RJ - MR - 5
November 15, 1957

# RESEARCH PAPER

## A PRELIMINARY REPORT OF CERTAIN WESCON SESSIONS

## AUGUST, 1957

by

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and

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November 15, 195'

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ABSTRACT

The informal reports of the authors on sessions they attended at the WESCON Show, held in San Francisco during August, 1957, are presented here for the ideas which may be of interest to those who did not attend.

The Magnavox Magnacard system is discussed in some detail by E. J. Supernowicz, whereas a précis of the sessions on Information Theory, Communications Systems Engineering, Computers in Network Synthesis, Passive and Active Circuits and some of the special sessions given by Russian engineers is by F. B. Wood.

I

This report covers the three papers presented on the "Magnacard" from the technical sessions attended on "Data Handling Devices."

The first paper presented was on the "magnacard" which was developed at the Magnavox Research Laboratories in Los Angeles. It was indicated that the system under development around the magnacard is a new concept in data processing. This system is being designed to perform the functions of routine data handling. That is, sorting, merging, selecting, file searching, input and output.

The system uses individual magnetic cards as the basic storage medium and pneumatic techniques for selective transporting of the media in order to perform the data handling process. The basic advantages of the system are as follows:

1. High-speed processing - 300 inches/sec or information rate of up to 450 bits/sec.

2. High Capacity and Storage Density - a 1 inch x 3 inch has a capacity of 1,000 decimal digits or 300,000 cards with over a billion bits in a space of 2.5 cubic feet.

3. Economy of Operation - routine handling operations are performed independently and in parallel removing it from the central data processor.

4. Flexibility - utilizing small, independently operating machines.

Some of the facts revealed at this session are as follows:

1. The discrete storage medium consists of a 5-mil mylar base, with a half-mil layer of magnetic oxide and binder, and a half-mil layer of protective overlay. The three layers are bound together by a laminating process which produces a strong card meeting the handling requirements. Information is recorded on 18 parallel channels at densities of 100 bits per linear inch and read in contact with the same techniques similar to those on magnetic drums.

2. The pneumatic card transport elements consist of a vacuum drum, and automatically reversible card feeding and stacking

station, a drum-to-drum transfer device, and a card holding station. The vacuum drum is a hollow 8 inch diameter by one inch high cylinder having a hollow shaft which is connected to a vacuum pump. The periphery of drum is slotted to create a pressure differential which holds the card rigidly on the drum, in effect, the card acts as a magnetic drum surface. The peripheral surface speed is 300 inches/sec.

3. The automatically reversible feeding-stacking station provides means to enter and remove cards from the drum. This permits several successive passes of cards to be made completely automatically. Feeding is performed either one card at a time at speeds of 100 cards/sec or continuously at the full rate. Feeding control is made by a vacuum shoe which lies between the card and the drum and is operated by a high-speed valve. Each station has the ability to hold a tray of 3,000 cards.

4. The pneumatic operating hold station performs the function of stopping a card at a point fixed in space, allowing temporary removal of a card.

5. The drum-to-drum transfer device is accomplished by an air jet which lifts the cards away from one drum and forces them to be picked up by the second drum. The air jet is controlled by an electrodynamic valve. All the operations of transport, feed, stack, and transfer are performed by selectively transferring cards between drums.

Two basic techniques of file mechanization were discussed in the system; and end-entry and a side-entry file. The end-entry consists of trays arranged in a rectangular block. These blocks are automatically positioned to a selected tray position and the selected tray is moved into the feeding station of a transport drum. Access to the contents of the tray is sequential at a rate of 100 cards/sec. Time to reinsert a tray into the block, select a new tray, and insert it into a feed station is 3 to 5 seconds. The side-entry is used for shorter access. This file uses a technique whereby the edges of the cards rather than the ends of cards are presented to the transport drums. The function is, that a small set of cards, which contain the desired card is selected out and inserted into the drum transport system. These cards are then run sequentially from the selection station through the drum system and back to the selection station at a rate of 100 cards/sec. When all the selected cards have been returned to the station, they are reinserted into the file and the cycle is complete.

The techniques described above are combined into four machines which comprise the Magnacard System. These machines are:

1. The Transcriber
2. The Collator
3. The File Block (end-entry)
4. The Interrogation File (side-entry)

To the writer, the collator appeared to be novel. This collator consists of four drums, four two-way transfer valves, six reversible feed-stack stations, two read heads, and two hold stations. In column sorting one bit at a time, all the cards are put into the feed station on the first drum and continuously fed past the read head. The least significant bit is read and it is determined whether this bit is a one or a zero. If it is a one, the card is transferred to the third drum and stacked there. If it is zero, the card is fed to the second drum, etc. When stations one and four are empty, the second and third are changed from feed to stack. The process of transfer is continuous until all of the selected bit positions have been examined.

The playback heads used are 18 channel heads with a center to enter track spacing of 50mils. The clock channel is near the center of the head and is isolated from adjacent channels by laminate shielding. The cores are laminates of high material wound with a coil inductance of 15 Mh. The head gap is one mil and the self-resonant frequency is 250 kilocycles/sec. About 30 ma of write current is used at one mil head to card spacing.

The recording system chosen is the Ferranti. The system was discussed in detail; essentially this system is a phase sensitive non-return-to-zero type of recording.

The amplifying system was chosen to be transistorized to take advantage of low power consumption, packaging logic, and because transistor amplifiers are much less sensitive to microphonic noise troubles. Also, they are less sensitive to noise from high impedance.

A brief mention is made here of the discussion of the major problems encountered in the development:

1. Card Skew - this problem was partially alleviated by centrally locating the clock track and putting the tightest practical tolerances on card width and guiding mechanism.

