Correspondence

October 14, 1971

COPY

Dr. Edward E. David, Jr.
Science Adviser to the President
The White House
Washington, D. C. 20500

Dear Ed:

I have a very negative reaction to the proposed Presidential Initiatives on Communications for Social Needs.

I am sure I am unduly cynical, but my immediate reaction is that this is a way to justify new NASA satellites. I am also suspicious that people might feel that a Presidential Initiative would give such high priority that the projects would not have to suffer the dangers, risks and delays of planned, well-thought-out and open-to-criticism type programs.

The FBI is well organized, and their needs are quite straightforward and hardly in need of a Presidential Initiative to solve them.

The Post Office has many needs and has to study many alternatives, but to concentrate on one could be very embarrassing.

Promising significant help in urban problems by use of communications is an area where angels should fear to tread. Before proposing 13 new channels of educational television, much analysis of previous experience should be carefully made before this idea is even leaked to the outside.

We could instead propose bold new experiments to develop the "best mail system in the world" and bold new experiments to demonstrate uses of modern technology in health, education and urban problems.

I would encourage the FBI, but I would not use it for publicity because it does not make for good political propaganda.

The Office of Science and Technology could use these experiments as vehicles to demonstrate how science explores unknown fields. We might start a tradition in government science that could be a more significant contribution than anything else. I am afraid that many of the administrators within the community are confused between buying tools and doing science. In most of these problem areas, we don't know what the answers are and we have to use systematic and probably traditional scientific methods for finding the optimum answers.

We should be sure that they define their problem and that they lay out the alternatives and systematically go about finding the best alternative. After a set of experiments, results should be reviewed and then the next step taken according to the predetermined plan. Above all, the final answer should not be predetermined because the President was talked into making it a Presidential Initiative.

I probably missed the introduction of this set of Initiatives, and because of my ignorance, my comments might be rather naive.

I look forward to seeing you next Monday.

Sincerely yours,

Kenneth H. Olsen

KHO/d

COPY

October 12, 1971

NOTES ON ELECTRONIC MAIL

I was very pleased with the enthusiasm and competitive spirit of the Postal Service. Their proposal however sounds like they are committed to electronic mail and they really should be committed to the best possible mail service. This means programs and experiments to solve all of their problems.

Some version of electronic mail I would assume is inevitable, but it will take careful planning and careful experiments to demonstrate what form it will take. It will take a great deal of discipline on the part of the users, and careful selling and introduction to make sure that the results are acceptable.

When the problems of equipment to handle, read and produce on each end are solved, they may, without electronic transmission, solve much of the Post Office's problem.

If electronic mail is readily accepted by the public, it might be that if the bulk of its application is in the production of bills which would be largely local, there might be no need for large transmission facilities.

The system might become easily saturated and therefore very unpopular because it would be so easy to generate personalized junk mail.

If the costs of communications gets very low it would encourage competition, particularly if the Post Office lost its monopoly position. With low line costs, a network system like TELEX that presented facsimile or fast printing might take care of much of the business mail.

The proposal seemed to ask for much technology development to avoid the need for rational rate fixing. If each piece of mail was made to pay its fair share, it would help solve many of the problems of the Post Office.

Kenneth H. Olsen

COPY

price vs quantity

Electronic mail

STAGES IN COMPLETION OF A MACHINE TRANSLATION

A Sample Page from:

Foreign Document

Unedited Copy of SYSTRAN Computer Printout

Edited Copy of SYSTRAN Computer Printout

Finished Translation

В. Р. ДУРОВ

БОЕВОЕ ПРИМЕНЕНИЕ И БОЕВАЯ ЭФФЕКТИВНОСТЬ ИСТРЕБИТЕЛЕЙ-ПЕРЕХВАТЧИКОВ

(ЗАДАЧИ С РЕШЕНИЯМИ)

Ордена Трудового Красного Знамени
ВОЕННОЕ ИЗДАТЕЛЬСТВО
МИНИСТЕРСТВА ОБОРОНЫ СССР
МОСКВА — 1972

ВВЕДЕНИЕ

Боевое применение истребителей-перехватчиков связано с различными областями науки и техники. Для успешного использования своего оружия авиаторы изучают конструкцию летательных аппаратов и вооружения, динамику полета, теорию боевой эффективности, тактику воздушного боя и другие дисциплины. Как показывает обзор открытой зарубежной литературы, часть из которой указана в конце книги, наиболее подробно к настоящему времени описаны общие принципы действия самолетов и ракет. Значительно меньше, причем разрозненно в различных источниках,— количественные методы оценки боевого применения авиации.

Динамика маневрирования истребителя в воздушном бою обстоятельно рассмотрена в известной книге В. А. Булинского [1]*. Однако в этой книге не рассматриваются последний этап перехвата воздушной цели — наведение ракеты на цель — и вопросы эффективности перехвата. Общие положения и методы расчета боевой эффективности оружия описаны в книгах [3, 4, 8], а вопросы боевой эффективности летательных аппаратов в [3, 14, 15]. В литературе [9—21] излагаются принципы управления, кинематика и динамика полета ракет, методы наведения летательных аппаратов на воздушные цели. Многие вопросы боевого применения истребителей-перехватчиков излагаются в виде статей в открытой отечественной [22—24] и особенно в зарубежной печати [25—28], хотя большинство этих материалов носит описательный характер, а количественные соотношения не доводятся до простых расчетных формул. Таким образом, хотя боевое применение истребителей-перехватчиков и является предметом рассмотрения во многих источниках, тем не менее в настоящее время нет книги, по которой можно было бы составить достаточно полное представление о применении аналитических методов при исследовании боевого применения истребителей-перехватчиков.

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* Номер в квадратной скобке в данном случае и в последующем тексте означает порядковый номер использованной литературы, список которой приведен в конце книги.

INTRODUCTION.

The combat employment of fighter-interceptors is connected with the various areas of science and engineering. For the successful use of their weapon the airmaces study the airframe structure and armament, flight dynamics, theory of combat effectiveness, to the tactician of the dogfight and the other disciplines. As it shows a survey of the open foreign literature, are frequent from which is shown at the end of the book, most detailed at the present time are described the general/total operating principles of aircraft and rockets. It is considerable less, whereupon are separate in various sources, - the quantitative methods for an evaluation of the combat employment of an aviation.

The dynamics of the maneuvering of fighter in the dogfight is thoroughly examined in V. A. Bulinsky's known book [1] *. However in this book are not examined the last/latter stage of the interception of air purpose/target - the missile guidance to purpose/target - and the questions of the effectiveness of interception. The general/total positions and the methods of calculation of the combat effectiveness of weapon are described in the books [3, 4, 8], but the questions of the combat effectiveness of the flight vehicles in [3, 14, 15]. In literature [9-21] are set forth the principles of control, the kinematics and the flight dynamics of rockets, the guidance methods of the flight vehicles to air purpose/targets. Many questions of the combat employment of fighter-interceptors are set forth in the form of article in open domestic [22-24] and especially in foreign seal [25-28], although the majority of these materials bears descriptive nature, but the numerical ratios are not led to simple design equations. Thus, the khtoya the combat employment of fighter-interceptors and is the object of examination in many sources, nevertheless at the present time there is no book, on which it would be possible to compose the sufficiently full representation of the use of the analytical methods during the investigation of the combat employment of fighter-interceptors.

05-24-72

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THE COMBAT EMPLOYMENT AND COMBAT EFFECTIVENESS OF FIGHTER INTERCEPTORS

(PROBLEMS WITH SOLUTIONS)

V. R. Durov

The combat employment and combat effectiveness of fighter interceptors. M., Voenizdat, 1972.

FTD-MT-24-1158-72

INTRODUCTION

The combat employment of fighter interceptors is connected with the various areas of science and engineering. For the successful use of their weaponry the aviators study the aircraft structure and armament, flight dynamics, theory of combat effectiveness, tactics of aerial combat and other disciplines. As a survey of open foreign literature shows, part of which is shown at the end of the book, at the present time the general operating principles of aircraft and rockets are described in most detail. Considerably less described, separately in various sources, - the quantitative methods of evaluation of the combat employment of aviation.

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[1]The number in the brackets in this case and in the subsequent text means the ordinal number of the literature used, the list of which is given at the end of the book.

the combat effectiveness of flight vehicles in [3, 14, 15]. In literature [9-21] there are set forth the principles of control, the kinematics and dynamics of rocket flight, the guidance methods of flight vehicles to air targets. Many questions of the combat employment of fighter interceptors are set forth in the form of articles in the open domestic [22-24] and especially in the foreign press [25-28], although the majority of these materials bears a descriptive character, and the numerical relations do not lead to simple design equations. Thus, although the combat employment of fighter interceptors is the object of examination in many sources, nevertheless at the present time there is no book by which it would be possible to compose a sufficiently complete representation of the use of analytical methods during the investigation of the combat employment of fighter interceptors.

Distribution of Electronic Mail Over the Broad-Band Party-Line Communications Network

WILLIAM B. GROSS, MEMBER, IEEE

Abstract—Cable television (CATV) is unique in that it is the only wire, besides telephone, with potential access to 80 million customers. Many new services have been proposed to utilize this access—from meter reading to transmission of an entire book in seconds. The author postulates that electronic mail is the market CATV should pursue and describes the market potential, a system design in some detail, and an estimate of the costs involved. An intriguing result of this analysis is the possibility of sending mail electronically for only 10 cents a letter.

I. New Role of CATV—Electronic Mail

CABLE television (CATV) is in the unique position of being the only wire, in addition to telephone, ultimately to have access to every household and business in the United States. Access to this market of 60 million households and 20 million business subscribers is likely to cause a radical change in the services supplied by CATV systems since direct access to the customer virtually guarantees an increase in magnitude and diversity of service. CATV is in this enviable position.

CATV has now grown to the point where it can independently promulgate its growth. With 2300 systems on line and 4 million subscribers, production of software (TV programs) and hardware has reached the point where one can consider the economies of scale. Further, by virtue of its entry into the metropolitan markets, CATV will be expanding at an even steeper rate. New York City is now being wired and other major cities are not far behind. Thus, one can see that CATV is at an important juncture. Decisions as to which new markets are undertaken will determine whether CATV will grow in value and importance or level off into being an alternative to other entertainment media.

With CATV's broad-band capability and access to subscribers, the door to new markets is open. Many new services have already been proposed [1], [2] and generally relate to information dissemination, computer services, and communication services (see Table I). Of all these services, a choice of mail as the most important new market should be considered.

Mail has a known predictable volume, and it is huge. By 1980, 108 billion pieces of mail per year will be handled. The ability of the Post Office to handle the present volume is marginal. Over the past decade, service has declined to such an extent that a crisis is developing. Thus, if one can develop an alternative to the physical transportation of mail at an equitable price, the door is open for entry into this market. That such a substitute exists has already been determined by the President's Commission on Postal Organization [3]. They indicate that the telephone is used as a substitute for about 2 percent of all mail and that the class of mail known as "transaction mail" is most amenable to electronic substitution.

TABLE I

Proposed CATV Services

Broadcast	Real-Time Point-to-Point	Store and Forward
Commercial TV	Telephone	Library access
Instructional TV	Videophone	Newsprint and magazines
Commercial radio	Telegraph/teletype	Computer services
Instructional radio		Interactive instruction
		Time-shared computation
		Aided design
		Transaction exchange
		Remote vending
		Airline and theatre tickets
		Point of sale vending
		Banking and credit
		Securities
		Polling
		Meter reading
		Voting
		TV shopping
		Mail
		Alphanumeric
		Graphic

Source: *EIA response to FCC Docket 18397, Part V*, Electronic Industries Association, October 29, 1969.

Transaction mail consists of those communications relating to bills, purchase orders, proposals, and the like. In general, they consist of alphanumeric information and thus are susceptible to transmission by teletypewriter or other electronic typers. Further, mail does not require immediate delivery; i.e., it can be stored and forwarded. These two factors, alphanumeric information plus store and forward, permit development of an electronic transaction-mail system that can provide mail at 10 cents per letter. At this price, demand is inelastic, and electronic mail is a direct substitute for all transaction mail. In reality, demand is elastic. Other substitutes such as Telex, TWX, PMS, and facsimile are $1.00 or more per letter, yet they all enjoy a substantial volume. Although ten cents per letter has been used herein, considerable pricing latitude would be available to the CATV operator electing to introduce the electronic mail service.

The immediately available market is that called business-to-business transaction mail. This comprises 16 percent of

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The author is with the General Electric Company, Philadelphia, Pa.

TABLE II
SERVICE CLASSES

Service Class	Characteristics	Where Used	Comments
Instant	Full time Low speed (150–600 wpm) Alphanumeric (ASCII-8)	Local	Will handle most transaction mail and data. Instant full-time access dictated by man–machine interface.
Immediate	3-second delay maximum Variable speed (50 bits/s to 20 Mbit/s)	Local and national	Required to satisfy response to inquiry Speed varies with subscriber station capability and data requested.
Same day	Within 4 hours	National	Permits spreading traffic over 24 hours.
Overnight	By 0700 next morning	Interchange	Reduces National Interconnect capacity.

all mail and would represent a volume of 17.3 billion messages per year by 1980. At 10 cents a letter, this market of $1.73 billion provides a respectable foundation for the development of the electronic mail service. Expansion of service would be directed toward all transaction mail, including households, and toward data communications.

The total volume of transaction mail is 40 percent of all mail for a projected (1980) volume of 43.2 billion pieces per year. To capture this market, a low-cost subscriber station is needed. Such a station is discussed later.

The total market including data communications, which has been estimated as equal to transaction mail, would be 86.4 billion pieces per year, or at 10 cents a message, $8.64 billion per year. With this size of market available, it behooves the CATV industry to develop a system specifically for mail and data. Although a patchwork of systems can satisfy the need, albeit inefficiently, there is no pressure to follow this route. CATV has not been encumbered with huge investments in equipment intended for the general communication service. Thus, the industry can develop an efficient system specifically for mail and data; such an approach is developed herein.

II. Converting CATV—A Total System Development

A. *Services*

In addition to alphanumeric mail, ideally the new system should be capable of assimilating other functions by simply changing the subscriber's station. Obviously, this cannot be accomplished for every class of user, and in particular the real-time point-to-point services that require a switched network. But CATV cable systems are suited particularly for broad-band party-line operation, and for mail and data this is implemented readily by a store and forward system. Thus, the design will be developed to handle, in addition to the TV channels, many and varied services; from 50 bits for meter reading to Mbits/s for newsprint and magazines.

Traffic Characteristics

Two interfaces determine the important parameters controlling the system response requirements. First, the man–machine interface sets the local loop characteristics for its class of services and second, the machine–machine interface controls both the local loop and national interconnect characteristics.

The man–machine interface has these basic characteristics.

150 wpm typing speed
600 wpm reading speed
instant access
continuous access
response to inquiry in 3 seconds.

The 150-wpm typing speed was derived from the necessity of reacting without error to all typists; the 600 wpm reading speed does not respond to all readers but does satisfy 98.5 percent. To satisfy all readers would require 2000 wpm and since a slower speed does not introduce errors, the increased system cost is not commensurate with providing the service for only 1.5 percent more readers.

The instant access is dictated by all people being annoyed by waiting for access to the line. Experience gained with time-shared computers tells us that once the subscriber has seized the line, he stays on it for extended periods. The combination of instant access and long hold times dictate continuous access.

The response time to inquiries was derived by all people being annoyed by a wait greater than 3 seconds. The other interface, machine–machine, requires speeds from 50 bits/s to Mbits/s. Access times range from instant to overnight.

From the foregoing man–machine and machine–machine characteristics, a group of service classes has been determined that sets the basic system requirements. Table II lists these service classes and their characteristics. To satisfy the requirements, a system capable of providing continuous low-speed local channels and a local store, which can transfer information immediately or at times 24 hours later, is needed.

B. *System Concept*

To satisfy the above, a store and forward communications system (SFC) has been delineated and is block diagrammed in Fig. 1. The elements that comprise the system are

subscriber station
local loop (CATV cable)
store and forward communication controller (SFC)
national message interchange (national loop).

The electronic typers and other low-speed subscriber stations are assigned full-time channels into the SFC and the

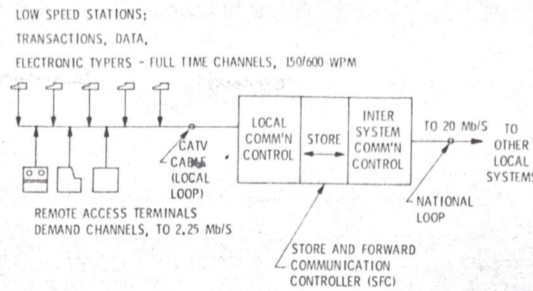


Fig. 1. Block diagram of local system.

TABLE III

SUBSCRIBER STATIONS

Type	Characteristics	Typical Use
Data collection	Reads coded cards, meters. No display. May have a release circuit or verification lamp.	Gas stations sales. Utility meter reading. Voting. Remote shopping.
Transaction recording	Credit card and price ticket reader and keyboard entry. Alphanumeric display of entry and computer response.	Point of sale transaction recording.
Electronic typer: Soft copy	Simple keyboard and "billboard" or "line-a-time" display.	Basic business and home unit for mail, computer time sharing, and transaction exchange.
Electronic typer: Hard copy	Typewriter keyboard and paper printout. Teletypewriter and modified electric typewriter are typical.	Business or home unit for those desiring hard copy.
Console	Special purpose units with keyboard, cathode-ray tube or matrix display, light pen, frame-by-frame memory, or other special features.	Designed for specific applications such as data entry and retrieval stations, computer-aided design, interactive computer-aided instruction, newsprint, and magazine typesetting and graphics.

high-speed subscriber stations use a low-speed channel as an order wire for the demand assignment of high-speed channels capable of bit rates to 2.25 Mbits/s. Information is exchanged between the subscriber station and the SFC. The SFC can transfer the information to either a local subscriber or put it on the national loop for transfer to the SFC at another location. In addition to the communication functions, the SFC can hold the information for later transfer or can put the information into a permanent memory for retrieval at some future time.

III. System Design

A. Subscriber Station

As will be seen under the section on cost, two thirds of the system cost resides in the subscriber station. Fortunately, subscriber stations for most services are already available or in development. Table III describes the various subscriber stations needed to satisfy the variety of services contemplated.

The basic unit will be the hard-copy electronic typer used for business-to-business transaction mail. Suitable station equipment exists and units capable of both upper and lower case (full ASCII character set) are also available. Providing an electronic typer with "executive" font will permit use of the machine as a regular office typewriter or as a communication terminal. The duality of function will move electronic mail directly to the user thereby providing secretary-to-secretary communication. This should have a profound effect on the convenience and speed of business-to-business mail.

But, in order to proliferate the electronic mail system, a low-cost soft-copy unit is needed. This unit will be used in the home and on the office desk when acceptance of stored data, instead of hard copy, grows.

Since the soft-copy unit will be used mainly by persons not trained as touch typists, a new kind of keyboard is needed. Attributes of the keyboard will consist of the following.

