Air Traffic Control Project
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SUBJECT: BI-WEEKLY REPORT, DECEMBER 9, 1949

1.0 GENERAL

(W. G. Welchman)

In the last bi-weekly I mentioned a paper by a Mr. D. Barnett of the British Air Transport Command. We heard more about Mr. Barnett from Mr. Lyman of Sperry's, who considers him to be the leading expert on Air Traffic Control in England. An excellent paper in Aeroplane, December 26, 1947, describes the orbit system that Mr. Barnett introduced. We should investigate this system and determine its limitations. Mr. Lyman also told us that the Operations sub-committee of the International Transport Association have done good work, and we have written for their reports. An account of our visit to Sperry and A.I.L. is being prepared as a separate memorandum.

Most work on the approach problem has assumed that random arrivals are inevitable, so that delays are a matter of statistics. Improved navigation and guidance may make it possible to regulate the arrivals and so simplify the approach problem. However maintenance of en route schedules will only be possible if schedules are planned to avoid excessive congestion en route. The problems that this involves are being considered.

(C. R. Wieser)

The study of closed-loop guidance is being continued.

Visits were made to Airborne Instruments Laboratory and Sperry Gyroscope Co. to discuss communications, navigation, and control. An account of the trip has been written in M-2020. Time did not permit discussion of aircraft control characteristics, and another visit to Sperry will be made soon.

(P. Franklin)

Studied a simplified form of the equations of motion of an a/c subject to control. A note on approach sequencing was issued as E-2006.

1.0 GENERAL (continued)

(W. K. Linvill)

Work is continuing on the analysis of the controlled flight of an aircraft. Below is a summary of aerodynamic relations (much simplified) which at least can be used as a first approximation.

Assume:

1) Controls will be of three types: (a) bank, (b) climb, (c) speed up.
2) Aircraft is so controlled by auxiliary control (rudder) so that it does not side-slip or skid.
3) Responses to the three controls mentioned in 1) are independent of each other.

To describe the attitude of the aircraft the plane axes are simple to use. The conventional axes are these. Origin at center of gravity. X axis out along propeller shaft. Y axis out of center of gravity parallel to right wind. Z axis downward. Measure clockwise rotations about each of the axes as θ_x, θ_y, θ_z. In undisturbed level flight assume $\theta_x = \theta_y = \theta_z = 0$ Call control deflections positive if they result in torques to increase angles. Call the resultant airspeed v. The equations are:

(1) $k_1 v^2 \delta_e = J_1 \ddot{\theta}_y + vB_1 \dot{\theta}_y + K_1 v^2 \theta_y$.

δ_e is elevator deflection.

(2) $k_2 v^2 \delta_a = J_2 \ddot{\theta}_x$

δ_a is aileron deflection.

(3) $k_3 \delta_t = M_3 \ddot{X} + vB_3 \dot{X}$

δ_t is increment thrust increase.

No equation for response to rudder control is given since it merely reduces side-slip or skid to zero. The problem of conversion of coordinates from plane axes to ground axes is one which comes in when one determines what quantities shall determine δ_e, δ_a, and δ_t. The control equations (1), (2), and (3) are complicated by the fact that the parameter v varies over wide limits.

1.0 GENERAL

(W. K. Linvill) - continued

At the present an investigation is being made to determine how δ_e, δ_a, δ_t should be controlled. As a start the techniques of the Sperry Zero Reader are used. The objective is to evolve a stable system insensitive to extraneous effects such as winds and as independent as possible of changes in speed and of changes in the system due to coordinate conversion. A memorandum will be prepared as soon as this work is completed.

(A. Orden)

Work continued on formulation of several types of aircraft control in mathematical form in order to permit investigation of the relation of possible flight patterns to air traffic control.

(F. A. Foss)

A memorandum has been initiated which will contrast the requirements of a private line communications system for air traffic control with the characteristics of conventional radio telemetering and other multiplex systems. Factors which directly influence the ultimate choice of the overall system will be discussed. These factors will determine the choice between frequency multiplex, time multiplex or a composite system; the type of modulation; the carrier radio frequency range; power; etc.

(D. R. Israel)

Copies of the summary forms of "An Introduction to Coding" and "The Order Code," which will appear in Summary Report 3, are now available in the library.

Some consideration has been given to the use of the helix for speed reduction in the approach zone of an airport and to the advantages or disadvantages of the translational equivalent of the (rotational) helix.

This past week has been spent in preparation for the writing of a code for approach scheduling. Aircraft will be scheduled

1.0 GENERAL

(D. R. Israel) -- continued

into the helix from three main routes, each route consisting of four flight lanes. Each lane of a route would be devoted to an aircraft of a certain speed range. It is expected that aircraft will arrive at the boundaries of the system with, at most, a two-minute error from a prearranged schedule. This schedule would be such that the rate of arrival on each lane is one per ten minutes. Aircraft would be scheduled by speeds - very fast, fast, medium, slow - within each ten-minute cycle.