Crashworthiness and the Shoulder Harness

THE DESIGNEE CORNER

By Antoni (Tony) Bingelis
EAA Designee Co-Chairman

8509 Greenflint Lane
Austin, Texas 78759

AT AN ALTITUDE of 200' soon after take-off, the engine lost power. The aircraft was observed gliding in a shallow left turn until it disappeared from view behind a knoll. The biplane impacted in a level attitude in a soybean field hard enough to fail both main gears and then slid to a stop in approximately 45 to 50'.

The seat belt held but . . . with no shoulder harness to restrain him, the pilot's head struck the top of the instrument panel displacing it forward.

An extruded aluminum section, illustrated in Figure 1, used to support the top of the instrument panel and secure the coaming pierced the pilot's head causing a fatal injury.

If this extruded aluminum section had not been in this location, the pilot probably would have ended up with nothing worse than a headache.

IMMEDIATE ACTION IS RECOMMENDED

There was no reason for the spear-like extrusion or angle reinforcement to be positioned as shown in the drawing. If such a reinforcement is installed in your aircraft, it should be removed, or at least modified so that it does not extend beyond the fuel tank. The evidence shown in Figure 1, should be sufficient. This kind of reinforcement is more likely to be found in biplanes as presence of center section brace wires, in some designs, makes the installation of the instrument panel hood in one piece very difficult, if not impossible. Nevertheless, I would suggest that perhaps no reinforcement at all is needed as this is not a primary structure type of thing. That metal hood or coaming merely has a fairing and streamlining function in most cases. By using nut plates even a two piece coaming could be installed with no need for a reinforcement strip.

Equally as dangerous as the absence of a shoulder harness installation is the presence of protruding knobs, switches and ignition keys in the central portion of the instrument panel of single seaters. In the case of two seater aircraft, you should avoid the placement of such protruding devices in the areas directly in front of either the pilot or the passenger.

REMEMBER THE SHOULDER HARNESS PLEDGE?

The critical need for the installation and use of pilot and passenger restraint systems in sport aircraft was recognized and pioneered by the EAA for more than 20 years. EAA membership applications have long contained the Shoulder Harness Pledge. Do you remember how it goes? Most of us have signed it.

"I _____ hereby promise to install and wear shoulder harness and safety belts in my private built aircraft to protect myself, passenger and the good name of the association. Air Force and Navy tests have proved that a 20G harness will eliminate 90% of aircraft accident injuries."

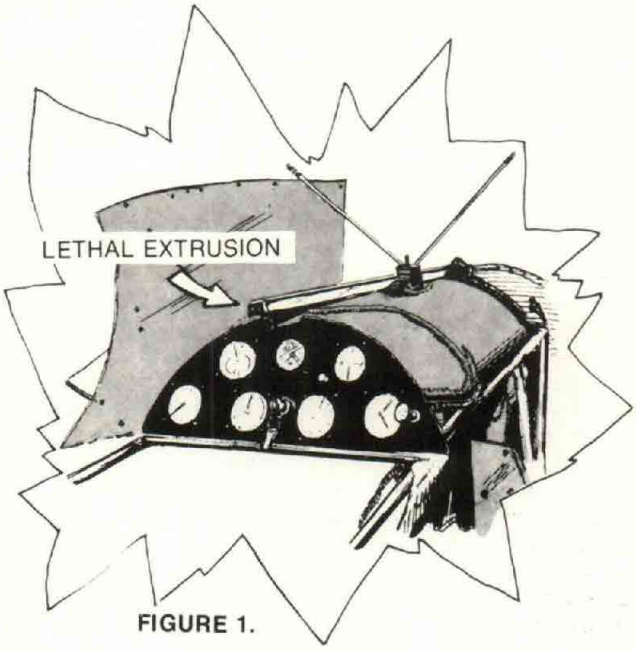


FIGURE 1.

The necessity for pilot and passenger restraints is well documented with numerous examples of serious or fatal injuries sustained in potentially survivable accidents. By potentially survivable accidents we mean those in which the surrounding cockpit or cabin structure remains intact without serious deformations and where the level of impact forces is below expected human tolerances.

Time and again it is proved that one of the prime factors contributing to head injuries is due to the widespread reliance on only a seat belt to restrain the body. A seat belt alone cannot provide the needed protection.

The installation and proper use of a shoulder harness will, however, help eliminate the jackknifing action of the body in event of sudden exposure to abrupt impact forces. See Figures 2 and 3.

SELECT ATTACHMENT POINTS CAREFULLY

Each builder should make a critical analysis of his aircraft to establish the best location for the seat belt and shoulder harness attachment points. If the belt is to be attached to the seat the structural integrity should carry though to the primary aircraft structure.

If the aircraft is being built from plans, the seat belt attachments and shoulder harness attachment points will probably have been worked out and detailed on the plans. It is too bad, though that a few of the aircraft designs have what I consider to be rather inferior shoulder harness installations . . . my own Emeraude, for example.

(Continued on Next Page)

This basic fault is as common to all-wood aircraft as it is to the tube and rag types. The particular deficiency I have in mind is that attributed to the use of the unreinforced seat back or fuselage cross member as an attachment or loop-over point for the shoulder harness. This method does provide some protection . . . but not much. Such structural members will fail long before the belts themselves fail. The completed installation might give you a nice moral feeling but very little protection. Aircraft with such installations should perhaps have a section of 1/8" flexible control cable running aft to some solid point on the aircraft as an additional restraining point. This would serve to increase the strength of the restraint system considerably.

