~~Initiator~~

FOR RELEASE: THURSDAY P.M.
September 26, 1968

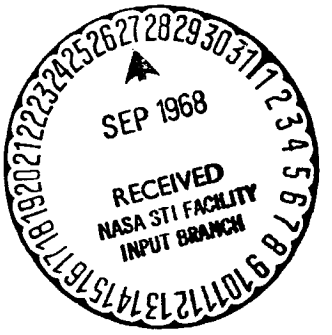
PROGRESS IN PILOT WARNING INDICATORS

By

Henry L. Anderton
Chief, Microwave and Optics Branch
Electronic and Control Division
Office of Advanced Research and Technology
National Aeronautics and Space Administration

Presented At

1968 Annual Assembly Meeting
Radio Technical Commission for Aeronautics
September 26, 1968
Washington, D. C.



PROGRESS IN PILOT WARNING INDICATORS

Henry L. Anderton

It was Vice President Thomas Marshall who said "What this country needs is a good five cent cigar", and his remark could well be applied to the dilemma in which we find ourselves on pilot warning indicators. If he were here today, and interested in improving his safety as he traveled, he might well have said "What this country needs is a good inexpensive pilot warning indicator." His remark is actually much deeper than it seems when it is first heard. You will notice, for example that he didn't just say that the country needed a good cigar. There were plenty of those. And if a man didn't have a financial worry in the world, he didn't have a cigar problem. He just bought a good expensive cigar and started puffing. Instead, what one needed was an inexpensive cigar.

Going back to the analogy, we do have a good pilot warning indicator -- or it appears that we will have one in the very near future. Frank White has just told us about it. And if all aircraft owners had plenty of money, plenty of electrical power, space, and weight carrying capacity, the FAA could just make a rule that everyone would carry one or two and the mid-air collison problem would be solved. So here is the first subtlety in Mr. Marshall's remark -- the influence of the market place, or the price problem, and this is a very important element in the providing of pilot warning indicators in our aircraft.

The second thing one might note from the cigar bon mot is that he did say a good cigar. There were also plenty of cheap cigars available in those days and if you were willing to stifle your wife and friends with the acrid fumes from an El Ropo you were in the cigar business at an inexpensive level.

Looking at the pilot warning indicator problem from that viewpoint, there are some cheap systems which have been proposed, but they all have the disadvantage that they either do not do the job well enough in the quantitative sense and have problems such as poor spatial coverage or insufficient range, or they have qualitative difficulties, such as a requirement for multiple radar stations to provide data, or for the presence of a secondary radar to act as an interrogator.

You did not come here today to hear a lecture on cigars or a comparison of cigars and pilot warning indicators, but I believe that the factors underlying the two problems are very similar and it is worth our while to consider them. These factors are the influences of the market place on our developmental efforts. We are trying to develop a usable device at a price which will generate sufficient sales to equip all our aircraft. This is the area in which we Americans excel. It is the free market principle that we tout against the controlled markets of Socialism. And I am sure that we can apply it successfully to the pilot warning problem as we have to so many others. However, in discussing progess on this as on many other similar systems intended for use by general aviation, we must continually keep in mind the trade-off of price against capability of the product, or we will not reach a broad enough market to achieve our purpose of a completely equipped fleet.

Any talk on pilot warning indicators is not complete without statistics on numbers of general aviation aircraft which will be flying in the future, and on the numbers of mid-air collisions which have occurred or which will occur under the traffic conditions proposed for the future. We have all seen these figures using a number of different bases for their generation,

and I doubt that there is much room to quarrel with any of them, except on the basis of the assumptions used in generating them. There appears to be little doubt that air traffic will increase or that the number of mid-air collisions will increase at least in proportion to the traffic unless something is done about it. There have been some indications recently that rule-making may prevent the predicted rates of increase of general aviation traffic into some of our high density airports, but even that rule-making is an interplay between price and demand. If one wants to land at a high density airport badly enough to be willing to pay the twenty five dollars, he can always console himself with the thought that he is contributing to the maintenance of the excellent facilities made available to him.

In any case few people disagree with the premise that we have a collision problem and that it will tend to get worse. What some people may disagree with is the idea that they should either willingly or - worse - under duress pay considerable amounts of money to equip their already over-expensive aircraft with a device which, even if it meets the specifications issued by the manufacturer, only protects him against the likelihood of being one of the fifteen to twenty cases of mid-air collision which occur each year in the United States. This case is not too different from that of seat belts in automobiles. People just would not install them on a general basis until rule-making entered the picture, even though the statistics were much more obvious than those in the mid-air collision problem. Now that they are installed, a great many people still do not use car seat belts for various reasons, and this raises the interesting question as to how many general aviation pilots, even if they were required to have a pilot warning indicator installed, would simply not turn it on, or would not monitor it, because

they were engrossed in other aspects of the cockpit workload.

This line of thought can, of course, be given a positive rather than a negative impact by considering other features which the pilot warning indicator might be made to offer that would make it so valuable to the pilot that he not only would not consider turning it off, but rather would make it one of his primary instruments. One such feature which immediately comes to mind is a radar-type presentation of all the aircraft in the traffic pattern around his field, or on an airway. I am sure that many of you have had that panicky feeling which comes when the tower addresses another plane, which is apparently at exactly your position and altitude, and gives him instructions as to how to land. Your first reaction is to try to do a slow-roll in the pattern to see where he is. If we could make our pilot warning indicator solve problems such as that, we would make it a useful tool for the pilot rather than just a piece of equipment to meet the regulations. Here again we would be solving the problem in the market place rather than relying purely on rule-making.

