

SAN JOSE LABORATORY  
ADVANCED SYSTEMS DEVELOPMENT

May 17, 1960

FILE MEMORANDUM: 5720-10.16

SUBJECT: Proposal for Computer Simulation of Error-Correcting Codes.

REFERENCES: File Memo: 5720-26.3 Plan for Developing a Recommendation on Data Transmission Codes.  
(Feb. 19, 1960)

File Memo: FBW-10.15 A Sample Non-Independent Error Probability Distribution (April 4, 1960)

File Memo: 5720-4.1 Coding of Error Data (April 19, 1960)

Simulation of Error-Correcting Code Performance

A preliminary block diagram of the computer program needed to carry out the code evaluation program described in 5720-26.3 is given in Fig. 10.16a. The simulation programs needed are numbered as follows:

1. Message Generator. This may operate in two modes:
  - (a) A standard set of messages.
  - (b) A random number generator with a table of random number addresses, where the characters are stored in the addresses in accordance with the relative frequency of use.
2. Error Correcting Encoder. This would consist of a set of sub-programs, one for each class of error-correcting code or error-detecting code to be evaluated.
3. Error Correcting Decoder. These sub-programs would be duplicates of the above with additional logic to perform the correction.
4. Error Generator. This would be a set of sub-programs, each simulating the error distribution for different channels and different mod-demod systems.
- 5 } Comparators. These subprograms would compare the messages at  
6 } the output of the encoder and at the input and outputs of the decoder to provide for statistics on the following:
  - A. Errors
  - B. Errors detected
  - C. Errors corrected
  - D. False correction
  - E. Undetected errors

### Development of Noise Models for Error Generation

A preliminary block diagram of the analysis of experimental error data is shown in Fig. 10.16b. The stages are indicated below:

7. Coding of Raw Error Data. A proposal for the coding is given in File Memo: 5720-4.1.
8. Statistical Analysis of Error Data. This might be a program similar to the SIS program in FLOPS, but written for the 704, accessible in FORTRAN, and suitable for non-independent error distributions. This should lead to a set of models (F) of error distributors which could be used in part 4 (error generation) of the simulation of the performance of error correcting codes.

### Evaluation of Techniques Developed Elsewhere

We should make use of any applicable techniques developed elsewhere. The following work should be reviewed for applicability to this project:

A. B. Fontaine, "Bounds on Probability of Error for Error-Correcting Codes," Report RC-25, December 27, 1956.

A. B. Fontaine and W. W. Peterson, "On Coding for the Binary Symmetric Channel," Report RC-43, February 21, 1958. Also Trans. AIEE, November, 1958, pp. 648-656. A sample program deck has been obtained from Dr. Fontaine.

W. W. Peterson, "An Experimental Study of Binary Codes," Report RC-34, August 15, 1957.

W. E. Brandt, "Performance of Error Detection and Correction Codes," Poughkeepsie, IBM-SEPD, Report TN 09.01012, 001., Aug. 1, 1958.

J. E. MacDonald, Jr., "Review of Error Correction and Error Detection Codes for Binary Data Transmission," IBM Poughkeepsie, Reliability and Serviceability Bulletin, No. 9, Code: TN 001.000.266. March 24, 1958.

M. P. Marcus, G. J. Saxenmeyer, M. E. Schatzoff, and L. H. Tung, "Coding Study Report," Endicott: Product Development Laboratory, Coding Study Group, Preliminary Copy, Jan. 28, 1959. Report 01.01012.565.

L. O. Nippe, "High Density Tape Channel Simulation Study," August 22, 1957.

E. G. Newman and L. O. Nippe, "Simulation of an Information Channel on the IBM 704 Computer," June 10, 1958. See also Report 00.01000.677.

Preliminary review indicates we cannot use any programs from the above work directly, but that sections of programs developed in connection with the above reports may be useful.

