

X. AIR NAVIGATION *

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The machine calculations for the case of aircraft flying without enroute control (Case (1) in the Quarterly Progress Report of April 15, 1950) have been practically completed, and graphs of the results are now available.

As mentioned in that report, runs for $\epsilon = 1.0$ and 0.95 had originally been carried out with a maximum stack of S planes assumed at the beginning of the sequence. This choice, called "saturation" in the case $\epsilon = 1.0$, leads to the most pessimistic results. In attempting to correlate the first and second moments of the enroute deviation distribution with those of the stack delay distribution, it was found that this procedure introduced irregularities which obscured the relationships. Therefore, additional runs were made for $\epsilon = 1.0$ and 0.95 starting from zero stack at the first instant of time. These cases were calculated for boxcar, triangular, and "Gauss" enroute deviation statistics with $S = 6, 12, 18, 24$. While all the final plots of these cases are not yet available, it appears that the modification has made the relationship between enroute deviation and stack delay somewhat clearer. It is the aim of these numerical calculations to provide enough information so that the general form of the stack-delay distribution can be predicted approximately, given the traffic density and any reasonable enroute deviation statistic which may arise. Inversely, the data should provide means to set the required limits on the spread (and possibly second moment) of the enroute deviation statistics when certain tolerable limits are fixed for the stack delay distribution and the traffic density.

An analytic method for deriving the stack delays has been found for cases in which $\epsilon = 1.00$ and the system is in "saturation". The analytic results check satisfactorily with the numerical ones from the IBM machine. It has also been possible to find an analytic method for deriving the stack delays when ϵ is very small, although the range of applicability of the method does not permit very much of the machine data to be checked. A combination of this method, where applicable, together with the more general method for $\epsilon = 1.0$, does however provide a sufficient number of checks to warrant the placing of confidence in the overall machine results.

It was mentioned in the Quarterly Progress Report, July 15, 1950 that Case (3), discrete control without rescheduling, had been formulated in a general way for machine computation. Since then, it has appeared that this case may not require such extensive machine calculation. It may be possible to reduce the effect of this particular type of enroute control to an "effective enroute deviation statistic" by convolution methods, and

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thus, by comparison with previously calculated cases, infer the form of the stack delay distribution directly. Work is proceeding now along these new lines.

At present the machines are being arranged to handle a problem which was formulated during a discussion with Drs. Ewing and Philpott of the Air Navigation and Development Board. This new problem deals with a modified scheduling procedure and does not involve any enroute control. Each plane is scheduled to arrive within a time block of length $S' + 1$. In each block not more than $S' + 1$ planes will ever be scheduled, but the precise number will vary from block to block in a random fashion. The overall average traffic density over a large number of such blocks will however be restricted to ϵ , as before. Within each block no effort is made to space planes regularly, and each plane scheduled within the block is assumed to have equal likelihood of being assigned to any one of the available $S' + 1$ arrival times. As before, each plane proceeds to the terminal with a possible enroute deviation having a boxcar distribution of spread S . Stack and total delay distributions are to be calculated for various values of S' , S and ϵ .