Numbers and letters in numerical and alphabetical order to eliminate learning their location on the keyboard.

All characters in field of view without moving head or eyes.

A small keyboard has been suggested for military field teletypewriters as a means of miniaturization [4]. By using a stylus to probe the keyboard, size can be kept small. The complete keyboard, with numbers and characters in chronological and alphabetical order is shown full size in Fig. 2. Convenience of the keyboard is understood readily if the reader will experiment by using a pencil as a stylus and operate on Fig. 2 as if it were the real keyboard.

The station outline is also shown in Fig. 2. Character display is by multicell flat gas discharge array or by monolithic arrays of light-emitting photodiodes. They act as their own memory and can be used for a line-at-a-time display similar to that used for rapid reading training. The number and size of characters in a line are such that the reader need not move his eyes, thereby permitting rapid reading. The

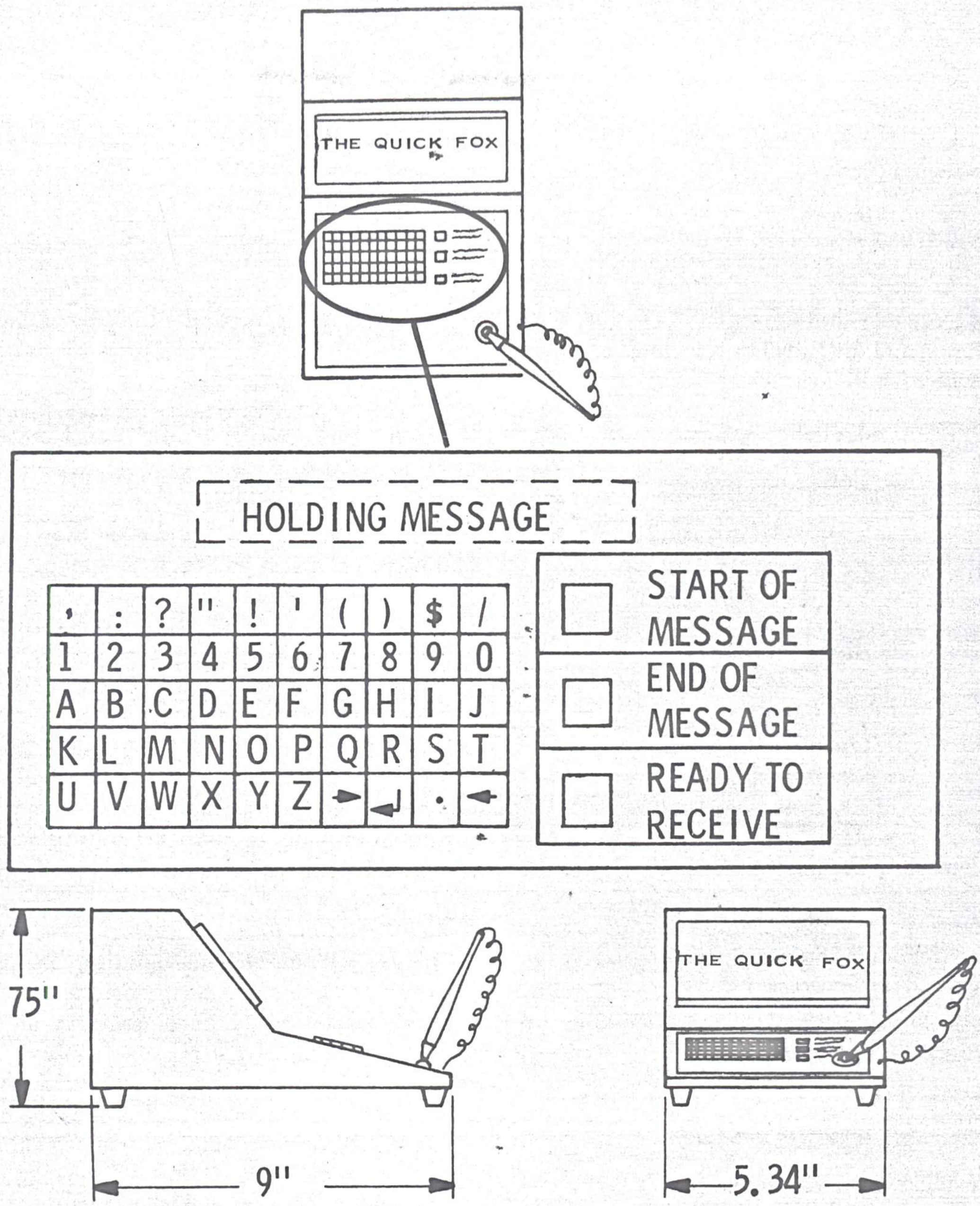


Fig. 2. Subscripter station exterior layout showing stylus probed keyboard and monolithic display panel. Stylus probe "hunt and peck" keyboard with chronological and alphabetic layout of characters is shown actual size.

overall size of the station was deliberately chosen the same as a telephone, a size every businessman and householder accepts. Communication electronics for the subscriber station is shown later in Section III-C.

B. Local Loop

A number of outside plant configurations have been considered. Round-robin cable-looped configurations are attractive for the two-way digital transmission since virtually no guard time is required to separate individual transmissions. But they have a very high first cost, in the range of 2.6 times that of a tree. Frequency-looped round robins can be implemented on a tree configuration but at double the first cost in extra equipment. Thus, round robins may be attractive for ease of design but are not desirable from a cost standpoint. The remaining plant configurations considered are "trees" or "hubs" and require either separate cables for transmission and reception or a single cable with the band above 54 MHz for reception and the band below 48 MHz for transmission.

The choice between a single-cable or a two-cable outside plant is controlled by the number of subscribers on the tree, but in actual practice the viability of providing two-way communication will center about the ability to provide service under the worst of field conditions.

If one were to design the data communication system to operate under conditions that make TV viewing intolerable, the viability of the two-way service would be assured. The assumption is made that customer complaints on TV quality will force repair of the outside (cable) plant. Specific requirements for these conditions are shown in Table IV. Calculations to determine the error rate at the data exchange design level follow.

Data transmission quality can be characterized by the bit-error probability P_e. To determine P_e the modulation method and signal-to-noise ratio (SNR) need to be known.

TABLE IV

DESIGN REQUIREMENTS FOR TV AND DATA

Requirement	CATV Design Level	TV Viewer Intolerance Level	Data Exchange Design Level
Picture grade: (S/N) per spec. NCTA-005-C	Grade I (44.5 dB)	Grade IV (23 dB)	20 dB
Cross modulation: N/S per spec. NCTA-002-0267	−48 dB	−40 dB	−37 dB

Noncoherent frequency shift keying (FSK) has been chosen as the modulation and the P_e will be calculated accordingly.

The channel SNR will be

$$\left(\frac{S}{N}\right)_0 = \frac{S_0 q}{N_c + N_r} \tag{1}$$

where

$$q = \left(1 - \frac{2t}{T}\right)^2. \tag{2}$$

Also, SNR can be stated as

$$\left(\frac{S}{N}\right)_0 = \frac{q}{\dfrac{N_c}{S_0} + \dfrac{N_r}{S_0}} \tag{3}$$

where

$(S/N)_0$ = signal-to-noise power ratio
S_0 = signal power
q = average bit synchronization degradation ratio
N_c = cross modulation noise power
N_r = thermal noise power
t = average bit synchronization error time
T = bit width time.

Allowing an error in synchronization of $t=0.1T$

$$q = (8 \times 10^{-1})^2 = 64 \times 10^{-2}$$

and from previously set field conditions

$$\frac{N_c}{S_0} = \log_{10}^{-1}(-37 \text{ dB}) = 2 \times 10^{-4}$$

$$\frac{S_0}{N_r} = \log_{10}^{-1}(20 \text{ dB}) = 1 \times 10^{2}$$

$$\therefore \frac{N_r}{S_0} = 1 \times 10^{-2}.$$

Thus,

$$\left(\frac{S}{N}\right)_0 = \frac{64 \times 10^{-2}}{2 \times 10^{-4} + 1 \times 10^{-2}} = 64 \quad \text{(18 dB)}.$$

The probability of error for a noncoherent FSK channel is [5]

$$P_e = \tfrac{1}{2} e^{-\frac{1}{2}(S/N)_0} = \tfrac{1}{2} e^{-32} \simeq 1.3 \times 10^{-14}. \tag{4}$$

At this error rate, excellent information transfer is attained even during the periods of customer intolerance for the TV reception.

Embedded in the statements about TV picture quality and the related SNR is an assumption that the digital signals and the TV signals are being processed by the same amplifier on the same cable. Such a system has been suggested [6], [7] and defined [8]. The use of a single-cable system would assure that the system will stay within maintenance margins, plus it is amenable to applications requiring conversion from one-way to two-way cable plants.

The other dominant factor in assuring that the system will remain within maintenance margins is the bit synchronization error q, see (2). Two alternative systems can be considered for subscribers: frequency division multiplex or time division multiplex. If each subscriber station is allocated a separate frequency division multiplex (FDM) return channel, no guard time is necessary and the ASCII code format provides for asynchronous transmission when start and stop bits are inserted.

Although the cost of frequency multiplexing each subscriber station to its allocated return channel can be kept low [9], the cost of demultiplexing each subscriber is excessive when compared to the cost of a single time division multiplex (TDM) channel to serve all subscribers. But, TDM to each of the possible subscribers would require most precise bit timing for each subscriber's transmission on the return channel. To determine the bit timing that can be readily achieved and maintained on the return transmission under field conditions, propagation and bulk delays in amplifiers and cables need to be estimated for the distance associated with each subscriber.

The time position of the subscribers burst in a TDM frame can be determined from

$$P_s = \frac{D_s}{cV_c} + nB_a + mS_t \tag{5}$$

where

P_s = wait time from beginning of frame to insert subscriber burst in correct slot
D_s = distance on cable to subscriber
c = velocity of light
V_c = propagation variation factor due to cable
n = number of amplifiers and associated filters to subscriber
B_a = bulk delay of amplifier and filter
m = number of time slots to subscriber position in frame
S_t = time for each slot.

TABLE V
BIT TIMING ERROR

Term	Error Cause	Error Value	Equivalent Time Error
—	SFC clock	1 part in 10^7	6.6×10^{-9} second (15 frames/second)
D_s	Actual distance to subscriber Cable length change with temperature	0.1 mile 9.5×10^{-6}/°F coefficient. −40° to 160°F temp. range (1.9×10^{-3} miles/mile)	$2 \times 0.72 \times 10^{-6}$ second $2 \times 0.21 \times 10^{-6}$ second (15 mile path)
V_c $\left[V_c = \frac{1}{\varepsilon}\right]$	Change in dielectric constant ε with temperature, pressure and humidity	Negligible for foam polyethelene cables	−0−
nB_a $\left[nB_a \simeq \frac{0.6D_s}{cV_c}\right]$	Change in filter components	2% of nB_a term	$2 \times 1.29 \times 10^{-6}$ second (15 mile path)
		Total Error	5.4×10^{-6} second

Of interest is the variation in each of the terms of (5), in order to determine the expected bit synchronization error. This error will set the value of q in (2) and thus determine the acceptable bit rate of the TDM channel. Field conditions are expected to yield values shown in Table V.

Most of the error is contributed by two of the terms, change in filter components, and distance to subscriber. The change in filter components is a function of the attention paid to outside plant maintenance and is set at customer (TV viewer) intolerance level plus a margin. The other factor, distance to subscriber, has a value such that a subscriber station can be set up by reference to his location, thereby eliminating the need for special field tests to "fine-tune" his TDM burst. Eliminating the need for a special field test permits plug-in installation or replacement of the subscriber station by untrained personnel or even the subscriber. Further, this approach is in line with the Carterphone [10] decision, which permits subscribers to furnish their own station equipment.

To maintain the P_e of 1.3×10^{-14} and the attendant high-quality digital communication, the bit timing error t in (2) was set at $0.1T$. With $t = 5.4 \times 10^{-6}$ second, T becomes 54×10^{-6} second for a bit rate of 18.51 kbits/s for the return channel.

C. Local Traffic Interchange

The foregoing calculation sets the bit rate for the TDM return channel. Previous discussion of traffic characteristics required 150 wpm as the station rate and that sets the frame rate at 15 frames per second. At this frame rate and at 18.51 kbits/s, each TDM return channel will support 102 subscribers (see Fig. 3). The return channel occupies 46.275 kHz (including 25 percent guard bands on each side) when transmitted as noncoherent FSK. A 6-MHz TV channel will FDM into 129 channels. Thus, each TV channel will support 13 158 subscribers (102 TDM × 129 FDM). In the band below 48 MHz there is bandwidth for seven TV

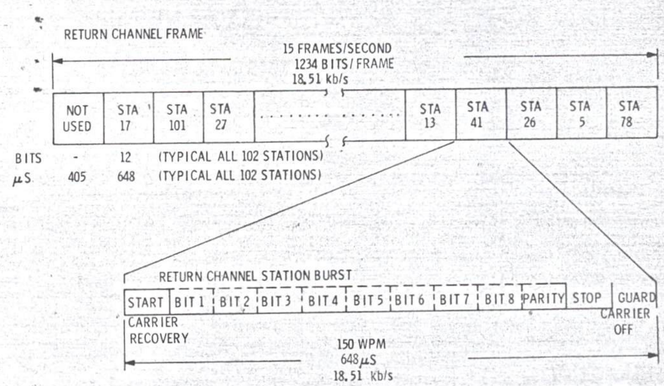


Fig. 3. Return channel frame and station burst formats. Note: Station numbers need not be chronological; station positioned in frame for most convenient solution of (5).

TABLE VI
SUMMARY OF RETURN CHANNEL CHARACTERISTICS

Channel Type	Total Available	Bandwidth or Slots	Bit Rate
TV	7	6 MHz	2.25 Mbits/s
FDM	903 (7 × 129 per TV Ch)	46.275 kHz	18.51 kbits/s
TDM	92 106 (7 × 129 × 102)	102 slots per FDM Ch	135 bits/s

channels. If these were all allocated to low-speed subscriber stations, the single-cable outside plant would support 92 106 subscribers. Except for the highest density metropolitan installations, a single cable will have excess capacity. Unused capacity can be demand assigned for data transmission at the various rates shown in Table VI.

Unlike the return channels just discussed, forward channels can be operated synchronously; since they all originate from one point; the store and forward communication con-

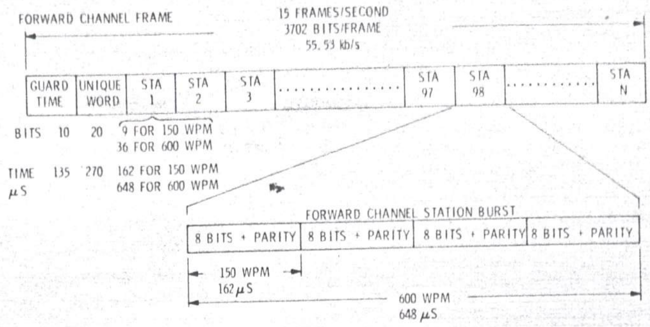


Fig. 4. Forward channel frame and station burst formats. Note: Station numbers need not be chronological; station positioned in frame for most convenient solution of (5).

TABLE VII

SUMMARY OF FORWARD CHANNEL CHARACTERISTICS

Channel Type	Total Available	Bandwidth or Slots	Bit Rate
TV	7	6 MHz	2.25 Mbits/s
FDM	301 (7 × 43 per TV ch)	138.825 kHz	55.53 kbits/s
TDM	122 808 at 150 wpm 30 702 at 600 wpm (7 × 43 × 408 or 102)	408 slots at 150 wpm 102 slots at 600 wpm per FDM Ch	135 bits/s at 150 wpm 540 bits/s at 600 wpm

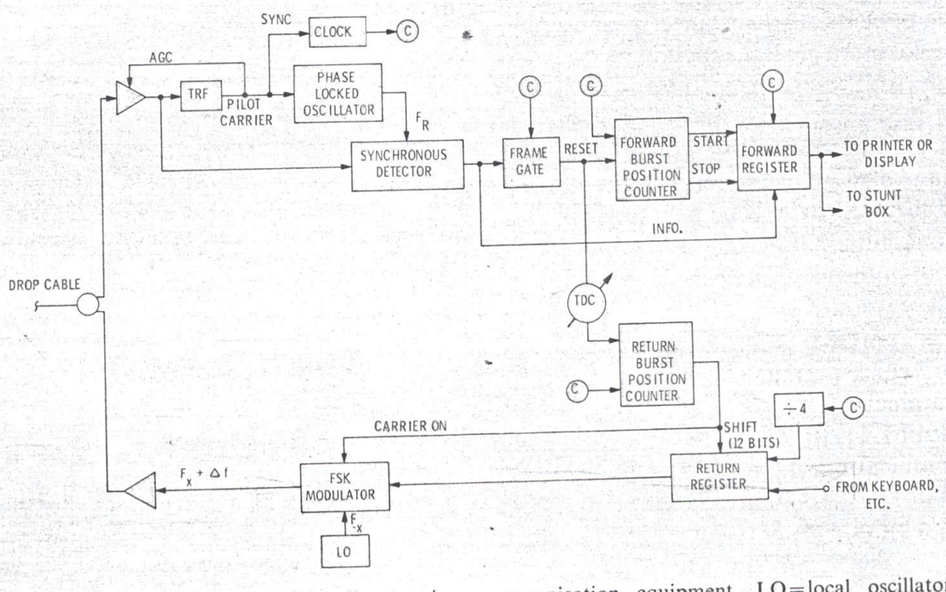


Fig 5. Block diagram of subscriber station communication equipment. LO = local oscillator, F_R = forward channel frequency, F_X = return channel frequency, TDC = time delay closing (range 15 μs).

troller. Start–stop bits and guard times are eliminated bringing the bits per character down to nine from the twelve used for the return channels. To achieve the 600 wpm rate for forward transmission, only 55.53 kbits/s are required. By using one to four characters per frame, the word rate can be varied between 150 to 600 wpm. Characteristics of the TDM frame are shown in Fig. 4 and the channel characteristics are shown in Table VII. The communication equipment to implement the forward and reverse channels at the subscriber location is shown in block diagram in Fig. 5.

National Traffic Interchange

To develop the interchange network an estimate of the number of local systems and the interchange traffic is required. Estimates on the number of local systems that will ultimately interchange data range from 5000 to 50 000 (See Table VIII). The exact number that will emerge is fairly dependent on regulatory and economic factors, but is most dependent on demography. As few as 5000 systems could provide service, but the area coverage for each would be excessive. The area coverage value per Feldman [11] in-

TABLE VIII
ESTIMATES OF ULTIMATE SYSTEM SIZE

Estimating Technique	Number of Local Systems
Tree capacity (20 000 subscribers): Each tree is separate system	5000
Number of telephone exchanges	10 000
Area coverage (20 by 20 miles)	16 000
Post office delivery stations	34 000
Area + multiple operations in metropolitan areas	50 000

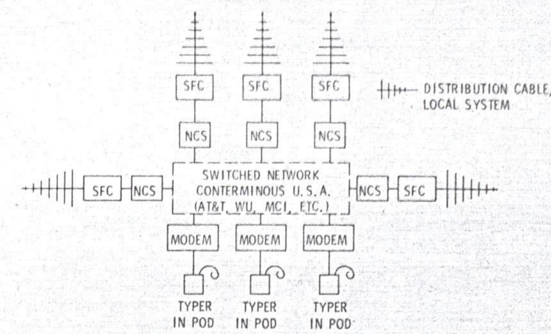


Fig. 6. Phase I: Switched network national loop. SFC = store and forward communication controller, NCS = network control signaling units, POD = Post Office Department.