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FBW:pm

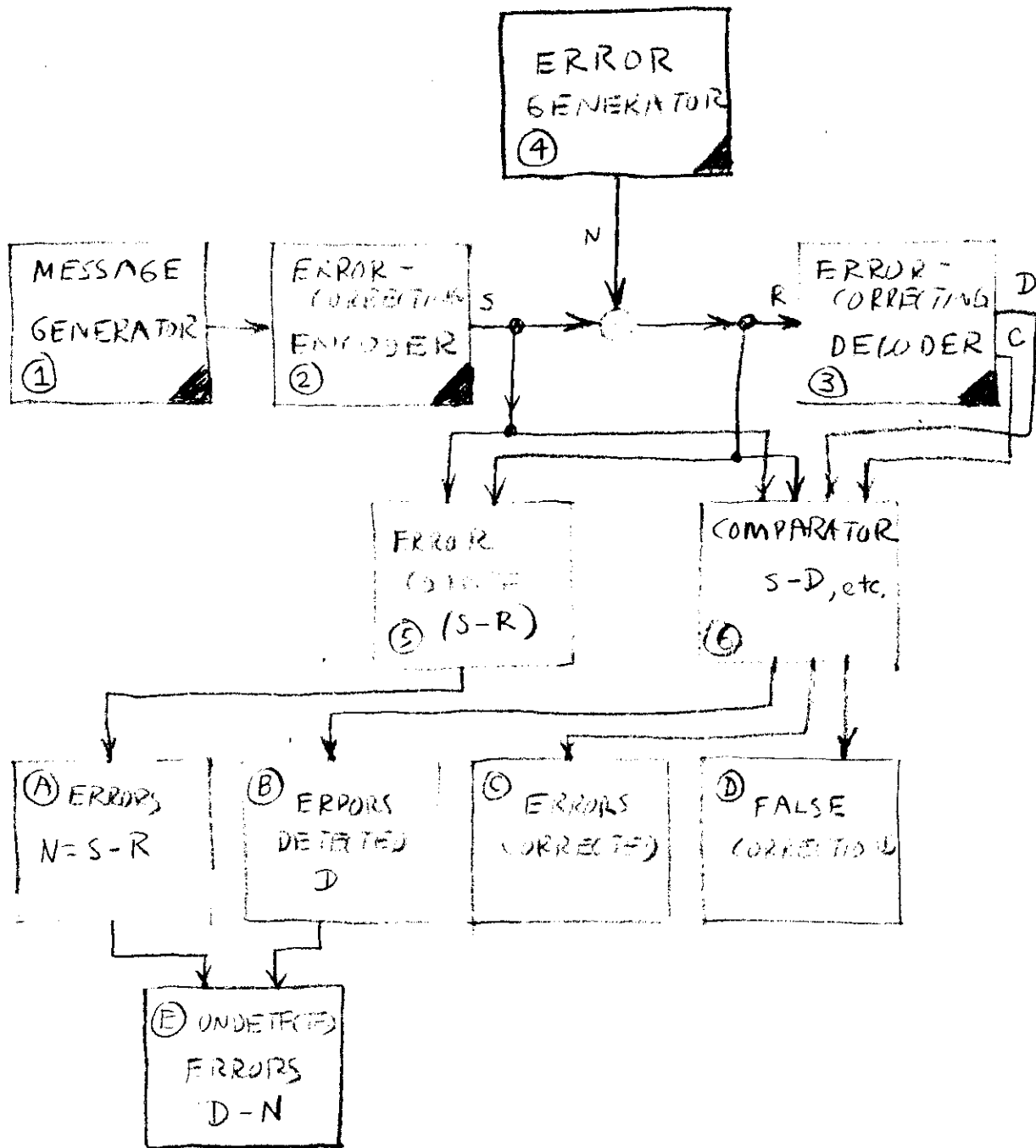


Fig. 10.16a. Simulation of Error Correction Code Performance

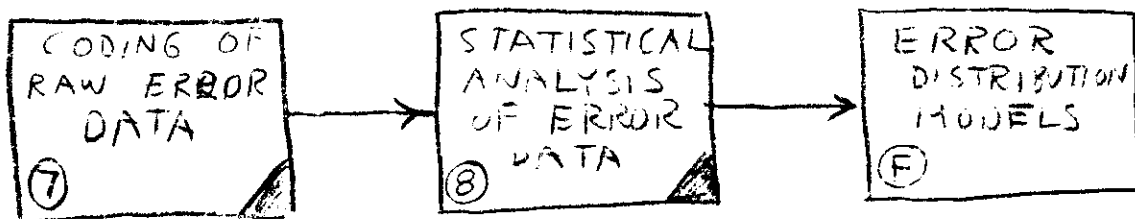


Fig. 10.16b. Analysis of Experimental Error Data