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Air Traffic Control Project
Servomechanisms Laboratory
Massachusetts Institute of Technology
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SUBJECT: BI-WEEKLY REPORT, NOVEMBER 25, 1949

1.0 GENERAL

(W. G. Welchman)

The short guide to coding that was mentioned in the last BI-Weekly Report is now in the hands of the printers. Engineering Note E-2004 entitled, NOTES ON AIRCRAFT NAVIGATION AND GUIDANCE, has been issued. This Note suggests a somewhat unsophisticated approach to the problem that may be worth further examination.

Mr. R. F. Nicholson sent us a paper on air traffic control by a Mr. D. Barnett of the British Air Transport Command. This paper, although two years old, is very interesting. A search through English journals for articles by the same man has produced several interesting papers that are now being studied. Amongst them is a paper by Dr. E. G. Bowen who was working in the Radiation Laboratory during the war and is now in Australia. We had heard Dr. Bowen's work mentioned on several occasions but had not been able to find references. Further library research by Lasse Ulman produced several more articles in American journals, of which the most interesting was one on automatic pilots.

We have reached the stage now when we ought to be able to prepare reasonably clear statements of information that we need. Such statements should enable us to make the most of our contacts with people who have been working in the various technical fields associated with air traffic control. The first such statement is in draft form and refers to the general information that we would like to obtain about the aircraft that are likely to fly in an all-weather system after 1952. This has been prepared as a preliminary to a discussion with Mr. Robert Shatz of the Cornell Aeronautical Laboratory, who is studying such matters for the Air Navigation Development Board.

(C. R. Wieser)

A preliminary rough analysis of closed-loop speed control has been made. The longitudinal damping inherent in the aircraft comes from drag forces which are roughly proportional to the square of the

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(C. R. Wieser) - continued

air speed, and are hence non-linear. The addition of ground-speed feed-back can supply linear damping and lessen the effect of non-linear drag.

Sample calculations were made using constants for a Lockheed Constellation. It was found that the available acceleration for speed control has a maximum value of about 2 ft/sec² for a power change of 45% of maximum power. This necessarily limits the useful natural frequency of the closed-loop system to the order of 0.01 cycles/sec, or a natural period of the order of 2 minutes. If such a slow system would allow sufficiently precise control, it could be operated with a fairly long sampling period, say, 5 seconds.

(P. Franklin)

Studied the time sequencing problem and the need for preliminary control before lanes coalesce.

(W. K. Linvill)

The study of the flight equations is continuing. Subsidiary results have still to be checked with Professor Seamans.

(A. Orden)

I have formulated simplified differential equations for several types of automatic air path control. These equations need further refinement before they can be considered as a suitable basis for determining the feasibility of various procedures for air traffic control.

(F. A. Foss)

Several references which deal with electric circuit behavior from a variable frequency (frequency modulation) point of view have been studied. If a frequency modulated subcarrier system is used to handle the identification and the data handling functions, problems are encountered that differ from those arising out of the conventional uses of frequency modulation.

One decision that must be made in any subcarrier system is the selection of the subcarrier frequencies. One approach attempts to

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(F. A. Foss) - continued

minimize harmonic distortion by choosing all subcarrier frequencies so that cross-modulation products do not fall in the band of any subcarrier. However, this method dictates a small deviation ratio with attendant increased harmonic distortion. An alternate approach concentrates the subcarriers in the low frequency end of the modulation pass band. Now a large deviation ratio is possible with an attendant small amount of harmonic distortion. Cross-modulation effects are now one of the limiting factors.

(D. R. Israel)

Last week saw the completion of the three appendices for Summary Report 3. The previously mentioned summaries of the Whirlwind order code and of the "Introduction to Coding" are included as the third appendix. These two summaries were carefully prepared and it is felt that they contain a rather complete digest of the important points.

This present week has been mainly spent in the reading of A. Orden's coded program which will soon be issued as an R report. I was chiefly interested in the techniques used by Orden which involved the storage of information as single digits.

Work will begin on Monday on the consideration of other possible schemes of aircraft scheduling, with particular reference to suggestions made by W. G. Welchman in Summary Report 3.

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