Problems in the Integration of Stabilized Mounts into Photo Systems

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WHENEVER one puts together a camera in a mount in an aircraft, one has a system. Any one of these things by itself is of very little practical use. Recently we have come to realize that the best system is never attained by taking any camera and any mount and any aircraft and putting the three together. Obtaining the best system—one with high performance and one that fulfills the expectations—requires a little thought and engineering consideration from the over-all viewpoint—an attempt to provide a good match between one part and another—an attempt to efficiently complement the characteristics of one part with those of the other. This is frequently referred to under the general heading of "Integration."

The integration with which we are concerned here breaks down into two or three logical subsections. There are the integration problems between the camera itself and the mount. There is the matter of how the camera will be supported in the mount. We used to provide two trunnions on the cameras. Then when they were mounted either in a stabilized mount or in a fixed mount, the bearings were positioned to pick up these trunnions, one on each side of the camera. This left a great deal to be desired, since it didn't provide a good, rigid way of holding the camera. Later, steadying braces were added. In other cases, clamp rings were provided around the front end of the camera. More recently it has become a practice to provide tapped inserts at several points in the camera bodies, and to design the mounts to permit bolting the mount structure to the camera castings at these points which are usually located far enough apart so that one can support the camera with a sufficient lever arm to guarantee it being maintained rigid and stable.

More recently we have tried to locate mounting points in more than one plane. We are now endeavoring to provide several mounting points near the top of the camera and one or more near the bottom. The reason for so much emphasis on the adequate handling of the details of the attachment of the camera to the mount is the extreme sensitivity of the longer focus cameras to angular motion. It only takes a few seconds of arc, or a few thousandths of an inch of relative motion, between one end of the camera and the other end, to cause a very serious degradation of resolution.

Another detail in connection with integrating the camera and the mount is the electrical connection and the vacuum line. In some of the more recent cases we are designing automatic connections between the camera body and the mounts, providing a plug on the mount into which the main plug on the camera connects when the camera is installed in the mount.

The second category is the integrating of the mount, or the mount and camera combination with the aircraft. Again, we can achieve a better system by giving considerable thought to this situation. In the past, there were standardized dimensions for the points on the mount where it would be attached to the aircraft, and in many cases this required extending aircraft structure to pick up these points. Sometimes this resulted in duplication of material. In some cases, for instance, the aircraft designer had to provide material extending upward from his main load carrying members to the standardized location of the mounting points. Then in the mount itself, material extended from these points down to where it supported the camera. In modern, high performance aircraft, one cannot tolerate this duplication of material; the indications are that in the future achieving the kind of required performance will necessitate designing these two things so they match each other more logically. Whether we save material in the camera mount, or in the air-frame, doesn't matter as long as we save it, because we are considering this from the standpoint of the over-all system.

A third category of integration has to do with the integration between our camera and mount and the other systems of the aircraft. In general there are two ways of supplying the vertical reference for a stabilized mount. One is to put it right on the mount itself. The second is to make use of a vertical reference which exists in the aircraft for some other purpose, and let it perform double duty. The second method is very attractive in attempting to achieve maximum performance in high density aircraft. It, however brings in other problems. There are losses in accuracy due to deformation of the structure of the aircraft between the location of the vertical reference and the location of the camera mount. This must be accurately calculated and kept below tolerable limits. Then, if the camera mount is supported on vibration isolators, these must be designed so that their deflection is uniform and does not introduce an angular error.

These are some of the problems concerned with integrating all of these components together to form a good, efficient, well-performing system. Also, there are a few things which should always be given emphasis and considered. One is "accessibility." It may not be easy to design all these parts so they work together and fit together in such a way as to provide plenty of accessibility—plenty of room to get at the parts one has to get at periodically. I cannot overemphasize the tremendous importance of good accessibility in any system. Many times a maintenance man suspects a little trouble; if the accessibility is good he will make a thorough investigation; if he has to go and get a tool and take something apart, he is likely to let it go, with the usual result of failures.

Problems in Connection with Installing Cameras Inside the Pressurized Compartment

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THE airframe designer falls heir to the unhappy task of putting all these mounts and cameras into an airplane. He is faced with quite a problem. It may sound simple to place a window in an airplane, but before he can do this he must consider the design and shape of the camera as to the distance between the trunnion, or mounting mount, and the ends of the camera, the distance of the lens to the end of the camera, the camera CG, and the mount CG, to determine where his pivot points are, and from his pivot points he then has to crank in pitch, roll and azimuth and try to establish a window.

Now, if we had a nice big airplane where the camera could move and do whatever these various manufacturers like to do to get a high performing amount, it would be very pleasant; but you can't do that. First of all, in a lot of these airplanes the surrounding structure at the window is very limited; the same is true of the area around the magazine and at these two extreme places we like to have a lot of freedom. The next thing which bothers airframe installations is whether or not the compartment is pressurized, and whether pressurization is from 3.3 to 7.5 psi. When you get to 7.5 psi—as you probably have read in regard to the Comet—there are quite a few problems. The other matter that he must consider is whether the windows are recessed with external doors to clean up the airplane and cut down his drag going to and from the target. Also, whether he has in-flight cleaning. This would be paramount in importance for inhabited airplanes where the crew can get to the windows. It has been shown in operational squadrons, in-flight cleaning capability can actually cause a mission to be accomplished rather than aborted.

Out of all this the designer has to obtain the minimum window size and weight, to cut down the stress problems in the structure and also to provide a capability for taking a high performing picture with the mount and camera. To do this, the designer not only must take into account the