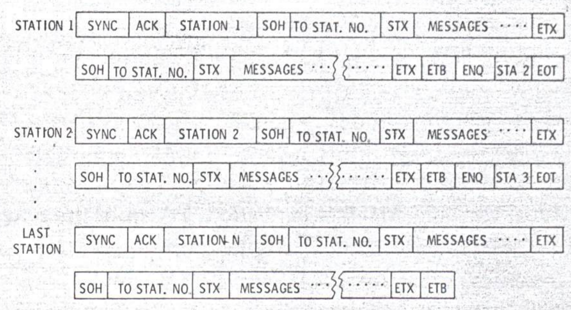


Fig. 7. Party-line message interchange format.

cludes every square inch of the conterminous United States and is regular in distribution. The population of the United States concentrates at the seacoasts and border. The best measure for selective area coverage is the number of telephone exchanges, and the boundary value for a saturated system is the number of Post Office delivery stations. A conservative estimate on the ultimate number of systems is 50 percent above that for telephone exchanges. This value provides area coverage plus an allocation for multiple systems in metropolitan areas. It results in an estimate of 15 000 systems.

With a projected traffic of 86.4 billion messages per year at an average message length of 150 words,[1] the bit rate to interchange all traffic as a continuous stream on a national party line is 5.8 MHz. Efficiency of interchange is assumed to be only 20 percent and with local traffic at 33 percent,[2] the required rate for all national interchange is 20 Mbits/s. No such 20 Mbits/s party line exists and alternatives are required. The alternative developed must be capable of providing service immediately to the 2300 existing systems and have the capability of growing as the number of CATV installations and traffic increases.

To satisfy this need a three-phase approach has been developed as follows.

Phase I: Use of switched network to provide immediate coverage.

Phase II: Improve the service by leasing a TV bandwidth channel for a national party line.

Phase III: Provide full bandwidth capability by a combined party line and domestic satellite system.

Phase I: Switched Network National Loop: As an initial step, traffic can be routed via the switched network. With a message length of 150 words and 72 bits per word, each message is 10 820 bits. At a rate of 3600 bits/s, each message is transmitted in 3 seconds for a message rate of 1200 per hour. With the projected ultimate traffic of 86.4 billion messages per year and with 15 000 systems deployed, the average load per local system is about 16 thousand messages per day. Of this, 11 thousand are for national interchange.

Although all traffic could be interchanged via the switched network, limited bandwidth of voice circuits and delays in network control signaling mitigate against more than 10 percent being routed this way. At this loading, the average local system would interchange about 1100 messages per day; a 2-hour task.

One other element required to assure utility for the Phase-I system is receive-only typers at local Post Office delivery stations. They would act as the means of exit from the CATV system to the Post Office, thus providing the link to individuals and companies who are not subscribers. This may be available soon. Western Union Telegraph Company is placing Telex machines in Post Office delivery stations; these machines could be the means for linking the electronic mail to regular mail. Fig. 6 ties these elements into a block diagram for the Phase-I system.

Phase II: National Party Line: This system operates in a party-line mode on a full-duplex TV channel. The message format is shown in Fig. 7. Each station begins transmission with a synchronization signal (for carrier and bit recovery). It transmits the acknowledge code, its own station number, and then messages addressed to other stations in the net. At the end of the text material it requests the next station in line to acknowledge with its station number. Thus, each station disposes of its traffic and hands over the line to the next station.

One station is designated to monitor the response of all stations. If a station does not respond within 1 second, the monitor bypasses it by transmitting ENQ and the next station number. When traffic is cleared by all stations, the monitor station will reinitiate the round robin. Each station is limited to time on line by periodic calculations of its percentage of total traffic, thereby preventing queue formation. Fig. 8 is a block diagram of the system.

[1] Telex and TWX average is 100 words.
[2] See [3], Annex III.

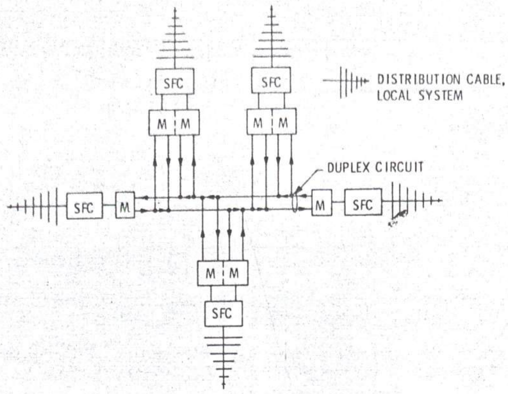


Fig. 8. Phase II: National party line. M = modem, SFC = store and forward communication controller.

Providing service via a wide-band party line permits the transfer of data at 2.25 Mbits/s. Services previously precluded via the voice-band switched network (Phase I) can now be served on a limited basis. Total traffic handled is limited to 10 percent by bandwidth; a 20 Mbits/s party line instead of the 2.25 Mbits/s is needed. Possibly the new networks specifically aimed at digital communication, being approved for construction by the FCC, could provide the required capacity for interconnection, perhaps even at reduced rates.

Phase III: Combined Party Line and Satellite: An examination of the character of the traffic reveals that not all locations originate wide-band data. In actuality, probably not more than 20 major locations in the United States originate data of a wide-band nature. These locations are in major metropolitan areas or associated with government installations such as NASA, the Library of Congress, etc. A study of population density and traffic demand indicates that 200 standard metropolitan statistical areas (SMSA) will provide 99 percent coverage of the population. If one were to assume 200 such regional centers for information generation and storage, wide-band data could be transferred to the 14 800 local SFCs for temporary storage until used by the subscriber. The request for transfer of data from the regional memory to the local SFC requires very few bits. Thus, by using a receive-only satellite station at the local system, broad-band information could be received, and by using wires, cable, or microwave from each local system to the regional system, information could be requested. This arrangement would be economical since only 200 regional stations would require the expense of transmit–receive stations. The bit rate from the local to regional system is 100 kbits/s, assuming evenly distributed traffic. For this purpose, a leased party line (Telpak C at 240 kHz) would be adequate. Fig. 9 is a block diagram of the system.

Since all of the traffic is store and forward, there is no requirement for a fully variable demand assigned multiple access (DAMA) satellite system. The partially variable (control) channel suggested for the domestic satellite [12] will suffice. Thus, the format of Phase II (Fig. 7) is used for regional traffic interchange and the partially variable DAMA format shown in Fig. 10 is used for both interregional traffic and for traffic to local receive-only stations.

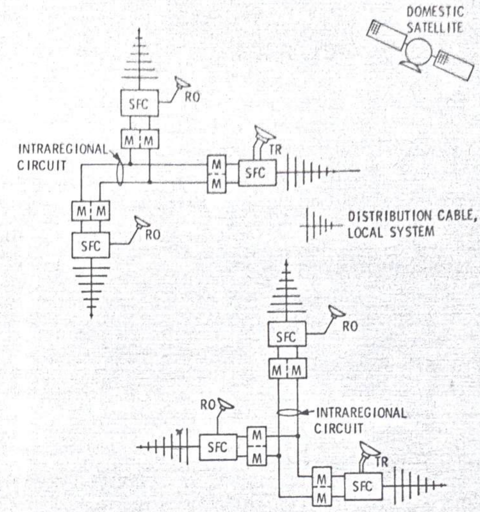


Fig. 9. Phase III: Combined party line and satellite. SFC = store and forward communication controller, RO = receive only (satellite earth station), TR = transmit-receive (satellite earth station), M = modem.

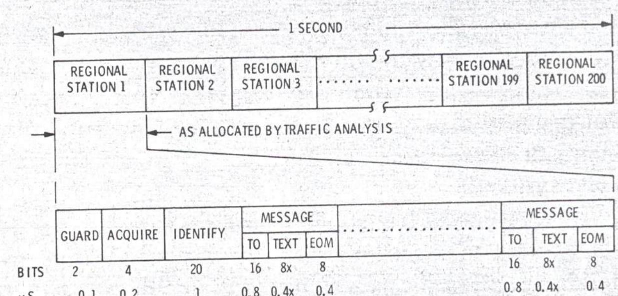


Fig. 10. Partially variable demand assigned multiple access (DAMA) message interchange frame format.

Fig. 11 details the equipment that the local and regional systems will need to implement Phase III.

IV. Cost Analysis

A. National Service

National message interchange costs vary with the method employed. During Phase I, when the switched network is used, messages between local systems would be stored in each SFC until a 3-minute minimum is on hand. As previously discussed, each message takes 3 seconds to send, thus during the 3-minute period, 60 messages will be sent. On this basis, an approximate transmission cost for maximal distances, e.g., Philadelphia to Los Angeles, can be established by using AT&T rates. Costs for various times of day are listed below.

Daytime	0700–1700	$1.70/3 min	2.83 cents per message
Evening	1700–1900	$1.25/3 min	2.08 cents per message
Night	1900–0000	$1.00/3 min	1.66 cents per message
Off hours	0000–0700	$0.75/3 min	1.25 cents per message
		Average	2.0 cents per message

In addition, 1.5 cents per message is required for trunk and network control signaling equipment (NCS) lease, for a

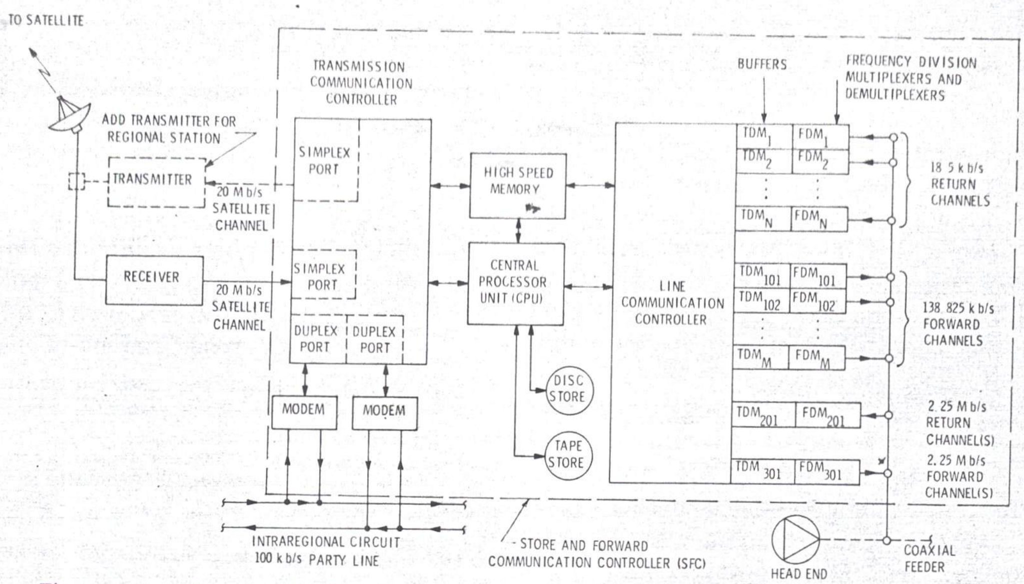


Fig. 11. Block diagram of local system, showing store and forward communication controller (SFC) and equipment for local, regional, and national information.

TABLE IX

System Elements and Costs

Element	Total in System	Element Cost	System Cost	Remarks
Transmit–receive station	200	\$200 000	40×10^6	30 foot antenna. Redundant transmitters and receivers. Standby batteries
Receive only station	14 800	\$25 000	370×10^6	15 foot antenna. Redundant receiver. Standby batteries.
Satellite	4 (1 active and 1 spare each 5 years)	—	90×10^6	Cost includes engineering, launch support, and satellites for 10 years. Satellite life 5 years. Coverage: 7.5° antenna. 20 watts RF per channel. 12 channel capacity. 4 and 6 GHz band.
		Total System Cost	500×10^6	

total charge of 3.5 cents per message to interchange anywhere in the contiguous United States.

The Phase-II party line dramatically reduces transmission costs. To interconnect all the local systems, approximately 30 000 circuit miles of full-duplex TV bandwidth is required. The yearly cost for this service at \$140 per channel mile month [13] would be \$50.4 million and the system would have 10 percent of full capacity.[3] Since the modem is part of the SFC, termination charges are negligible and the total message charge for interchange anywhere in the contiguous United States is only 0.87 cent.

Further savings and a wide-band capability are accrued by deploying the Phase-III system. The party line for this phase is on a regional basis and interconnection mileage is 20 000 at Telpak C rates of \$30 per mile month [13]. The yearly charge is \$7.2 million and at 57.6 billion messages;

[3] To handle all traffic projected for 1980 would require 20 Mbits/s. Existing channels will handle only about 2 Mbits/s.

TABLE X

Pricing Factors

Item	Factor	Comments
Capital recovery	0.149	8 percent interest 10-year life
Maintenance and operation	0.19	
Return on investment	0.225	

Total of Pricing Factors = 0.564 of investment per year.

intraregional traffic costs 0.013 cent per message. Remaining costs associated with national interchange are in 200 regional transmit-receive stations, 14 800 receive-only stations, and a satellite. Table IX details the system element costs and Table X shows the pricing factors.

Total system cost is \$500 million and at a pricing factor of 0.564 per year, \$282 million per year revenue is required. At 86.4 billion messages per year, cost per message is 0.326 cent each. Including the regional party-line charges, national interchange charges total 0.339 cent per message anywhere in the conterminous United States.

B. Local Service

To develop the cost for local service, the total traffic (86.4 billion messages per year) is allocated to each local system and subscriber on an average basis. The assumption is made that all households and businesses will be supplied with service. This represents a total of 80 million subscribers and 14 800 local and 200 regional systems; each would have, on the average, 5333 subscribers. Each subscriber would send 1080 messages per year.

Cost to provide the local service, excluding the subscriber station, consists of the store and forward communications controller and the two-way outside cable plant. The store and forward communications controller is estimated to cost $150 000. Required revenue is ($150 000 × 0.564) $85 000 per year. The two-way cable plant is estimated to cost 20 percent more than the one-way plant, or $1.00 per month per subscriber. These two items represent 3.055 cents per message. In order for electronic mail to cost no more than 10 cents a letter, revenue remaining for the typer is 6.606 cents per letter, on a yearly basis $71.35. This revenue would permit a typer costing $125.00 being supplied to each subscriber.

Whether the basic soft-copy electronic typer described in the previous section can be produced for $125.00 is unknown. If one compares the complexity of the electronic typer to existing equipment, it would appear within the realm of possibility, particularly when one considers that the available market is 80 million units.

General Comment

The pattern developed by this cost structure is unusual in its distribution when compared to existing telecommunication systems, but this can be expected from the nature of the system.

The single (at most double) hierarchy switching associated with the national system concentrates the equipment to the local level. Since the subscriber is given instantaneous and continuous access to the SFC, the cost per subscriber is greater than that associated with sharing the same equipment with other subscribers, again concentrating costs at the local level. Relative to existing telecommunication systems, the service is more than competitive in price and further has the advantage of broad-band information transfer, not now available at a reasonable price.

References

[1] President's Task Force on Communication Policy, Federal Clearing House, Washington, D.C., Staff Paper 1, Sec. G, PB184413, June 1969.

[2] FCC Docket 18397, Pt. 5 Amendment of Pt. 74 of the Commission's Rules.

[3] President's Commission on Postal Organization, *Toward Postal Excellence.* Washington, D. C.: U. S. Government Printing Office, June 1968.

[4] D. B. Davies, "Miniaturization of military teletypewriters," private communication, July 1958.

[5] S. Stein and J. J. Jones, *Modern Communication Principles.* New York: McGraw-Hill, 1967.

[6] EIA response to FCC Docket 18397 (see [2]).

[7] AT&T comments on FCC Docket 18397, pt. 5 (Appendix I).

[8] J. O. Norback, "Concepts for cable transmission systems," presented at the 18th Internatl. Wire and Cable Symp., December 4, 1969.

[9] N. A. Robin, "Phase locked frequency multiplier cuts cost," *EDN*, November 15, 1969.

[10] *Carter versus AT&T*, "In re use of the Carter-phone device in message toll telegraph service," 13FCC2d 420 and 14FCC2d 571.

[11] N. E. Feldman, "A scenario for the future of cable television distribution," RAND Corp., P-4270, December 1969.

[12] W. B. Gross, "Domestic communications via satellite," WESCON *Conv. Rec.*, session 12, paper 12/2, August 1969.

[13] T. Cosgrove and R. D. Chipp, "Economic considerations for communication systems," *IEEE Trans. Communication Technology*, vol. COM-16, pp. 513–525, August 1968.

Machines to crack the postal code

The postal code at the end of an address is the key to the automatic sorting system that the Post Office are installing. On the strength of their experience in developing similar equipment for other countries, Plessey have achieved a leading position as a supplier in the UK

1 Map of the UK showing the location of Post Offices which are currently planned to receive code sorting equipment

by Eric Jeffs

Automatic code sorting is being introduced to create the high-speed postal system of tomorrow in Britain. The outward signs of this transformation are the move to standardized envelope sizes and the introduction of alphanumeric codes at the end of addresses. These initial steps have not been well received by the public—the Post Office is a fair target for public criticism, much of which is born of a failure to realize the complexity of the service and the need for dramatic technical solutions to its problems. Some measure of standardization is necessary if machine handling is to be applied economically, hence the Post Office Preferred envelope sizes, and the address codes, translated into a binary phosphor-dot form, are the programmes which guide the letters through the sorting machines to their penultimate destinations, the postmen's bags which take them to the addressees.

Extending coverage of automatic sorting to the whole country will take some years. So far, only Norwich has a fully operational automatic sorting facility. Three more offices, at Southampton, Newport, and Croydon, are under construction, and the remainder shown on the map in **1** have been authorized and are in the initial stages of planning. But one office, at Stoke on Trent, has been let as a turnkey contract worth £500,000 to the Plessey Company, establishing them in a leading position as suppliers of mechanized postal sorting systems.

Sorting machines are the products of one division at the Plessey Electronics Group plant at Poole, Dorset. Their association with the Post Office in the UK is a long one, covering many fields, and they have played a significant role in the development of sorting equipment already installed. The experience is not, however, confined to the UK. Their Australian subsidiary has developed designs in collaboration with the Post Office there and were responsible for the installation of a 2M letter a day automatic system in the Sydney Mail Exchange, and in the United States Plessey Airborne Corporation have subcontracted for the mechanical handling element of a US Post Office automation scheme.