2. Parallel Shift - separate record and playback heads were used and the record track was made 10 mils wider than the playback.

3. Head Alignment - carefully machined heads and guides are mounted integrally with the head.

4. Head-to-Card Spacing - a component was developed which removes the card from the drum and forces it into contact with the head by means of a jet of air.

5. Modulation (variations in envelope of record signal) - a contact reading device is used. In addition, the last 1/8 inch of the card is not used for data storage.

6. Cross-Feed and Cross-Talk - the channels are widely spaced and provided with laminated shielding. Also, the clock track amplifier is disabled immediately after a signal is detected and kept disabled until the writing transient has died far enough down to be discriminated against.

E. J. Supernowicz

II.

The papers presented at WESCON which I feel are particularly significant to IBM are listed as follows:

Session 6 - Information Theory

J. R. Pierce and J. E. Karlin, "Reading Rates and the Information Rate of a Human Channel"

The significance of this paper is that the human brain cannot utilize information received at rates higher than 40 to 50 bits per second. Therefore, information received by humans must be received at a lower rate or be printed or displayed so the human operator can read the message at his own slower speed.

Nelson M. Blachman, "Communication as a Game"

This paper is an illustration of what can be derived in the way of limiting conditions to probability of errors by use of Statistical Decision Theory. Examples given are in a general way illustrative of our problems of choosing modulation systems for data transmission on the basis of the loss matrix of modulation systems and types of noise.

P. E. Green, Jr., "Information Theory in the USSR"

CPSU policy discouraged information theory research before 1953. Policy is now to encourage such research. A large group of mathematicians and engineers are presently working over all communication theorems. A better proof of one of Shannon's theorem has been developed.

MIT will translate articles from the following Russian Journals:

Radio Tekhnika
Electrosayv
Radio Electronics

We should subscribe to the MIT translation service in this area to keep up to date on information theory work done in the USSR.

W. S. Michel, W. O. Fleckenstein, and E. R. Kretzmer, "A Coded Facsimile System"

The work of Laemel (PIB) has been carried through to a practical system.

An 8 1/2 x 11 page requires $10^6$ dots in standard facsimile. A simplified compromise code has been developed that requires the following number of bits per page:

| | |
|---|---|
| Empty page | 5,500 |
| Drawing | 50,000 |
| Letter | 100,000 |
| Circuit Diagram | 120,000 |

Standard facsimile system requires six minutes for a page. This system would transmit $10^5$ bits (a letter) at 800 bit/sec in two minutes. This gain of a factor of three is conservative. This is of significance to the IBM Engineering Department and Methods Department as potentially a way to transmit drawings and engineering changes between Endicott and San Jose.

Peter Elias, "List Decoding for Noisy Channels"

If I understand this correctly, it means that if we decode with a list of m messages of n symbols each, instead of one message of n symbols at a time and make m large, the problem of design of the best code ceases to be significant, because the average of all codes becomes almost as good as the best code. This indicates an area for study on our part of how using larger block lengths may decrease the significance of choice of the best character-code.

Session 16 - Communication System Engineering

John Webb, "A Detailed Description of the Synchronous Detection Process"

This paper, through the use of vector diagrams, presents a simpler explanation of the grain of synchronous detection. This is helpful to us in understanding our own problems of developing detection systems with lower error rates.

W. A. Malthaner, "Experimental Data Transmission System"

This paper outlines the Bell System Data Subset in block diagram form. Tests on one of these Bell System subsets are already planned by Department 532.

Session 26 - Computer in Network Synthesis

Informal discussions with T. R. Bashkow of BTL have given us a potential method of getting by our difficulties in trying to compute the response of telephone lines to our special pulse.

Session 32 - Passive and Active Circuits

Richard C. Booton, Jr., and Moise H. Goldstein, Jr., "The Design of Synchronous Demodulators"

This paper deals with suppressed carrier modulation in which the carrier is usually sent by a separate channel for synchronizing the demodulator. Families of curves are calculated for different ratios of quadrative to in-phase carrier for different demodulating waveforms. This is important for our analysis of related types of synchronous demodulators.

Special Session - Russian Engineers

V. Krassilnikov, "On the Propagation of Ultrasonic Waves of Large Amplitude in Liquids"

Strong components of 12th and 13th harmonic present in large amplitude ultrasonic waves. Measurements made with electro-mechanical filter plates in wave guide-like troughs. Waveforms analyzed by finding amplitude and phase of different harmonics present by substituting different resonant filters. This work could be of significance in acoustical type delay lines. Perhaps this should be brought to the attention of components research in Poughkeepsie.

V. I. Siforov, "On the Capacity of Communication Channels with Random Parameter Fluctuation"

Fading in amplitude and phase of radio communications channels follows a Rayleigh probability distribution. Gaussian noise does not limit channel capacity due to lack of correlation between noise and fading. Under fluctuating fading conditions the channel capacity can theoretically be increased over standard limits formula: $\Delta f \log (1 + Ps/N)$. (They did not offer any suggestion as to how to practically realize this potential gain in channel capacity.) The significance of this paper to us is that there may be conditions for which Shannon's fundamental theorem on channel capacity can be modified.

A. N. Prochorev, "Theory of Molecular Amplifier and Oscillator Using Auxiliary Radiation to Produce Active Molecules"

Work is proceeding on the use of non-linear effects of resonant fields in MASER amplifiers. They predict sensitivity sufficient to detect the effect of changing acceleration due to gravity at different elevations. This may be of significance to Dr. W. B. Smith in Poughkeepsie.

F. B. Wood