However, even with all the attractive features which we can offer in a pilot warning indicator, there will still be a little problem as to how one might assure the safety of all aircraft in a high density traffic zone without some rule-making. Even if a pilot is not worried about his own safety, and is therefore willing to forego the advantages of pilot warning, he is likely to be a collision menace to others including some aircraft carrying large numbers of passengers. It appears quite certain that rules must be made to take care of these situations and that the views of the pilot or owner cannot be relied upon to achieve the required safety levels.

Another feature which is normally a part of talks such as this is a listing of the various equipments under development and a discussion of their operating characteristics. Most of you have heard these discussed several times at various meetings. The FAA symposium on pilot warning indicators last December contained excellent papers on most of the proposed systems and I would only waste your time by repeating or summarizing them. Instead I would like to take one which seems fairly representative and comment on its progress and some of its problems. The one which I will discuss is the cooperative doppler pilot warning indicator being developed at Langley Research Center. I did not choose it because of its particular merit or because of its advanced state of progress but because it is representative of this dilemma of price versus capability and because it is far enough along to have developed some of the problems which plague all such developments as they reach the mechanization stage.

Incidentally, the fact that we have some equipments which have reached the mechanization stage does not indicate any closing of the door on new ideas. None of the proposals which have been made so far come close to achieving all of the desired features and specifications which are inherent in the pilot warning problem, so I would like to encourage all of you to keep your mind and ears open for ideas that offer promise of a better solution.

The Langley doppler system is a three-frequency system will all aircraft operating on the same three frequencies. Each aircraft recognizes its own reply signals by random coding of its interrogating signals. Azimuth and elevation indication of intruder aircraft is achieved by the use of an antenna array which, in the simplest system is placed on the nose of the aircraft or

at least looks forward. Already you can see that we have a problem -- many aircraft do not have an unobstructed nose which is available for such an antenna array, and to install a pod or other enclosure, even though it need be only eight or ten inches in diameter, is not only a hardship from the drag and obstructed vision point of view, but is also an expensive venture. Such an antenna will give coverage up to one hundred degrees each side of the nose of the aircraft and therefore assumes that all collision threats for which that aircraft is expected to take evasive action will come from a two hundred degree azimuth sector in the forward direction. If additional coverage is desired, an identical antenna facing the opposite direction to the first is required, thus increasing the cost and difficulty of installation. This same installation does reply in an omnidirectional pattern to all aircraft through another antenna, so similarly equipped overtaking aircraft will receive collision warning and can take appropriate action.

The Langley pilot warning indicator, like all those now being developed on which we know the details, is a cooperative system. It requires that all aircraft in the area be equipped with at least a repeater or beacon of proper design. A cooperative system does not, of course, meet all the requirements of the prospective customers for a pilot warning system. The only reason it and the several other systems now under development are being worked on is that we do not know how to build a self-contained system or one which does not require equipment in aircraft other than the one being protected.

I think everyone agrees that the ideal system would be a self-contained one. With such a system only those who wished to pay the price for collision protection would have to be equipped and the specter of FAA rule-making to

make it a general system would disappear. There have been quite a few florid statements to the effect that any nation who could do this or that wonderful feat of spacemanship certainly ought to be able to achieve a workable little old thing like a non-cooperative pilot warning indicator, and the implication or statement is often included that the government and industry just aren't devoting much attention to the problem or they would have solved it long ago. It is my opinion that people who make such statements are simply not willing to face the facts. There would be no point in anyone working on a cooperative system if there were any hope of achieving a non-cooperative system at our present state of technology. An infrared technique is the one most often proposed for the self contained system and in that case, we just aren't able to make those infrared sensors more sensitive than they are. And looking at what the Apollo program is about to achieve won't make them any more sensitive, no matter how much we wish it. We have examined what appears to us to be every possible technique within the prescribed price range and none of them will do the job which we want done.

We do intend to continue to examine all possible techniques for a non-cooperative system, and to produce one when the state of technology permits. However, until technology does permit, we also intend to develop the best cooperative systems which we can devise, so that those who control national policy can retain the option of implementing such a system if the situation requires it.

I do not believe that anyone wants to ram a system of any kind down the throats of general aviation or anyone else. Instead, we would like to make a sufficient number of alternatives available to the users and to the rule-

makers so that together they can continually pursue the course which appears best for the national needs.

The Langley pilot warning system has about 90% of its hardware complete and ready for a flight test. If the program continues on schedule, flight tests should commence the first of calendar year 1969 and be completed by the summer of that year. The model being flight tested will be scaled down in frequency by a factor of approximately two to reduce costs in this feasibility test.

To summarize we can say that no economically feasible technique for non-cooperative pilot warning has yet been devised. Efforts are continuing to devise such a system, and in the meantime, several promising cooperative systems are about to reach the stage of flight test. Whether these cooperative systems are operationally and economically sound has yet to be determined, but if the best of them were installed in all aircraft in an area and properly used by all pilots, it would materially lower the risk of mid-air collision in that area. Better systems are still needed, and continual effort should be exerted to achieve the improved technology needed to make possible the desired goal of a non-cooperative pilot warning system.