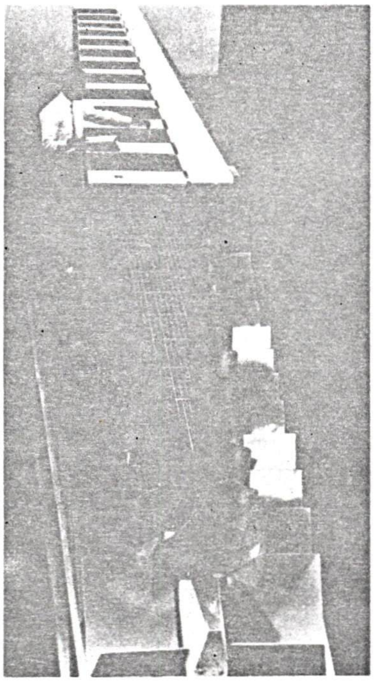
Postal mechanization is not therefore exclusively British. The evidence of its intended adoption is there in many addresses in many countries. American addresses terminate in a 5-figure zip code. Canada is trying to construct a code system that will integrate with the US codes in the same way that direct distance dialling covers the telephone networks of the two countries. Australia also has a numerical code, but in the UK it is alphanumeric.

The British postal code is constructed from the analysis of the delivery network in each postal district. An example is the hypothetical address of a Mr A Whiterose, 100 Minster Road, York YO1 6EB. In it, 6EB defines the postal round in which the house is located. It may be a street or a single building and is determined by the volume of mail at first delivery each day. Thus the round can be constructed so that it can be divided up according to the availability of postmen so that each has an equal load. The YO1 defines the district office, in this case, in York. If Whiterose's address was a place of business with a sufficient volume of mail, the 6EB might be an exact identity. Then, in theory, it would be possible to write Mr A Whiterose, YO1 6EB on the envelope and still expect delivery. But what happens to the letter en route?

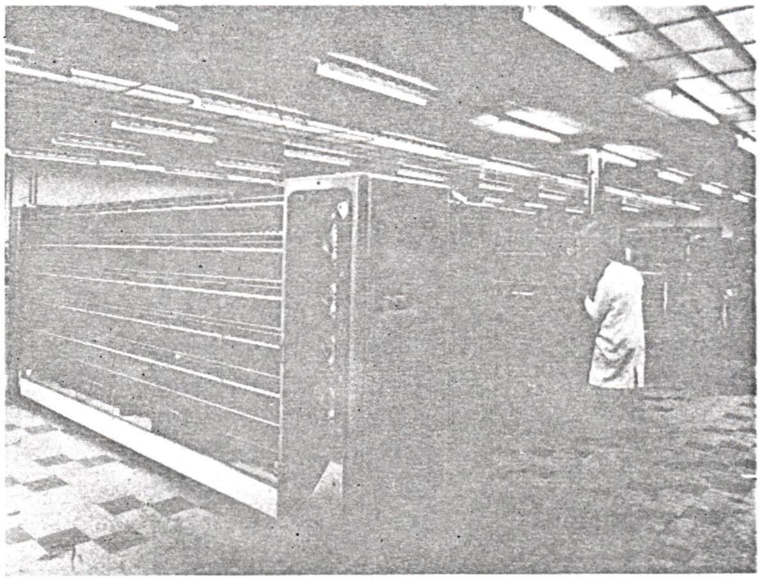
The bulk of the mail on any one day is handled between 4 pm and 9 am—around 80%. This is collected up and taken to the outward sorting office where it enters a segregator. This is simply a rotating drum formed from a number of slats with slots between, through which any letter less than ¼ in thick falls on to a conveyor. This conveyor feeds the letters through a set of pinch rollers which deposit them on their long edges on a second conveyor. Further pinch rollers set above this conveyor remove envelopes whose dimensions fall outside the POP size. The remainder are stacked in three groups to be fed to the automatic letter facing machine, ALF.

ALF can process 20,000 letters an hour, segregating first and second class and unstamped mail, cancelling the stamp, and stacking the letters ready for coding. The ingoing envelopes may have the stamp leading or trailing, facing towards or away from the scanner. The reading heads are sensitive to the emission from the phosphor stripes on the stamp. The value of the stamp is recognized by counting the number of stripes, but if the first scan produces no response the envelope is diverted on to a separate path which causes it to turn over before joining the main stream again. If there is then no response, the letter is transferred to the postage due stream. The bulk of letters are separated into those of each class with the stamp at the leading edge and those with it at the trailing edge. The reading heads can also identify the red ink of prepaid postage marks and the black of Official Paid mail.

The transfer to the coding machine is done by hand. Partly this is a buffer between machines of differing speed and



2 Plessey large letter sorter takes non POP sizes and enables manual sorting to be speeded up



3 Medium speed letter sorting machine can sort 8,000 letters into 144 compartments every hour. Gap between letters enables vertical gates, right, to be cleared before the next enters the system

4 Plessey coding desks at Croydon Head Post Office are one of the earliest units in the UK. The design was developed in collaboration with Post Office engineers

partly the result of economic necessity in cramped conditions. Many British Post Offices are old buildings which could not be economically adapted to take a completely automatic system.

The letters are fed into the coding desk so that they drop into a window above a keyboard. The operator types out the address code, and the signals from the individual keys are fed into a translator which generates the signals that print the phosphor code on the envelope. In the example, the YO1 is printed below the address at the bottom of the envelope and the 6EB at the top. If the letter carried no code, it would be possible for the operator to apply an extract code which would at least get it to the correct district office at York. There a similar extraction would be made to locate the part of the round containing the actual house.

The coding operation eliminates the need for further human intervention in the actual sorting process. The initial sorting can be performed on the coding desk to separate local from distant addresses. In the Sydney office, the sort is even more precise due to the simpler structure of the postal system and the layout of the office. A conveyor system runs under a bank of coding machines and the letters drop into the appropriate channel. With a smaller population concentrated in a few large cities, Australia has only five main postal centres like the Sydney Exchange.

The main sorting operations are carried out in an automatic machine as shown in **3**. This has 144 separate pigeon holes on four levels and can handle 8,000 letters an hour. The envelopes are fed in at the bottom, long edges to the front and stamps to the rear. This ensures that the two parts of the address code appear consecutively, which makes for easier interpretation. An ultraviolet source is exposed to the phosphor pattern and a detector reads the emission pattern. The signals are translated into command impulses which cause the appropriate gates to open to direct the envelope correctly.

The heart of the translator is a matrix of magnetic core switches through which individual circuit wires are threaded. Each wire, and hence each command circuit, can only be excited when the cores correspond to a given address code are energized. Each sorting programme has its own matrix which must be manually changed by a series of simple plug connections.

Plessey recognize that there is scope for a computer in the translation function. They have a suitable processor which could replace the matrix system. It is, however, a design for the future and it could well be that a foreign customer will be found for it first. This is not to accuse the Post Office of excessive conservatism—in many respects they are in advance of other countries—but the present system of collaborative development with industry dictates the speed with which technical innovation is introduced in a complex exercise where standardization can pay dividends in reliability early on.

When it comes to seeking new ideas in materials-handling equipment, fluidic devices, with their inherent advantages of few moving parts and rugged construction, offer a natural avenue of investigation. Here are two fluidics-based mail-handling techniques being evaluated for the Post Office Dept.

Fluidics Moves the Mails

C. E. SPYROPOULOS

Harry Diamond Laboratories, U.S. Army Materiel Command

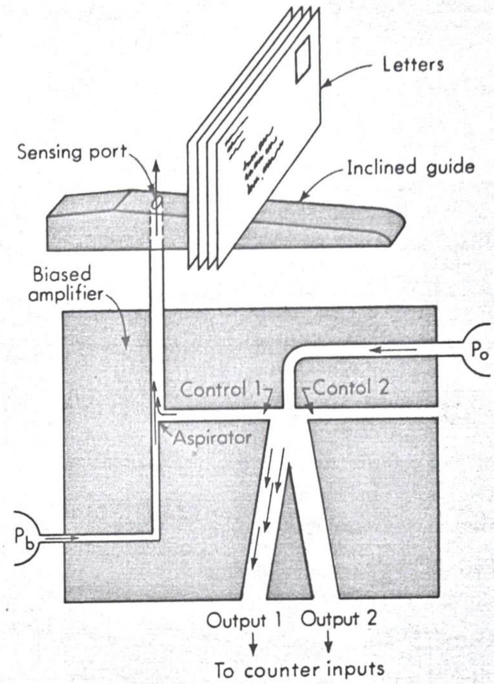


FIG. 1. Fluidic stacked mail counter.

Feasibility models of fluidic devices designed to count stacked mail in trays and to "singulate" the mail, a Post Office term meaning to withdraw a single letter at a time from a stack of letters standing on edge, have been built by Harry Diamond Labs. Fluidic circuits are being used for sensing, counting, logic, and letter acceleration, eliminating the need for complex electromechanical devices.

Fluidic mail counter

A system has been devised for counting stacked mail in trays as it passes a pickup head on a conveyor system. The counting does not interface with normal operation, and can be made automatic if desired. The system is designed so that all outlets exhaust in normal operation and, as a result, fibers shed from the letters cannot be ingested.

Here is how it works:

Mail to be counted is placed in a standard-type mail rack, modified by three narrow slots cut along its base (Figure 1). Counting is done by passing the edges of the vertically stacked row of letters over a sensing port located on an inclined guide in a sensing unit. The sensing unit also contains a biased fluidic amplifier and a fluidic binary counter.

As the edge of each letter blocks the sensing port, the fluidic amplifier changes state, triggering the binary counter. Air jets located above the sensor are directed downward between the letters to assure adequate letter separation during sensing. System sensitivity is assured by raising the sensing ports above the letter guides and making the guides elliptical, with their major axes in line with the edges of the letters.

The letter-edge sensor itself consists of an aspirator and a load-insensitive bistable amplifier. Air flow is introduced into the binary amplifier at P_o and into the aspirator at P_b (Figure 1). Flow introduced at P_b causes aspiration of fluid from control port No. 1 of the binary amplifier, and the mixed flow exhausts from the sensing port. When the aspirator lowers the pressure sufficiently at control No. 1, the amplifier becomes biased to output No. 1. The result is a quiescent condition in the system.

As a letter begins to pass over the sensing port and its edge partially blocks the jet, a portion of the flow from P_b is diverted to the amplifier's control No. 1, causing the output of the element to be switched to output No. 2. When movement of the letter unblocks the sensing port, the aspirator switches the amplifier back to output No. 1. Thus, as a stack of letters sweeps past the sensing port, the output of the amplifier changes state twice each time a letter passes over the port.

A ten-stage binary counter counts the output pulses from the sensing circuit. Each counter stage contains a buffer amplifier and a logic circuit. The outputs of the sensing circuit are fed into the controls of the buffer amplifier of the counter's first stage, which returns to its original state after every second input pulse. In the feasibility model, readout is obtained by connecting one output from each counter stage to transparent vertical cylinders containing pistons.

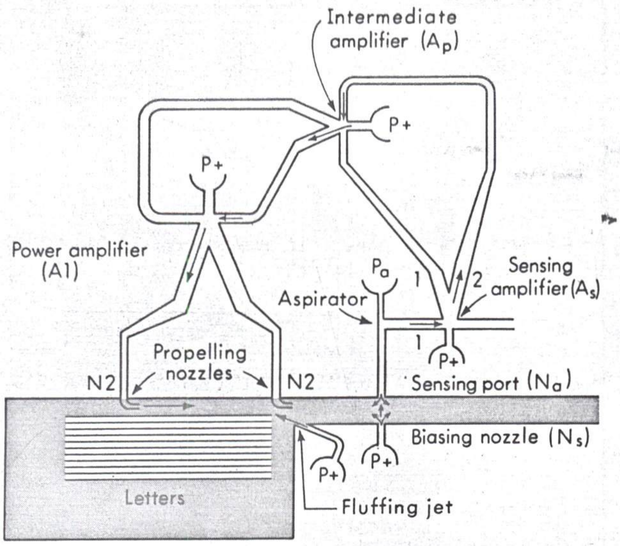


FIG. 2. Fluidic mail singulator.

When the piston is down, the cylinder is in state 0; when it is up, the cylinder is in state 1.

When counting mail in trays passing along a conveyor, the counter can transfer its binary output to a card on the side of the moving tray that gives the binary count of the number of pieces of mail in that particular tray.

Fluidic mail singulator

To be faced, canceled, or sorted, letters must first be separated from a stack and individually transported to a work station. This process is commonly referred to as singulation. The usual requirements for a singulation system—that it be rapid, inexpensive, and as maintenance-free as possible—are all met here; and in addition wear on the letters is minimized.

Like the mail counter, the fluidic singulator uses shop air and is designed so that in normal operation all outlets exhaust to atmosphere to avoid system contamination by ingested fibers from the letters.

As shown in Figure 2, the singulation system consists of a letter-acceleration station, a letter position-sensing station, and a horizontal guide on which the letters are transported. The speed of each letter is accelerated by horizontal air jets blowing between the moving letter and a vertical wall. The entrainment of the jets reduces the pressure between the letter and the wall, thus drawing the letter toward the wall. At the same time, a drag force exerted on the face of the letter by the turbulent boundary of the air jets slides the letter along the wall. The letter moves to a sensing station where its leading edge turns off the first pair of jets and turns on a second pair located downstream from the first jets. The second pair of jets exhausts between the letter and the vertical wall, causing the letter to accelerate.

The next letter in the stack remains in place until the trailing edge of the preceding letter moves beyond the sensing station. Then the first set of air jets is activated again, causing the second letter in the stack to be singulated. This cyclic operation continues as the letters, one by one, are transported along the horizontal guide.

The logic controlling this operation is shown in Figure 2. Air supplied to each of the propelling nozzles is obtained from the output of bistable amplifier A1. One or more fluffing jets may be directed between the letter being singulated and the following letters in the stack to reduce friction between the letters and make sure that only one letter moves at a time. This air flow may be directed from above, below, or in front of the first letters in the stack. When directed from the front, the fluffing jet not only separates the letters but also causes a slight force on them in a direction of motion of the letter being singulated. This helps to hold back letters not yet scheduled to be moved.

Biasing nozzle N_s and sensing port N_a are located at a fixed distance downstream from propelling nozzles $N2$, at a fixed height above the horizontal guide, and they exhaust across the direction of travel of the letters. When a letter is at the sensing port, the biasing jet from N_s does not interact with sensing port N_a. Air introduced into the input of the aspirator at P_a flows unimpeded from N_a, causing aspiration of fluid from control port No. 1 of bistable amplifier A_s. When pressure is lowered sufficiently at control port No. 1, amplifier is biased and the fluid issues from output No. 1. At this point, if the sensing port is clear, air from nozzle N_s interacting with the output of the aspirator at N_a raises the pressure at control port No. 1. This causes the amplifier to switch and exhaust from output No. 2.

The output of sensing amplifier A_s is in turn amplified by intermediate amplifier A_p, which controls the state of power amplifier $A2$. Thus, when amplifier A_s exhausts from output No. 2, amplifier $A2$ exhausts through the first propelling nozzles ($N1$). The first letter of the stack then accelerates under the influence of the force exerted on it from this nozzle.

When the leading edge of the letter reaches the sensing station, the air jet from nozzle N_s is unable to interact with the jet from N_a and the aspirator exhausts through N_a to atmospheric pressure. Pressure at control port No. 1, which switches amplifier A_s to output No. 1, is lowered, and $A1$ switches from the first propelling nozzles ($N1$) to the second ($N2$).

The next letter in the stack remains stationary as the second propelling nozzle $N2$ continues accelerating the first letter—until the trailing edge of the first letter passes the sensing station. At this time, amplifier A_s is once again switched to output No. 2 and amplifier $A1$ switches to the first singulating nozzle. The next letter in the stack at once starts to accelerate. This operating cycle continues as the letters are picked off one at a time and propelled along the horizontal guide. □

Product
Engineering

Post Office is beginning to enlist technology for handling mail

The postal system has surprisingly sophisticated equipment—but not enough. Optical readers now handle typed addresses, and it wouldn't be too difficult, says one expert, to process all letter mail automatically

The happy side of last month's paralyzing walkout of postal workers is that the strike brought to the front page what's long been known and longer ignored: The Post Office is the most under-engineered organization in the nation. Indeed, Ben Franklin would feel right at home at most of the 32,250 branches that span the country today.

The reason is obvious. Postal service has grown like Topsy, but postal authorities have failed to automate as the volume burgeoned. Until very recently, new procedures have almost never been tried. The typical approach to handling more mail has been to hire more men to do more of the same.

The increased labor cost resulting from the recent settlement will make the need for automation even more pressing. Right now, postal revenues of nearly $6 billion barely cover the wages of the system's 720,000 employees. Congressional appropriations are necessary to cover building costs, equipment buys, research, etc. Postal fees would have to skyrocket to cover all expenses.

Running to stand still. Fortunately, the move to automation has been accelerating in the past 3 years, and if the Post Office has its way, it will continue to gain momentum in the future. Since the Department has not kept pace with technology, officials are now finding they must spend large amounts on development projects just to catch up. This year, the research and engineering budget amounts to $60 million—only 1% of the Department's total revenue, and not much as big R & D budgets go, but that's more than 100 times what the Post Office spent on research and engineering only a few years ago.

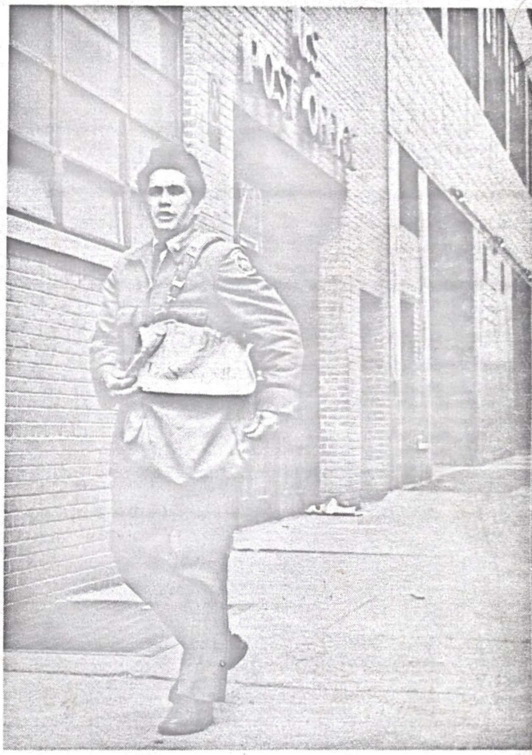
As a practical matter, R & D in the Post Office today is more "D" than "R." Says one postal researcher: "Just to catch up with the state of the art is a superhuman job. And besides, there's no reason to push technology for the kinds of jobs we want to do."

Some advanced equipment already. Put simply, the postal research job is to develop machines for moving the mail quickly, reliably, and as cheaply as possible. Ideally, the mail would never be handled by humans. The ideal, however, is impossible even with today's sophisticated optical character reader (OCR). Ten OCRs—Model Ones, built by Philco-Ford—are now in use throughout the country, and the Post Office has 10 more on order.