The builder should also be careful not to weaken the basic structure of his aircraft by drilling holes through unreinforced portions of his longerons just to find a good place for the belt and harness attachments.

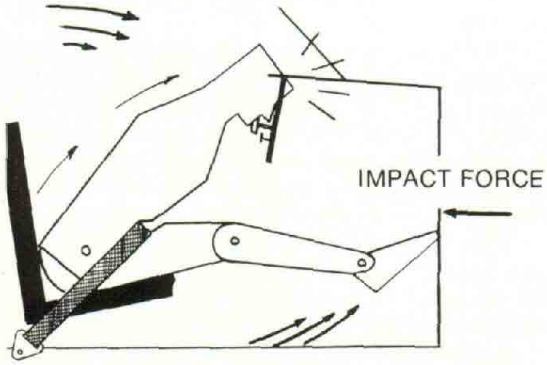
Not only must the points of attachment be strong enough to develop the full potential of the restraining belts, but the attachment ends of the belts must present and maintain certain relative positions or angles as they pass over the lap and shoulders.

The shoulder harness must also be so positioned as to permit limited freedom to accommodate normal body movements of the pilot and passenger without head-neck contact or interference with vision.

Typical good and poor restraint configurations are illustrated in Figures 3 and 4. Do you see the basic differences?

The installation of shoulder harnesses is really uncomplicated and at worst would require but little change or modification of the structure to accommodate them.

Undoubtedly the four place aircraft causes the greatest difficulty when it comes to finding a suitable attachment location for the shoulder harness belts. Part of this is due to the likelihood that the front seat harness might unduly restrict the vision of the rear seat passengers. This sort of inconvenience can be minimized, however, by making use of suitable attachment points located in the upper-side areas of the fuselage structure.



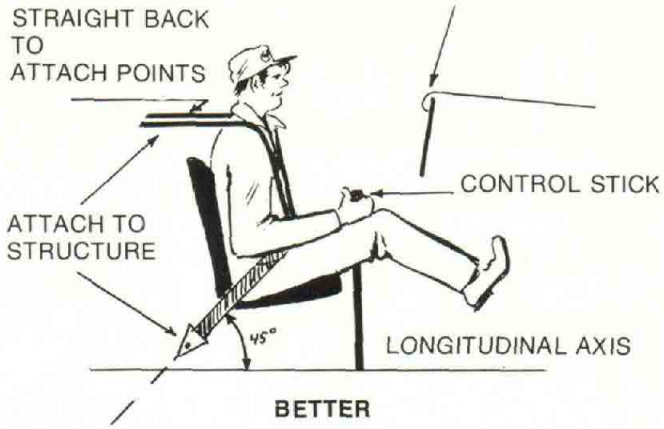
ELIMINATE JACKKNIFING EFFECT

FIGURE 2.

A GOOD INSTALLATION CAN STILL BE BAD

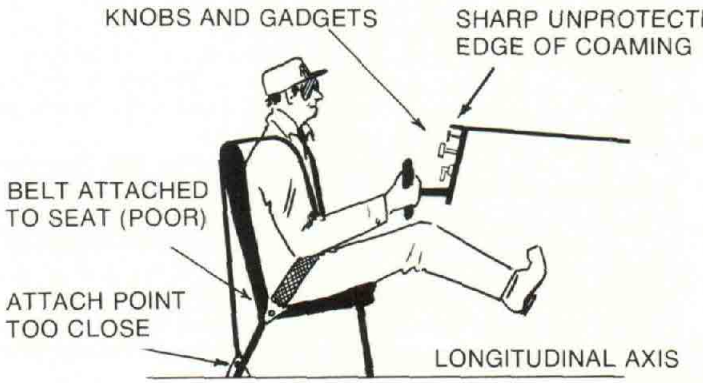
Alright, so your seat belt and shoulder harness installation is a pretty good one and should be effective. Well, if you are over that hurdle this might also be a good time to think about the physical condition of your belts and harnesses. Were they new when you installed them? What sort of condition are they in now? The sun is pretty rough on most material, especially fabrics. Take a good look, for after all when sudden stoppage of an aircraft occurs, the difference between little or no injury and disaster often hinges on the condition of the belts and their attachments to the aircraft structure.

Replacement of your seat belts and harnesses is recommended when:



BETTER

FIGURE 3.



POOR

FIGURE 4.

1. Frayed belt edges have become quite apparent to you.
2. There are indications that the stitching is deteriorating.
3. The buckle serrations have become worn to the point where slippage is possible. (belts of this type)
4. The belt shows signs of deterioration.

THINK ABOUT IT . . .

It is natural enough for many builders to over-rate the protective benefits of the safety belt and as a result under-rate the value of the shoulder harness and the need for building crashworthiness into the cockpit and cabin installations. I'd say these gents are dead wrong and no pun is intended. I still recall early military training reports which the Air Force used to convince us of the value of these safety precautions. Later, studies by the Cornell University Medical College in New York, the FAA and others, all tended to strengthen the case for adequate body restraints and improved cockpit design to reduce bodily injury in survivable accidents.

All this is not new . . . in a report issued twenty years ago, the Cornell Medical College study group found that almost 80% of the survivors of light aircraft accidents, in which seat belts were the only body restraints used, sustained head injuries.

Any time you have the situation where the head is injured three times as often as the other areas of the body which are adjacent to the safety belt, it is mighty hard not to believe that some sort of restraints should be provided for the upper torso. The simplest means for this sort of protection, we realize, is a shoulder harness. Not just any shoulder harness but one that is sufficiently strong, properly anchored, and used. Take another look at Figure 1. It also makes a good case for the use of crash helmets, doesn't it?