the same way as standard aircraft instrument presentation and corrections to and from course line similar to instrument landing system norms.

The camera requirements for such an aircraft will be subject to one important constraint - that of weight. If however, we can make several assumptions in order to modify the overall specifications for such a camera, this can be resolved. Firstly we can assume that the cost of such an aircraft will be relatively low and as such will be a single use vehicle, - in this case only air survey. If this is so then the camera system could be permanently installed with individual components dispersed around the fuselage as aircraft system components - with the exception of the lens which would, of necessity, be interchangeable with other focal length units, and removable for calibration. Heavy damage proof casings and large shielded cable runs could be dispensed with, reducing overall camera weight to below 80 kgs.

In this way, for the first time the aircraft itself becomes a camera, many of the camera systems being operated by the aircraft systems as dual purpose items.

Flight planning and overall survey programme management can be handled by computer with target data being stored centrally and dispensed daily in updated form to several such aircraft units dispersed over a wide area, thus making the most of available weather. A single Navajo aircraft with a normal 3-man crew coul be replaced with 3 such ULSAC units giving triple coverage on a given day with much reduced operating costs, each aircraft d having improved performance over its equivalent 'big brother'. Since the original concept was suggested events and technology have moved rapidly. A Long-EZ derivative, the Gyroflug Speed Canard has been produced for certification and, complete with Certificate of Airworthiness is now being series produced in Germany - the first of many composite aircraft to reach the market.

ITC have purchased a test fuselage of this Speed Canard and the various areas of study are now being carried out and equipment designed and installed into this prototype.

The systems exist, the aircraft now exists in certified form, cameras can be modified, but do the pilots exist? Another problem for the researchers; what type of pilot do we need - a trained pilot who may leave to head for an airline job, a navigator with survey experience who can be taught to fly, a photographer, a surveyor or a computer wizard? Only time will tell.

Aircraft fuel efficiency and performance are dominant in survey costing today and the use of such simplified aircraft, albeit with complex systems, must be seriously considered. As was suggested in a recent seminar at ITC the technology exist already to leapfrog this system and go on to pilotless R.P.V.s. With the reluctance of survey practitioners to be even consider such changes as ULSAC so far, I think that this advance may be still some years away.

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