A. P. Hanes, chief of the Letter Mail Processing Div. in the Bureau of Research & Engineering, reports that only 75% of the mail fed into the OCRs is readable. Unlike the standard in a manufacturing operation, however, a failure rate of one in four is tolerable for mail handling. When a letter is rejected, it's merely set aside for hand sorting, with no appreciable time lost. Even with only 75% success, the OCRs handle 8000 letters an hour. They take the place of 12 human sorters and pay for themselves in a little more than a year. (Unlike some unionized employees in industry, postal workers don't seem to resist such displacement, probably because of their guaranteed job security.)

For outgoing mail, the OCRs read the city/state/zip-code line, and they program a delivery system to drop the letter into one of 277 receptacles. The reader is connected to a memory with 40,000 entries, accounting for all possible spellings and abbreviations of common addresses. The reader compares what it sees with the memory bank, and if it has read either the address or the zip code completely, it earmarks the letter for the correct location.

The Model One can be less than 100% successful if, for instance, it reads just the state. The letter is then sent to a receptacle that covers a somewhat broader area. But the equipment is not sophisticated enough to interpolate: It can't recognize that "Bro-klyn," for instance, is Brooklyn, at least not in all cases.

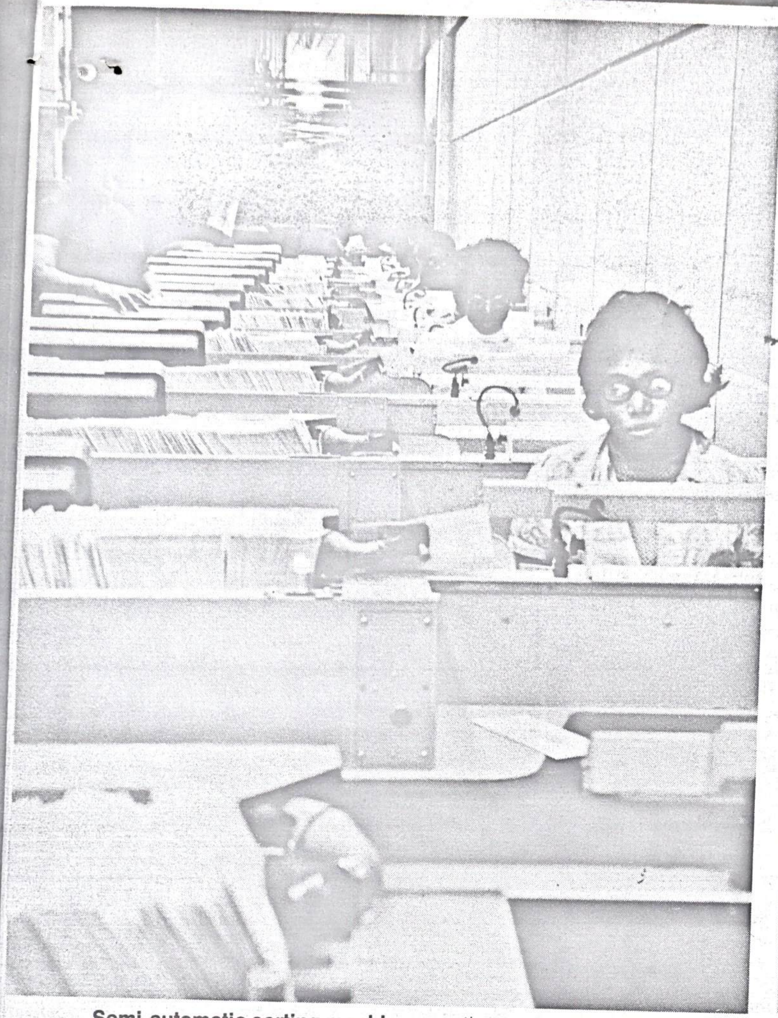


Neither snow nor rain nor heat . . . but perhaps strikes, if an engineered approach to processing mail isn't used.

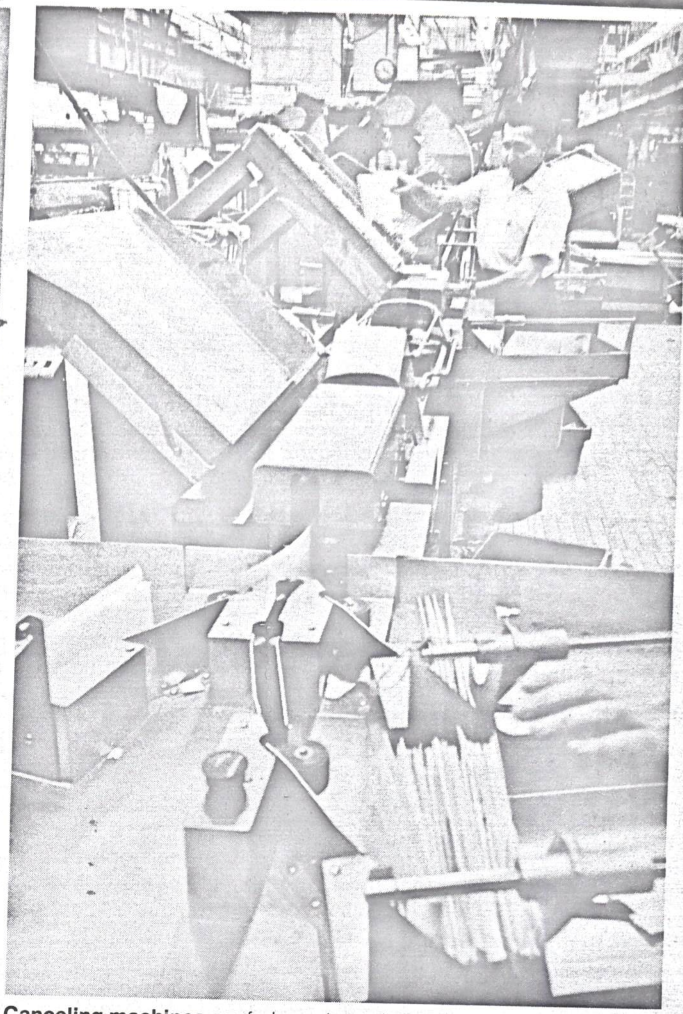
Improvement sought. For mail coming into a city, the OCRs read the street-address line to make a similar sort. But either way, the machines are used only for "high quality" addresses such as those that commercial customers print automatically. Post Office officials would like to develop an OCR to read and sort all the way down to the individual carrier's route, but they're pessimistic about their chances, since, they say, the memory for such a system would have to be larger than what's currently feasible.

But work is progressing on an advanced OCR that can read more than one line of an address at a time. The new models will be tested starting sometime in the coming fiscal year.

So far, the Post Office has made no attempt to sort general mail with optical readers, and postal researchers don't think it's feasible in the near future. But



Semi-automatic sorting machines are the most common today. Machines feed envelopes one by one—with help of swiveling suction arm—to operator, who keypunches destination. Special training is necessary to teach operator code.



Canceling machines are fed envelopes in any orientation. They locate stamps and discharge envelopes into four different slots, covering all four possible orientations. But they can't find postage marks affixed by office meters.

experts in industry disagree. "Script-reading machines are possible," claims Jacob Rabinow, a vice-president of Control Data Corp. and a leading expert on optical character readers. Rabinow is also an authority on postal equipment. While with the Bureau of Standards in the mid '50s, he first proposed semiautomatic sorting machines, which were later built for the Post Office by the Burroughs Corp. and are still in use today.

Rules needed. "After all," Rabinow explains, "to read envelope addresses, a machine really only needs to recognize a few words. Certainly it's possible to design a machine that can read hand-written numbers, at least.

"With a few simple rules, the Post Office can easily automate letter-handling completely. The problem is that the department has been much too timid. Right now, for instance, it's studying the possibility of using phosphorescent ink or two colors in meter stamping machines, because the Department's canceling machines can't locate the light meter lines as they can ordinary stamps. There's no need for anything like that if postal authorities instructed the public to stick to some basic procedures."

Rabinow's list of basic rules is surprisingly limited. First, he says all envelopes should be sealed—tucked-in flaps should be done away with. Envelopes should be light-colored with dark printing, and practically any shape except square. On the back of the envelope, the upper right hand and lower left hand corners should be completely blank—the mailer could write or print as much as he liked everywhere else. On the front, the stamp or meter mark should be in the upper right hand corner, the return address at the upper left only. The forwarding address, Rabinow says, can be put anywhere else.

It would help, he adds, if envelope manufacturers settled on a few standard-size envelopes, instead of the infinite variety now offered. But other than that, he claims nothing else would be necessary for engineers to design all the equipment the Post Office needed.

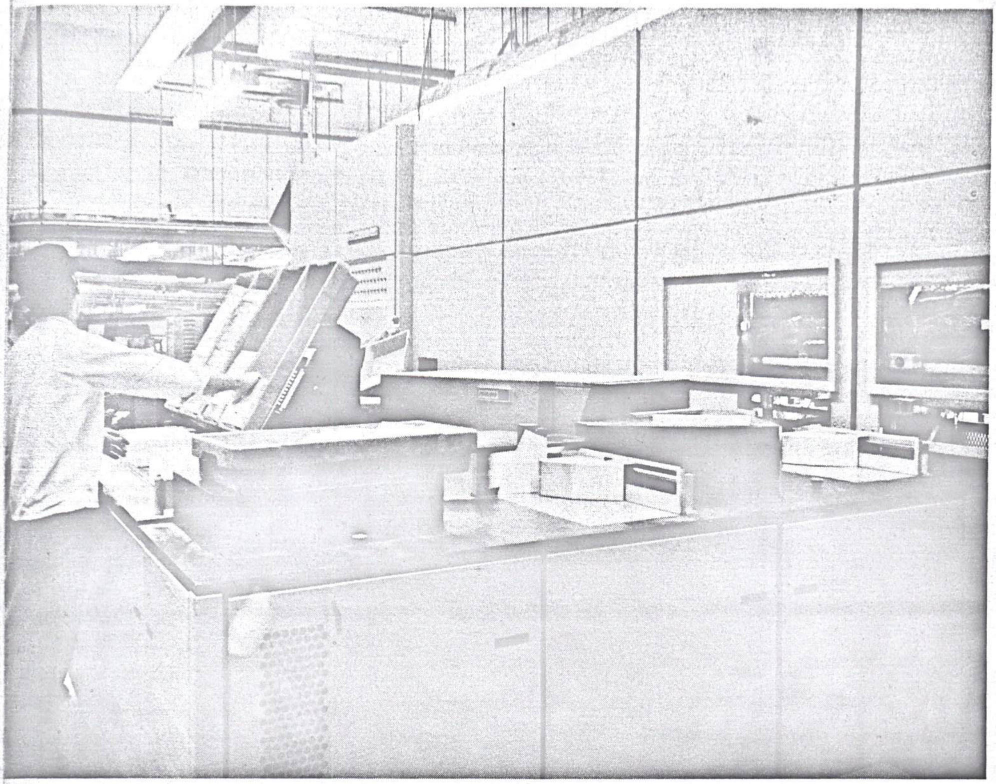
No zip code? Surprisingly, Rabinow doesn't stress the zip code. In fact, he bemoans it. "I'm opposed to any postal scheme that requires some action on the part of the system's 200 million customers, except for adhering to the few rules I've mentioned. Besides, it's easier for OCRs to read words than numbers, for handling mail at least, because of the redundancy inherent in a word. A machine can miss part of an address and still figure out what's meant, but what can it do when it misses just one number in a zip code?"

Rabinow cites other inherent disadvantages of numbering systems. "The Post Office has just about got the public trained to use zip codes," he explains, "and it's already discovered that five digits aren't enough. Zip codes can't break the mail down to the local street addresses. So now the Department is faced with the dilemma of either telling all the bulk mailers to change their address banks, or living with the shortcoming. I predict zip codes will eventually disappear."

Rabinow argues that any mail that doesn't fit his guidelines should be considered a package, whether it is or isn't. The customer wouldn't be forbidden to violate the rules, but any mail that didn't fit the guidelines would obviously take longer to reach its destination, and might cost more as well.

Packages studied, too. Packages amount to only about 1/60 of the unit volume of the Post Office, but in cube volume—perhaps a more meaningful measure—it accounts for almost half.

A prototype system for handling packages is now being built in Secaucus, N. J. When it goes into operation in 1971, it



Optical readers are surprisingly sophisticated, though probably not the most advanced systems that can be designed today. Operator merely stacks envelopes in feed bins in front of him. Reading head is around corner to his right. Automatically programmed conveyor is behind wall at far right of machine.

will be an elaborate semi-automatic model for handling an even flow of mail during a 16-hr. work day. The system calls for an operator to read the address and punch in a code that is fed to a computer memory bank. He will then place the package on a conveyor belt, and the machinery will automatically route it into the proper storage area for truck loading. George Cavell, who heads the development effort for nonletter mail handling, hopes eventually to develop an OCR "wand" that would read the tags on parcelpost bags automatically.

The Department is also having RCA study the possibility of using voice-actuated machines, which would free the operator's hands for loading only. (RCA is heavily involved in voice-actuated systems and is currently studying one for NASA as well.)

Here again, Rabinow disagrees with the approach. "I recommended that they develop a machine to recognize special sounds that could be taught to the operator. It's difficult for a machine to understand English, but an operator could easily learn, say, ten sounds in some machine language corresponding to the digits."

Momentum there, at least. One thing that Rabinow, Hanes, and Cavell do agree on: The postal system should be better in the future. "Things are changing," says Rabinow, "but traditions are strong in the Post Office."

But while the postal engineering staff doesn't talk about it, Rabinow is quick to point out a critical turning point coming up: Much of the hope for postal modernization rides on the Administration's proposal for turning the Department into a government-owned corporation, like the Tennessee Valley Authority.

Currently, all modernization attempts must be authorized by Congress. The processing time is painfully slow and the outcome too often tinged by a political battle. A postal corporation would have the power of quicker decisions on financing development projects. It would also be staffed by officials appointed on merit, not favoritism; and presumably they could then serve for long enough periods to plan and develop long-range improvements.

Furthermore, adds Rabinow, "The corporation could—and should—have its own research laboratories, where it could do much of the work itself. It's a $7-billion business, yet its engineers do no more than call shots from their desks—and that's not engineering." [1.21; 6.322; 11.6]
A. J. Parisi; W. Hickman, Washington

Paper close to oxygen may have downed Apollo

Incredible though it was, astronauts Lovell, Haise, and Swigert limped the 300,000-mi. circumlunar loop home in their half-dead stack of spaceships, proving the extraordinary versatility and the reliable redundancy of the Apollo equipment. By the time they were picked up in the Pacific, their life-saving lunar module and the telltale service module had both burned up in the atmosphere.

Overpressure. NASA officials say the pressure in the oxygen tank that ruptured rose from 935 psi to "over 1000 psi" before plummeting to 0 in less than 1 min. During flight, the tank pressure is supposed to be 900 ± 35 psi. There's a poppet relief valve for each tank; they begin to open at 983 psi and reach wide-open position at 1010 psi. The tanks are designed to withstand a pressure of 1530 psi.

It's conceivable that if the relief valve for Tank 2 failed to open, the pressure buildup might have ruptured the container. But it is unlikely that a simple expansion—however rapid—could have accomplished the staggering damage the astronauts saw after they jettisoned the service module. An explosion—that is, a combustion and shock wave—seems more plausible.

Paper in fuel-cell bay. The question is, what burned? The spherical oxygen tanks have an inner shell slightly over 25 in. dia. (0.061 in. thick) and an outer shell about 26½ in. dia. (only 0.020 in. thick). The 1½ in. between the two Inconel shells is first evacuated, then filled with fiberglass insulation, aluminum foil—and paper matting.

Possibly, a slight leak developed in the inner shell, filling the gap with oxygen. If this happened, the paper could have been ignited by some kind of spark from the tank heater. A chain reaction would have culminated in the "bang" the astronauts heard.

Each tank is equipped with a heater that maintains the pressure. There are also fans to circulate the fluid, and sensors to measure the pressure, temperature, and quantity. The tanks begin the mission with 326 lb. of oxygen each. By the time the mishap occurred, each had about 250 lb. left.

Interestingly enough, an official with a top contractor on Apollo 13 says that one of the oxygen tanks "appears to have had an abnormal amount of abuse." He explained that the tank had been installed in a previous spacecraft, then removed and later installed in the Apollo 13 service module. [1.211]

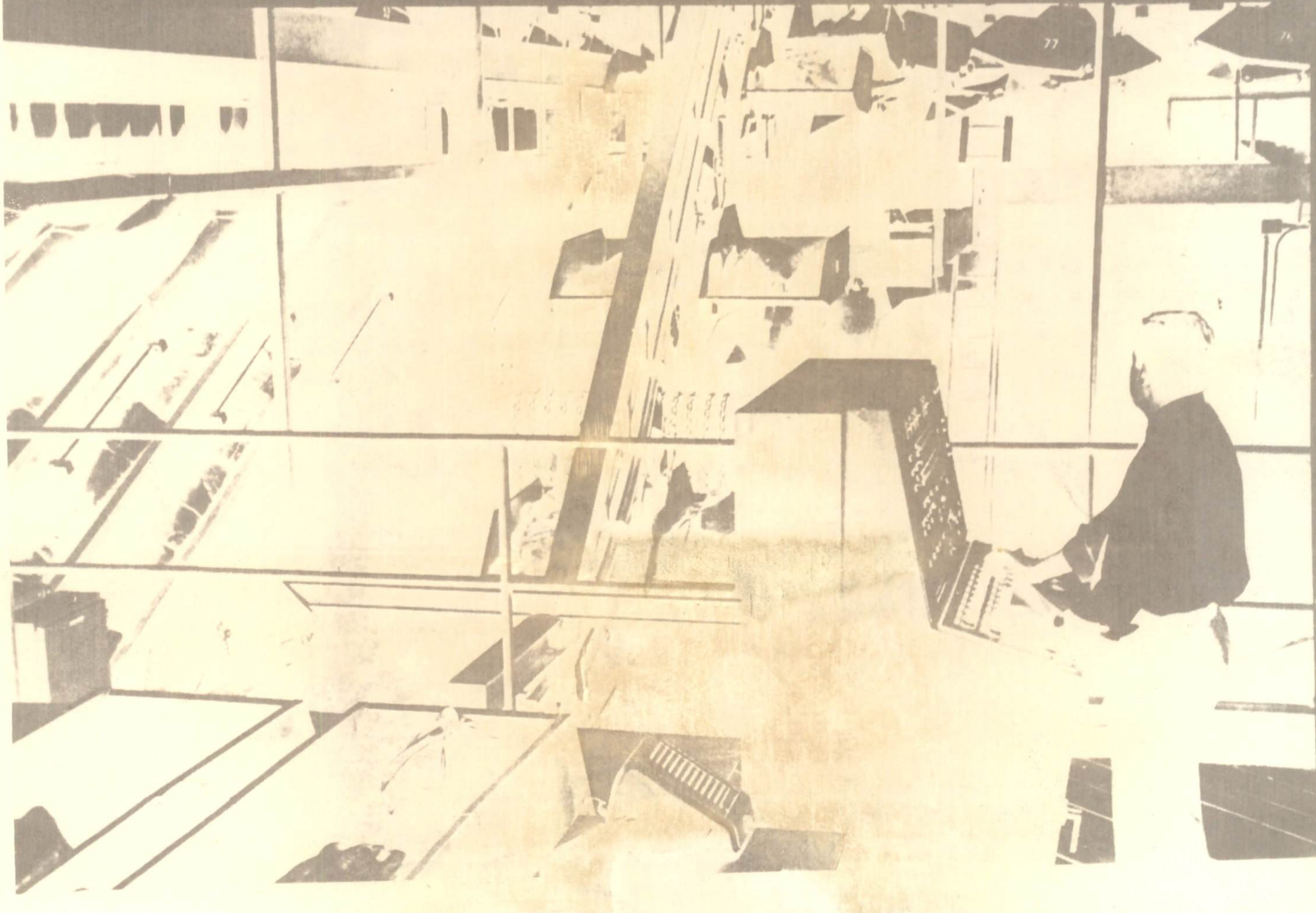
STANLEY KLEIN
Regional Editor

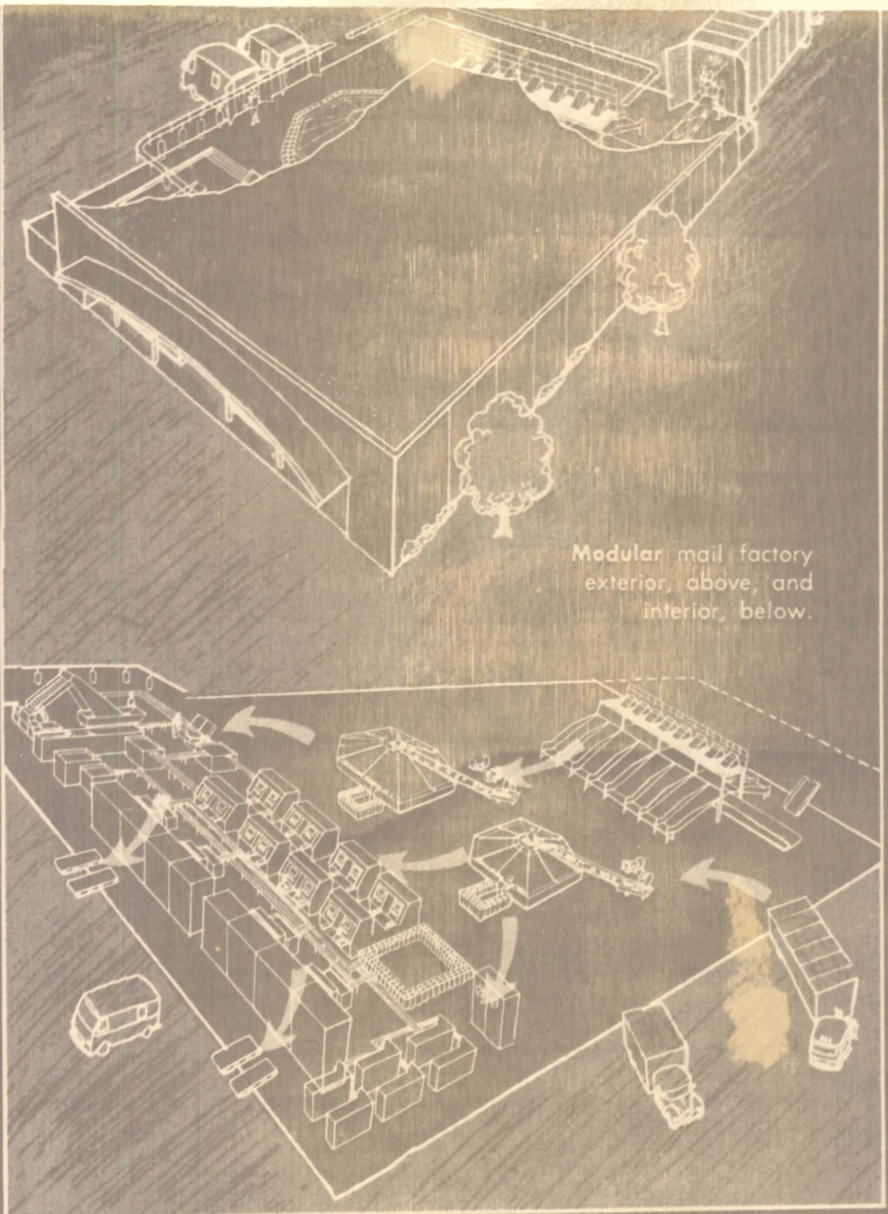
A TECHNOLOGICAL SLEEPER: MECHANIZING THE MAILS

WHEN research and development budgets had to be axed during the waning inflation-riddled term of the Johnson Administration, one of the few programs to escape intact was that of the Post Office Department. Such favored treatment testified to both the urgency and viability of the government's newest and fastest growing technical venture—the automation of the mails. A relatively unpublicized affair overshadowed by lunar landings, ocean habitats, and artificial hearts, the drive to develop a first class engineering and research capability within the postal system, nevertheless, represents a radical innovation in the management of the multibillion dollar operation. It is giving rise to a mushrooming source of opportunities for engineers, scientists and businessmen and, in many ways, poses a challenge to the Nation's technology.

Behind the research thrust, of course, is a widespread concern

Sack handling and sorting, often done manually, poses a weighty problem. Here, an FMC prototype system, installed at Oakland, California, automatically transports, sorts, stores, and dispenses sacked mail and parcels at a rate of 2,000 items per hour.

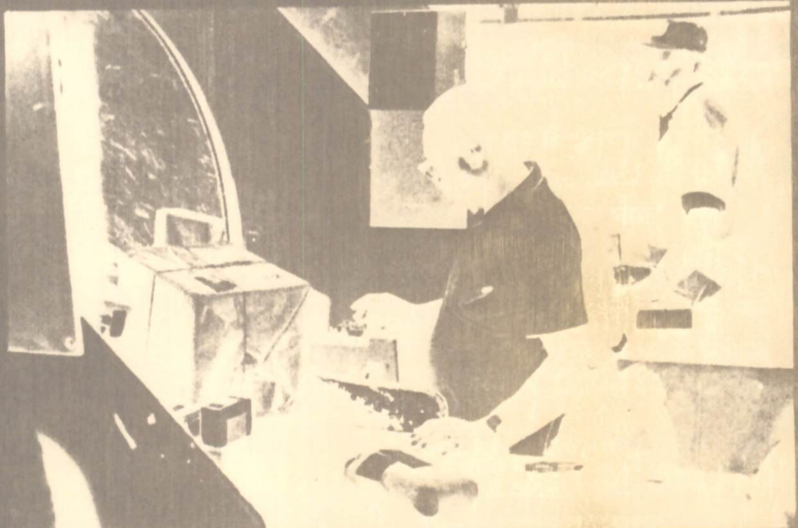




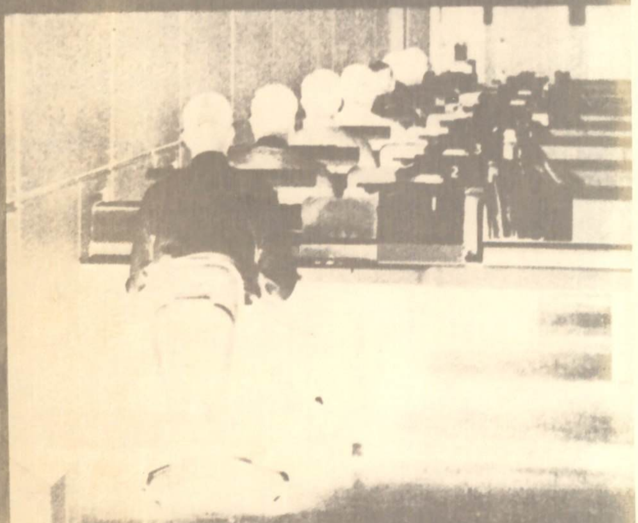
Modular mail factory exterior, above, and interior, below.

Mail Factories

As one of its final acts, the outgoing Johnson Administration recommended a change in the construction of post offices away from the public monument style located in congested center cities to a "more appropriate" single design built adjacent to arterial highways in outlying areas. These "mail factories" would be constructed so that future mail growth would not require a new building, but only an extension on land already set aside. Under the concept, the buildings would all be constructed from a master set of plans—one designed for warm climates, another for cold. Each facade would be varied to meet esthetic wishes of individual communities, but the basic inner-box comprising the work area would always be identical.



A parcel-sorting system, wholly controlled by computer, is being built by the Jervis B. Webb Co. for the new Boston postal complex scheduled for completion in 1971. Instructions are fed to the computer by an operator who punches the zip code of each parcel into a keyboard terminal. A central control unit, developed by Milgo Electronic Corp., then routes the parcels to destination bins on conveyors.



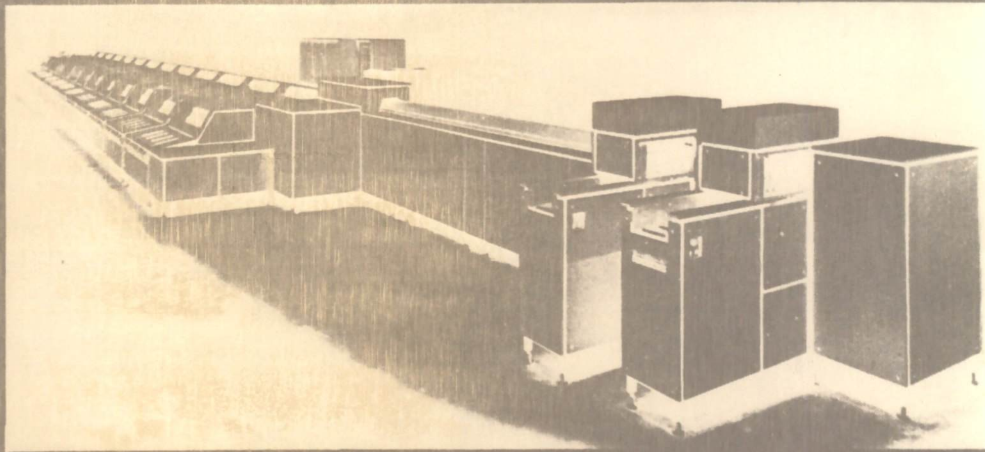
Eight-position letter sorting machine from Burroughs. Improperly coded letters are dropped automatically into a reject bin.

over the wretched condition of the nation's postal complex, which has led to deteriorating mail service, rising postage rates, and mounting deficits. A thorough study by the President's Commission on Postal Organization judged the postal system to be in "serious trouble" because of "decades of low priorities assigned to its modernization and management needs." "Bring back the pony express!" is how the New York *Times* whimsically summed it up in a recent headline.

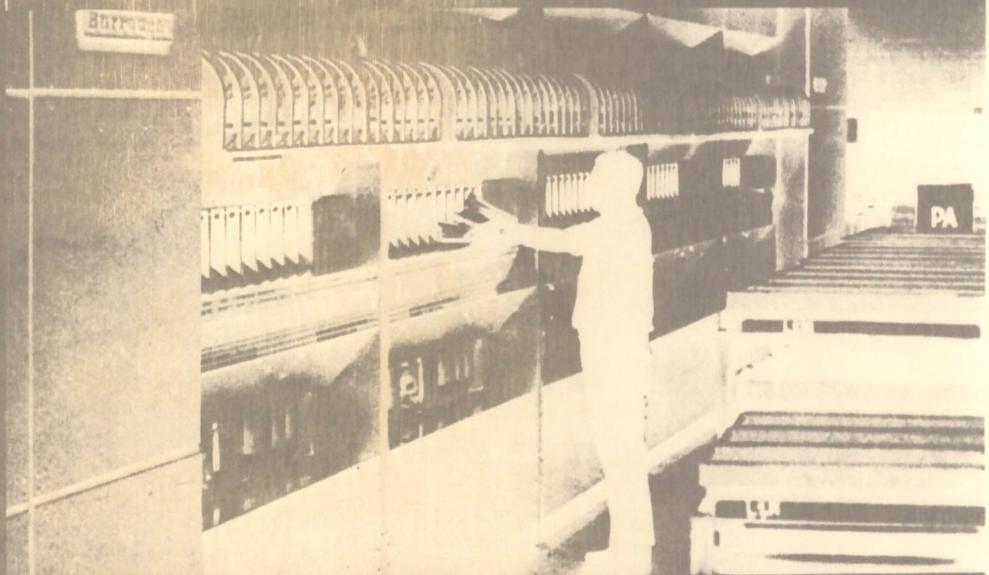
Just how badly the neglect has been is reflected in an R&D budget that, for all of its recent growth, is still less than 1% of postal revenues. Capital investment expenditure amounts to a meager $1,145 of net fixed assets per employee. (The latter figure may be compared to $151,710 for power utilities, $25,053 for transportation, $7,170 for manufacturing, and even $2,836 for merchandising.) Understandably, postal productivity has gone up only a negligible 2.5% over the past ten years at the same time the private sector increase has averaged 34%. Since mail volume was climbing 50% to 90 billion pieces during the same time span, more and more people had to be hired to process the increasing workload, until now the postal labor force numbers 720,000. The average salary, meanwhile, has risen 56%. In what has thus become an extraordinary labor intensive operation, personnel costs come to 80% of the total postal budget. Without adequate automation, deficits and postal rates are now not only likely to soar further, as the extrapolation of trends suggests, but also the postal system threatens to break down entirely as occurred in Chicago two years ago.

No Load Control

A serious constraint that severely taxes the postal operation is, like other public utilities, the lack of control over peak loads which occur seasonally, but particularly, at the end of each business day. Also, the raw mail contains items of greatly varying sizes, weights, thicknesses, enclosures, and address legibility, all of which strain both men and machines alike, especially the machines. Thus, what otherwise might be an ordinary factory-like function, the processing of mail becomes a highly sophisticated materials-handling problem that entails culling, facing, canceling, address reading,



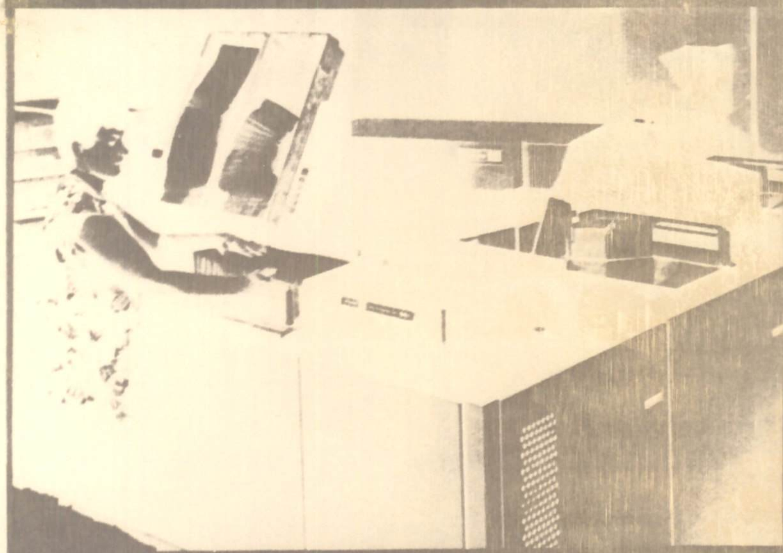
Letter sorter, from FMC, is being tested at the Postal Laboratory in Washington, D. C.



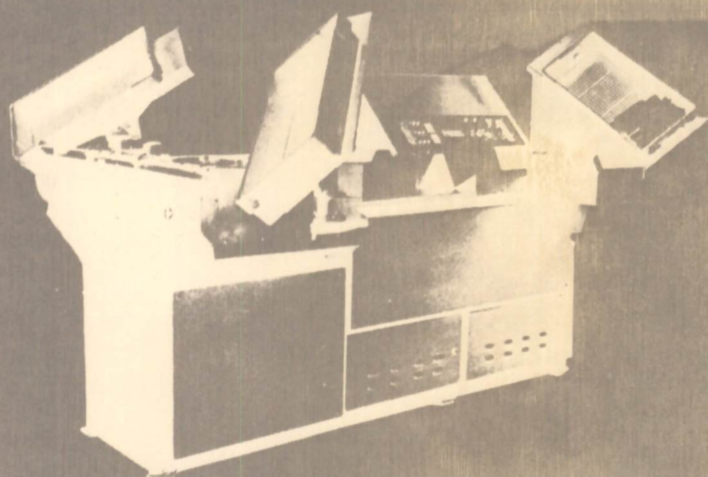
Operator removes sorted letter from the pockets of the machine.

Speeding the Sort

THE CLASSIC post office setting of a clerk perched on a stool stuffing mail into a bank of pigeon holes is being altered by high-speed sorting machines. Letters, carried automatically by conveyor, are passed in front of trained operators, who key routing instructions into a terminal according to sort schemes committed to memory. Each letter is then whisked away to one of 277 destination bins. Light indicators and audible alarms alert workers stationed in the rear of the machines when a bin is nearly full. When interfaced with optical character readers, as many as 12 keyboard operators can be replaced. By the year's end, 178 of Burrough's machines are to be installed in 71 cities; another design by FMC is undergoing trials.



Effective mail sorting requires the filtering out of letters that can not be read by optical scanners. A presorter, above, did not work out too well, so more efficient designs are being sought. The character reader, below, makes possible mail sorting at a rate of 36,000 pieces per hr. It reads city, state and zip code, then sends the piece of mail to one of 275 bins.



Automatic Address Reading

So CRITICAL has been the need for automatic address readers that Post Office-sponsored research in the field dates back to 1954. The new Bureau has even created a distinct unit to monitor its burgeoning programs in optical-character reading. As in 1954, the main thrust remains to aid the processing of letter mail.

Though still considered experimental, nine first-generation readers have been installed and are operating on-line. In the most sophisticated of installations, the reader is linked to automatic letter sorter machines. Each mail piece is scanned by the OCR to locate the address block. Relevant information is extracted and fed to a computer/directory which routes the letter to its appropriate bin via a conveyor system.

Because of limitations on first generation equipment, the mail processed by OCR must bear address impressions of high quality. Preselected mail, therefore, has to be used; this consists of carefully-chosen, first-class metered mail from high-volume mailers. Unfortunately, such OCR-compatible mail accounts for only a quarter of the total. Moreover, use of current equipment is being confined to "out going" mail where the machine need only locate and read the last line in an address, i.e., the zip code and/or city-state. OCR processing of "incoming" mail, which is inherently more difficult, entails locating the middle line of an address block and interpreting more varied and complex street designations.

To overcome these inadequacies and others, the Post Office is seeking an improved version of its current reader and advanced designs that will have a capability to handle degraded print, interference markings, poor address formats, a greater range of print sizes, and various color and patterned envelopes. In its quest, the Bureau is investigating a myriad of technologies:

- Electro-optical and all-optical techniques for scanning.
- Laser, as well as ordinary light, in the optical scanning systems.
- Digital and analog means for making logic decisions.
- Adaptive and non-adaptive processes for character recognition.

sorting, sweeping and tying, sacking, and dispatching. An additional headache is that postal schedules must be matched to the arrivals and departures of common carriers.

Even in those facilities, however, where the latest technology is used, the effects are not always salutary. Postmaster General W. Marvin Watson, who served under President Johnson, was stunned by a study that showed a highly mechanized post office to have lower productivity than one "from the horse and buggy era." He blamed the poor showing on a lack of systems integration in deploying postal hardware. Individual machines, he observed, are frequently operated "in isolation as islands of mechanization." A human to load, tote, and unload serves as the interface between the sundry mechanized stations.

Lack of Engineering

It was this total lack of tradition by the Post Office in systems engineering, industrial engineering, human factors, and R&D that prompted the President's Postal Commission to conclude: "The depressed state of postal productivity reflects not the performance of individual workers but the primitive state of postal technology." It observed that the productivity of major postal facilities could be advanced by as much as 50% through the use of such techniques as process control, scientific plant layout, worker training, improved production processes and mechanization, all used in conjunction with an overall systems approach.

Not everyone believes that a beefed up R&D and automation program alone will alleviate the

No one likes to receive anonymous letters, but in many cases we can understand why some people who correspond with this column would rather not have their names printed. We promised the author of the following letter, and any future people who request such treatment, to divulge nothing but their opinions.

Your March 20 issue had an article describing a current problem that has been misdirected—the mechanization of mail processing. The concept upon which the system is based has been selected by a theoretician who has lost contact with reality. The theoretician made the mistake Jocob Bernoulli described in "Arts Conjectandi" published in 1715. In the discussion that forms the basis for the development of statistics, Bernoulli divided problems of prediction into two different types—ones like predicting the weather where the outcome is controlled by the forces of nature or the will of man.

The basic error made in establishing the proposed mail system was in basing it on the ZIP code. This assumes that the problem is one like a game of throwing dice where all of the possibilities and probabilities are known. But the problem is like predicting the weather—all of the possibilities and probabilities are not known. The system assumes that all mail will contain the correct ZIP code and that the necessary optical reader can be successfully developed. The article states that there were no problems where pressure could be applied to the addresser to conform with the assumptions—high volume addressers had to conform but the cooperation of individuals was not assured. Even then, the lack of an effective optical reader made the operation possible only with outgoing mail.

Rather than design a new sorting system that is based on non-standard sizes and on location designators that all people understand and are familiar with, the original system designer made his job easy by establishing an arbitrary system.

The original design concept, then, set up conditions that produced a net loss for society. To make his job easy, the man who designed the system made more difficult the tasks of all those who use the mail. The Post Office Department on POD Notice 42 (September, 1967) gives this advice "for the addresses you write to most often:"

1. Check the return addresses on your mail and record the ZIPs in your address book.
2. Use the National Code Directory in the post office.
3. Fill out and mail special ZIP Locater Cards available at your post office.
4. Call the post office.

The error in logic made with the present system is the same one that had to be overcome to permit flight—man had always tried to imitate the bird. The Wright brothers got around this obstacle. The Post Office Department's error is in trying to develop a system based on a machine that acts like a craftsman. The industrial revolution was accomplished by substituting an assembly line for the craftsman—the high skill in one person was replaced by adding the lesser skills of a larger number of people. The development of the inspection function was the way the craftsman's pride in workmanship was added to the product.

Lest this be considered as an excuse for the theoretician, a second example involves the basic 200-year-old mail system and the theoretician's panacea for all problems—the computer. The computer functions in the same manner as an assembly line—its outputs are produced by performing a large number of simple operations in series. The theoretician sees the problem as one that can be solved by using the computer rather than using the operation of the computer as a model for the best process. For this reason the "dream system" appears as an arrangement of complex machines run by a few highly educated people who perform high-level functions. The "dream system" that can do the job in a socially constructive way is a "disassembly line" where the logic elements are trained workers performing simple tasks in series. The key to the success of the "disassembly line" is that the human workers are able to perform the function of direct reading.

Despite all of the publicity to the contrary, the ZIP system is not functioning in the advertised manner. The efforts to mechanize the process, as your article indicated, have reduced the effectiveness of it down to a level below that which is possible manually. This was determined experimentally as the result of a problem with my mail. The ZIP system makes it possible—this is amazing—to train people for a "disassembly line" operation. The Post Office Public Relations man who visited my home said that, using it, any new employee can sort incoming mail—the craftsman operation is reduced to a simple operation that can be performed by a person with little training. When (and if), by association with the ZIP code numbers, he learns the associated location designators, he can graduate to the higher level task of sorting the mail that is not ZIP coded. Any well-educated person, then, would not have tried to automate the mail by means of the ZIP code. Any person who had any experience would know that the feasibility of the automated system was questionable on technical and economic grounds.

Name Withheld by Request

"Do something, cried the editorial in the May 15 issue. Do something about the slow destruction of air, water, and land, and our crumbling cities and society. Most scientists do their part, it went on, but engineers and their societies tend to run off and hide. Of the people who reacted to the accusation, the following two letters are typical, and state that a whole new organization or society needs to be created.

After reading your editorial in the May 15 issue, my faith in the engineering profession as a social force was rejuvenated. But, sir, it also left me quite perplexed. I do not accept your grand-sounding idiom, "technological backlash," because it's true and effective meaning is obscured by jargonism in much the same way as gobbledegook obscures official government literature.

Government electronics

Computers replace clerks in parcel post prototype

Keeping manpower down while providing more service is a tricky task—but it's what the reorganized U.S. Postal Service was chartered to do. To pull it off, the service is eyeing computer-controlled, self-service stations that will eliminate the need for window clerks to handle parcel post at new locations.

Field tests of prototype hardware, which Design and Development Inc. of Cleveland built under a $325,000 contract, are scheduled to begin in November, says Thomas Lanyi, the program manager for the parcel post mailing facility. If they support the claim that the program will pay for itself in five years, postal engineers will next attempt to simplify the machine to reduce its cost and only then turn to industry for production. Ultimately, he adds, "a very large market for the units could result."

To use the prototype, the customer places his package on a built-in scale and punches in the parcel post code of the package's destination. The postage required is then displayed on cold cathode readout tubes and the customer inserts either coins or bills into the machine. A printer developed especially for this application then prints three copies: one for postal records, another that serves as the customer's receipt, and a third that is affixed to the package as postage. Postal rates are stored in one quarter of a custom-built computer's 4,096 words of 16-bit core.

Lanyi says that special postal restraints required a custom machine. One was that postal rates are nonlinear and could not be calculated with each use, so that special features had to be added for efficient table look-up. The other restraint was that rates change about once or twice a year. Since postal workers are at best semiskilled repairmen, the unit had to be easily reprogramed with available manpower. This was achieved by adding mechanical switches that change the values of the rates stored in memory.

Lanyi notes that the prototype is a "Cadillac" unit that will have to be simplified if it is to be widely used. But reducing unit cost—at present $40,000 in small quantities —will be easy, he feels. For one thing, the Design and Development machine offers seven types of special service, including the capacity to handle special delivery mail. Chances are good that the machine's cost can be lowered by dropping some of these little used services. The use of newer technology, such as MOS for the computer's logic circuits and programable read-only memories for storing rates, should also reduce its cost. Finally, Lanyi says, the 5-megahertz computer has excess capacity to share. If each computer were time-shared between a number of stations, the unit cost of the stations would drop sharply.

Medical electronics

A digital advance in patient monitoring

Changes have come slowly to patient monitoring systems. But this month a system is being introduced that radically departs from older designs. Developed by Abbott Medical Electronics Co. (a joint venture of a pharmaceutical giant, Abott Laboratories, and an aerospace firm, SCI Systems Inc.) it is digital. The system multiplexes to reduce cables, and has a minicomputer to process data and control bedside equipment. In addition, the system's modules are in plastic chassis to reduce shock hazards.

In layout, Abbott's system resembles older units. At each bed is a console containing modules for taking cardiograms and measuring and displaying blood pressure and other physiological parameters. Signals from all the consoles in a ward are fed back to a central station along a single pair of wires, thanks to the fact that each console multiplexes its outputs. Normally, in similar layouts, as many as 50 leads come out of a single console.

At the central station the minicomputer reduces the data, does trend analysis, and looks for the irregular heartbeats called arrythmias. It can also control instruments or send information back to a physician at bedside. "The central station has the capacity for controlling as many as four activities at each of the bedside units," says Abbott Medical president Elliott Farmsworth.

Instrumentation

Computer system tests, matches diodes

When diode maker KEV Electronics Corp. found that it couldn't check out its products with commercial production test equipment, it developed its own. Now the equipment, which tests the devices at operating frequencies instead of at dc or kilohertz, will be marketed.

KEV, in Wilmington, Mass., makes ion-implanted voltage variable capacitors for electronic tuning of TV and fm receivers. A major problem is selecting the three or more diodes needed for a tuner so that their capacitance changes match as tuning voltage varies. According to Jerome L. Hartke, technical director for device development, KEV's diodes have tightly controlled capacitance versus voltage curves, and are sorted into only 10 categories instead of the 1,000 typical for conventional double-diffused or epitaxial diodes. Nevertheless, they do have to be matched before shipment, so KEV put together its computer-operated system which is now matching diodes in pilot production lots.

KEV feels the system should interest other diode makers, too, but would rather make diodes than test equipment. So it developed the tester with Digital Equipment Corp.—partly because Hartke lives across the street from Roger Pyle, manager of DEC's custom software group. KEV makes the rf test head and analog circuitry, which DEC

Postal automation outlook brightens

Reorganization act will free management and R&D funding from political interference, spurring outlays for implementation of new systems

By Jim Hardcastle, *Washington bureau*

The struggle to convert the Post Office Department into a public corporation took 12 years, and it will take at least as long again to change the deficit-ridden, $8 billion giant into an efficient, self-sustaining operation, predict officials of the new U.S. Postal Service. The process will make the service a big market for electronics companies, since it will take a lot of money to develop and build the automated equipment necessary to handle the nation's mail. But it won't happen overnight.

A relatively limited research and development budget rules out a technological revolution in the Postal Service. But Harold Faught, the former Westinghouse Nuclear Rocket Program manager who heads the Bureau of Research and Engineering, believes the outlook for automating the system is bright. Outlays for Postal R&D in fiscal 1971 will remain essentially unchanged at $63 million. But as the system becomes self-sustaining, he feels the percentage of R&D will more nearly resemble private industry's—about 3% of sales. Based on a total budget of $8 billion, postal R&D could eventually reach $240 million a year. The largest expenditures will go for optical character readers and computers.

Meanwhile, Faught says, the service will be able to use some of its $10-billion borrowing authority to develop and acquire automation systems. And because the service has lagged in developing new machinery, opportunities for savings are plentiful. Programs already in the planning stages should save $1.9 billion a year by 1975 by cutting costs in major postal centers, Faught claims.

Broader R&D programs may well be launched following completion of major systems studies the Postal Service is awarding to industry. Faught warns, however, that the Postal Service right now is more interested in applying existing technological knowledge than in developing new technology.

The program with by far the most significance for the electronics industry is "code mail," which uses computers and optical character readers to sort letters. It began in Cincinnati in 1968 with a $5 million effort to develop an advance letter handling testbed. Eventually, the techniques developed there are expected to be applied in the 110 largest post offices, which handle 70% of the nation's mail.

In the Cincinatti system, which was assembled by LTV Electrosystems Inc., letters are fed into a drum located at a coding station and rotated before a clerk at the rate of 60 a minute. The clerk extracts the portions of the addresses needed for the code, typing the code on a keyboard. A Xerox Data Systems Sigma 2 computer then searches a disk file, matches the code with addresses stored in memory, and automatically prints a series of bars on the back of the envelope. These identify the zip code, house number and street.

Next, the letter passes to a conveyor where the bars are read by a simple optical code reader. Then the code is fed to the computer, which runs a mechanical sorting machine that puts the letter in the appropriate bin. At present, the machine breaks down the mail by carrier route, but the computer could be programed for sorting individual routes to match the order of delivery. Thus, Faught says, code mail may someday eliminate the 1.5 hours a day that the Postal Service's 200,000 letter carriers now spend sorting mail by route.

Code mail offers further advantages, he notes. Because the computer's memory allocates bar codes, the coding station operator needn't remember which of 150 to 200 bins a letter should be placed in.

Such a system should encourage large mailers, such as publishers and credit card companies to invest in equipment that could imprint

Approved. Supervisor authorizes employee overtime by inserting both the employee's badge and his own into transactor.

bar codes on all their mail, Fought believes. For their investment, these mailers would get better service and probably a cost rebate.

In addition, the bar code system leaves room for the advances in optical character recognition equipment that are expected to revolutionize mail handling. Abraham Tersoff, an engineer who heads the Postal Service's OCR efforts, says that his goal within the next five years is to develop equipment capable of reading at least 50% of the mail. Such readers could scan all mail coming into the sorting system, and also assign bar codes.

To date, some $20 million has been spent on OCR development, an amount Tersoff says is justified because of the demanding nature of the postal mail service.

Automation equipment, however, is not the postal service's only requirement. It also needs improved systems to keep track of the flow of the mail and keep tabs on its 750,000 employees. Thus, it has spent $50 million to date for its Postal Source Data System.

In the system, more than 10,000 input devices—mostly employee badge readers and transactors which input payroll and labor distribution data, plus scales that monitor the flow of mail through postal facilities—feed data concentrators at each main post office. Leased voice-grade lines then lead to four dual Control Data Corp. 1700 computers that edit, format, and further compress the data for processing by dual CDC 3300 computers at data processing centers in Wilkes Barre, Pa. and St. Louis.

The system's critics charge that the setup is underused and overly expensive. Only 20% of the computer's capacity is employed, and 115,000 miles of leased lines cost $2 million a year—facts expected to draw fire in a forthcoming General Accounting Office report.

Industry and labor also have their reservations, although their complaints follow entirely different lines. One industry source says the machine could do much more than payroll processing, which he says is its main task. For example, it could be used for postal accounts payable and receivable and general ledger accounting.

Labor, on the other hand, fears the network's potential for monitoring an individual's efforts. "It's what we call a clock watching system," says David Silvergleid, president of the National Postal Union which represents about 80,000 postal clerks.

System manager Anderson, however, is not particularly worried about the criticisms of the data system. Already, he notes, the system has surpassed manual reporting in both accuracy and timeliness. And while he concedes that it is greatly under-utilized, he views the excess capacity as just another opportunity to put more applications on line.

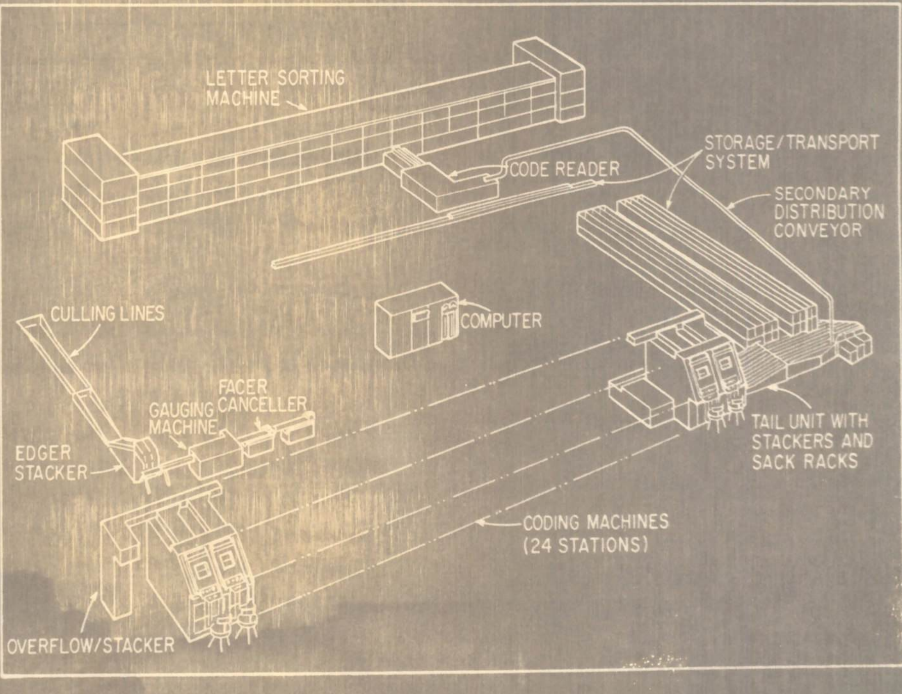
Up the reorganization

No organization plan by itself can guarantee that the Postal Service can either develop or use automated equipment, but Harold F. Faught, the former Westinghouse Nuclear Rocket Manager who heads the Postal Service's Bureau of Research and Engineering, says that reorganization should step up the pace of electronics R&D for two reasons:

First, he says, the reorganization of the Post Office will end political interference in appointments of top postal research managers and will level out the cyclical nature of the postal research and development budget. With most top managers being replaced every two years and the R&D budget fluctuating wildly, he notes, there was a "very disruptive influence on engineering programs where you're trying to do things over a five-year period."

Equally important is the autonomy granted by the reorganization act. Congress will appropriate 10% or less of the budget through 1979; the remainder will come out of revenues and its $10 billion bonding authorization. This new management freedom will permit the Postal Service to allocate research funds on the basis of projected benefits, rather than on what is left in the Federal budget, Faught says. The same autonomy will be used to upgrade salaries so that the Postal Service can hire the best engineering talent.

Coded. After "code mail" system in Cincinnati removes mail that can't be sorted by machine, it sends other letters to computer-assisted stations where they get bar codes. Then mail goes to an optical card reader where the code is entered into a computer, telling the sorter where to put each letter.



Focal points

Automatic letter sorting to ease the postal load? It may be with us someday but not for quite a while

After listening to a number of technical papers and speaker comments at a recent symposium on artificial pattern recognition, one could only come away with the conclusion that pattern recognition is still among the most amateur of technical fields. The symposium, which was sponsored jointly by the U.S. Post Office Department, the National Security Industrial Association, and the IEEE Systems Science and Cybernetics Group, and was held in Washington, D.C., on May 6 prior to the start of the International Conference on Artificial Intelligence, brought out the fact that there is much controversy among adherents of various pattern-recognition techniques; and although many methods have enjoyed limited success, no one way has proved optimum.

Discussions at the symposium were limited to work being carried out under the direction of the Post Office's Bureau of Research and Engineering. According to Paul G. Hendrickson, Acting Assistant Postmaster General, the Post Office has been engaged in automatic address reading research since 1954. This work has been referred to as optical character recognition (OCR).

For the researchers, their efforts fall mainly into two categories: the development of techniques and a system for reading handwritten script; and the improvement of an existing system for reading machine lettering, as well as the development of a new OCR for machine-imprinted letters.

Perhaps the biggest stumbling block in the path of automatic letter sorting is how best to read script—and some 50 percent of the addresses on letters and packages are in handwritten script. Some people write large and loose; others write small and tight. Some people use capitals; others use a combination of upper- and lower-case letters. Add this to the many styles of shaping the address block and you begin to get a hint of the magnitude of the problem.

An ideal character-recognition technique is one that is orientation-free and able to read any type of lettering, machine or handwritten; is insensitive to degradation of any kind; has relatively simple logic to keep costs down; and has a low error rate. Current techniques, however, are orientation dependent. That is, they require that the address block maintain a certain format. They are also extremely sensitive to degradation, and multifont capability has been a real problem. To implement any of the existing techniques, a complex logic system is required.

During the meeting, several pattern-recognition techniques, such as the "feature extraction method" and the "nearest neighbor classifier," were briefly discussed. In commenting on them, Dr. Laveen Kanal, senior staff scientist, Philco-Ford Corporation, and chairman of the meeting's morning session, said he felt that of all the methods described the technique using Fisher determinants seemed to outperform all others. He questioned the validity of reading individual characters, pointing out that "instead of reading characters and putting them together, we should emphasize reading blocks and splitting off where needed into separate characters." He went on to say that he felt that any attempt to identify characters by curve following, orthogonal expansions, etc., is not relevant.

Relevant or not, it appears that this is the direction in which the majority of recognition research is headed.

About the only piece of hardware capable of reading script (numbers) has been developed by Philco-Ford. It uses a flying-spot scanner to locate handwritten Zip codes. A combination of feature extraction and storage logic is used with a computer-aided decision process to recognize characters. Under laboratory conditions, this OCR has been able to recognize the last two digits of the Zip code about 70 percent of the time; the first three digits about 61 to 63 percent of the time; and all five digits about 47 to 54 percent of the time. Although the machine is still in the early stages of its development, there already appears to be some question as to whether it will ever be installed in Post Offices.

What about those letters whose addresses have been machine imprinted? The Post Office does have a reader–sorter capable of reading such addresses, although not very well. According to the Post Office's own figures, the present OCR reads only about 25 percent of machine-imprinted addresses. And only by preidentifying "good" mail (addresses) with special tags can an accept rate of 75 to 80 percent be achieved. An improved version of the OCR will soon be introduced; however, it will only increase sorting capability to about 35 percent whereas a future Mk II reader–sorter is expected to increase the sort rate to about 50 percent.

The reasons for this apparently poor performance are obvious. The OCR is sensitive to fonts, misspelled words, tic marks, degraded print, pattern backgrounds, orientation, irregular indentation, spacing, and so on. In other words, it is sensitive to the same problem areas as the numeric script reader. Automatic reader–sorters for machine-imprinted addresses are used in about eight cities across the U.S.: Detroit, Houston, Boston, and New York among others.

As far as the Post Office is concerned, all of the work now being carried on is futuristic. That is, the OCRs now under development are being designed to work with the expected mail mixes five or ten years from now though they must also be compatible with the present-day mix.

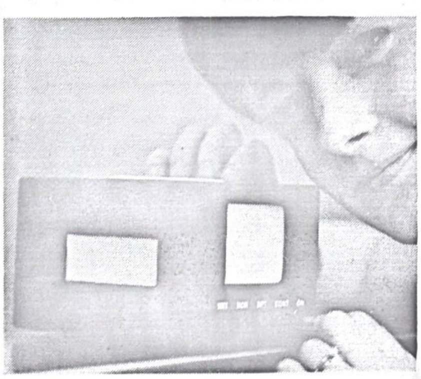
And still the price of a postage stamp continues to climb. It is evident that charges will level out only when the Post Office Department becomes more cost effective. Postal officials hope that OCR machines can cut costs by almost eliminating manual mail handling and reducing "time in transit" to a minimum. But also needed is closer cooperation between the Post Office and industry, and the consumer. Standardization of envelopes and the adoption of a uniform font for machine-imprinted mail would help. Congress could help too by providing incentives, such as a reduction in postal charges for mail conforming to a specified standard.

Among the companies and universities researching the problems of pattern recognition for the Post Office are the Philco-Ford Corporation, Control Data Corporation, IBM Corporation, Burroughs Corporation, Recognition Equipment Inc., Radio Corporation of America, Cornell Aeronautical Laboratory, Inc., Battelle Memorial Institute, and the Rensselaer Polytechnic Institute.

Apollo 10 module carried color TV and 'mini' monitor

A color television camera that weighs less than 7 kg (15 pounds) and a "mini" monitor—a television set with a screen smaller than a credit card—were part of the equipment carried by the Apollo 10 astronauts on their mission to the moon in May. The equipment was built for them by the Westinghouse Electric Corporation.

THIS TINY television monitor was used by the Apollo 10 astronauts in focusing their color television camera during their mission to the moon. Carried inside the command module, it enabled astronauts to see in black and white the exact pictures that were transmitted by the camera back to the earth.



The camera is about 43 cm long, including a variable-focus "zoom" lens. It was designed to be carried aboard the three-man Apollo 10 command module and is the first color television camera designed for use aboard a manned spacecraft. The use of a zoom lens and a television monitor aboard a manned spacecraft are also space "firsts."

The lens has a variable focal length ranging from 12.5 to 75 mm and provides a diagonal field of view variable from 54 to nine degrees respectively. There is a range of aperture stops from *f*2.2 to *f*22 for operation in the expected light levels and a focus range to infinity.

The little television monitor, which weighs less than 2 kg, has a black-and-white viewing screen that shows the astronaut using the camera the exact scene that is being transmitted back to earth.

The color camera uses an imaging tube called an SEC (secondary electron conduction) imaging tube that can produce an image at very low light levels. The tube is the same type that was used in the lunar camera flown on Apollo 9 and is scheduled to be used on the moon's surface during the Apollo 11 flight. However, a significant addition to the camera is a rotating color wheel with red, blue, and green filters arranged so that the filters pass in front of the imaging tube. The wheel spins at 600 revolutions per minute and is divided into six sections so that the sequence of color filters as they pass in front of the tube during one revolution is red, blue and green, red, blue and green. Separate red, blue, and green images are transmitted to earth receiving stations where they are combined to produce a single live color picture. The conversion equipment produces images at the rate of 30 frames per second compatible with the standard rate for commercial television.

The "mini" monitor on the spacecraft receives its power and video signal through a cable connected directly to the camera. The monitor requires about three watts of power.

List of radio museums may interest traveling readers

Bruce Kelley, secretary of the Antique Wireless Association, has assembled a list of radio museums in various parts of the United States. This list, which is reproduced here, is by no means exhaustive, but it does indicate a number of interesting and well-organized exhibits, both public and private. It

E. POSTAL SERVICE

1. EXPERIMENTS

2. PURPOSE OF EXPERIMENT

The purpose of the Electronic Mail Handling (EMH) experiment program is to evaluate subsystems concepts, gain operational experience, and provide a performance information bank from which the operational equipment design specifications can be formulated.

3. EXPERIMENT DESCRIPTION

An experimental EMH station will be established to operate an evaluation program. After the EMH system becomes a reality, state-of-the-art equipment technology will be evaluated to enhance the efficiency of the operational system. The station will be divided into four major subsystem areas:

- Input conversion
- Data processing and storage
- Data transmission
- Output conversion

Initial testing will be directed to each major subsystem and will be effected through simulation modeling, actual equipment testing, and equipment interfacing. Overall system tests will be conducted when feasible and early point-to-point demonstration will be performed to gather data on loading factors, based on user acceptance and the progress of system development. The various series of tests that will be performed are outlined below:

a. Input Conversion Subsystem

- Scanning rates
- Paper handling problems
- Rejection and thru-put data rates
- Resolution and data compression performance
- Multifont reading capibility

b. Data Processing and Storage Subsystem

- Input and output conversion control and monitor functions
- Storage and sorting stage techniques
- Error and reject rates

c. Data Transmission Subsystem

- Determination of acceptable transmission links error rates
- Refinement of station-to-station transmission specifications
- Development user-to-EMH station transmission requirements

d. Output Conversion Subsystem

- Acceptable thru-put rates
- Paper-handling techniques
- Sorting, storage and delivery techniques
- Output device noise levels

e. System Tests

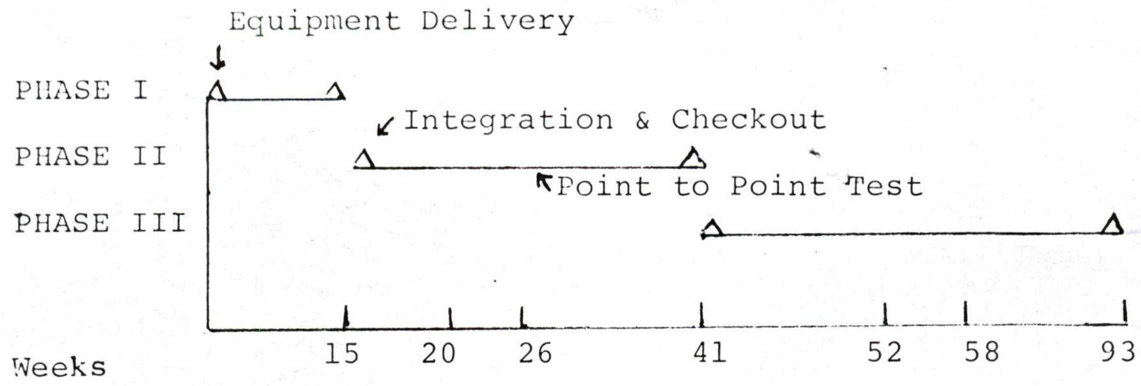
- System loading factors
- Multiple store-to-store transfers
- Overall system capacities
- Overall error and reject rates

f. Module-to-Module Test

A point-to-point demonstration test over a combination of land lines plus satellites will be conducted between two EMH modules to determine the degree of user acceptance and measure progress within the evolving system. The data gathered will be used to refine the operational system loading-design specifications and determine system weaknesses and requirements for further testing.

4. KEY MILESTONES

The point-to-point demonstration can begin 20 weeks after authorization to proceed. The projected schedule is as follows:



5. REQUIRED COMMUNICATIONS SERVICES SUPPORT

All tests, except the point-to-point demonstration test, are conducted in the EMH experimental station and require no external communications support. However, the point-to-point demonstration test will require communication support. A cross-country loading data base would be useful and would be obtained with a communications hook-up between the East and West Coast EMH modules. One effective low-cost method would be to interface the East Coast module into the Goddard Space Flight Center by land communications, then via the ATS-1 or -3 satellites to the Mojave Tracking Station (California), and from Mojave to the West Coast module by land communications.

6. OPERATIONAL SYSTEMS

a. Description of System

A systems concept which will provide the services required for the postal system is discussed in this section. The approach to technical studies has been highly conservative. All of the technology required for the described system presently exists in operational or demonstrable prototype form. Thus no major technological breakthroughs are required for this system to be feasible. Cost data are conservative; in each case the price used reflects a cost at which the item is presently available in small lots. The types of equipment required for this system are in a field where new developments are presently increasing the ability and decreasing the cost of the individual components very rapidly. No allowance has been made for either technological improvements or cost reductions.

The system described is capable of processing one hundred million letters a day. This adds up to a volume of thirty billion pieces a year, assuming full usage for three hundred days each year. It will accept letters in computer-generated form on magnetic tapes. All handling of input letters will be mechanized so that the original letter can not be read while being converted for transmission. All materials will be finalized in sealed letter form. Thus the letter will never exist in a form which can be read during the time it is in the Post Office, and the sanctity of the mail will be preserved.

The system is sized assuming that 70% of the mail will be originated by business users in computer output form. It further assumes that 20% of the mail will be in printed form which can be read by optical character readers. The final 10% of the mail will be handled by full scanning and will be capable of transmitting handwritten documents and graphics with better resolution than a TV set.

Hardcopy letters which are to be transmitted via the Electronic Mail Handling system will be submitted at an EMH served Post Office by the originator. The letter will be submitted in flat open form with the destination ZIP code added in a fixed location by a special Post Office printer. The letter will be inserted by the originator into a machine handling cartridge and will not be handled in open form by any Postal Service employee. Digital data messages will be submitted on magnetic tape reels. High volume users may elect to obtain a direct connection to transfer data via common carrier to Postal Service storage rather than submit tapes.

Hard copy letters are then processed by optical character readers or graphical scanners in accordance with the patron's desires and converted to electronic storage form. The messages will then be processed through a computer which will provide inventory control so that no message can get lost. The message will then be transmitted from an antenna on the postal station to a spacecraft located in a stationary orbit over the United States. The spacecraft will retransmit the message to a receiver in the destination post office. The data is then sorted and automatically printed out in the order the carrier delivers it.

The initial Electronic Mail Handling system will interconnect the 125 largest mail originating locations. One station may serve several closely located cities and thus this system will actually interconnect approximately 180 cities. (A list of the interconnected cities is given in Appendix IV-C-5. Several of the cities (e.g. New York, Chicago, etc.) will have a higher daily volume than a single processing unit can handle and thus approximately 160 modules will be required to service the 125 cities.

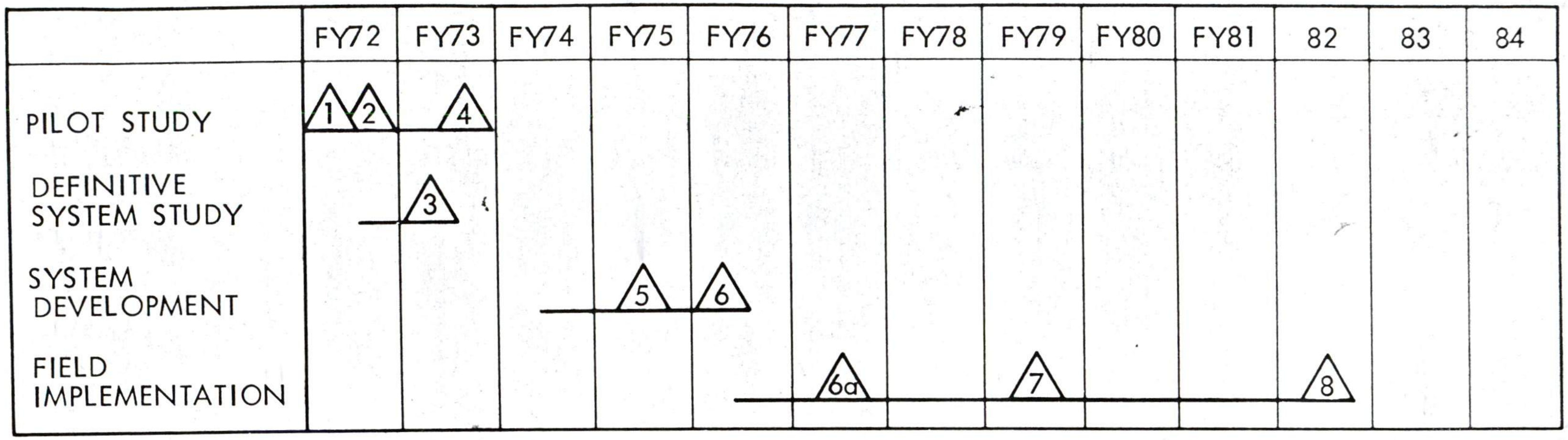
b. Supporting Experiments Required

The experiments program (App. IV-C-5-a) will be used to define the operational system requirements, and no supporting experiments per se are required. When two stations are operational and the spacecraft is in position (reference introduction schedule, milestone 6), operations tests will be performed to verify experimental data i.e., station load limits, acceptable transmission error rates, reject rates, etc.) and to gain operational experience prior to implementing EMH service in the next 23 cities. Similar data will be collected once 25 cities are operational and prior to going to the full 125 city system.

c. Introduction Schedule

Figure IV-2 shows the schedule required to develop a fully operational EMH service for 125 cities by 1982. The milestones on the schedule are as follows:

- The funding for the experiments program is approved and the experiments project is manned.
- The East-West coast EMH demonstration takes place.
- The operational EMH program is approved and funded.
- The final specifications for the operational system are approved.
- The first operational EMH station is installed and tested.
- The second EMH station is operational, the spacecraft is launched and operational tests begin.
- EMH service is started between 2-4 cities.
- EMH service is available between 25 major cities.



(1) APPROVAL & MANNING

(2) COMMUNICATIONS TESTS EAST-WEST COAST

(3) PROGRAM APPROVAL WITH FIRST YEAR FUNDING

(4) OPERATIONAL SYSTEM SPECIFICATION DEFINED

(5) FIRST STATION INSTALLATION SPACE CRAFT LAUNCH

(6) OPERATIONAL TESTS

(6a) SERVICE BETWEEN 2-4 CITIES

(7) 25 MAJOR CITIES OPERATIONAL (APPROXIMATELY 60 SYSTEMS)

(8) EMH OPERATIONAL (125 CITIES)

Figure IV-2 Program Plan-Electronic Mail Handling System

° The EMH system is fully operational between 125 cities.

The system will be capable of processing one hundred million letters a day. This adds up to a volume of thirty billion pieces a year assuming full usage for three hundred days each year. It will accept messages in letter form, printed, hand written or with graphics. It will also accept letters in computer-generated form on magnetic tapes. All handling of input letters will be mechanized so that the original letter can not be read while being converted for transmission. All materials will be outputted in sealed letter form. Thus the letter will never exist in a form which can be read during the time it is in the Post Office, and the sanctity of the mail will be preserved.

October 21, 1971

DRAFT

File

Mr. Patrick E. Haggerty
Chairman of the Board
Texas Instruments, Inc.
13500 N. Central Expressway
P. O. Box 5474
Dallas, Texas 75222

Dear Pat:

I was pleased with the enthusiasm and competitive spirit of the people representing the Postal Service at the meeting on initiatives on communications for social good. I am not, however, completely sold on the conclusions they have ~~apparently~~ reached.

In trying to figure out in my own mind how science and technology is run in the government, it seems to me that first of all there are two kinds of organizational situations which we encounter.

A. Those situations in which the management of a government organization sees the problem and feels that the proposed solution is theirs, and they are willing to take the responsibility and claim the success or failure as their own ~~after the fact~~.

B. Those organizations in which someone lower down in the organization is carrying the ball, but the top management of the organization doesn't know about it, doesn't care, or thinks that OST or OMB is running it.

C. Those organizations which either don't see the problem or don't see the ~~obvious~~ answer, and OST is trying to initiate a program where none is seen.

Then, it seems to me that there are three categories of technical program.

1. Those in which a tool is necessary, such as a telescope, an accelerator, or a bomber. In this case, the organization at least makes believe that they are confident of what they are asking for and puts on a hard sell to get a specific device.

2. Those cases in which the problem isn't clear, or at least the solution is far from clear. Because so many people have seen the success of this professional approach to trying to sell the idea for a tool, when they have a problem in this category they feel they have to make beleive they know the answer and sell it hard when really they should sell a program which in a careful, planned way outlines the alternatives, lists the experiments for finding the best alternative, and plans how decisions will be made as a result of each of the experiments. This sounds like classical science, but I don't remember hearing anyone talk this way because it apparently sounds like a sign of weakness to admit you don't know exactly where you are going.

3. The third case is a program to find knowledge. This is true research. Where we are just looking for knowledge we should feel free to do so, but we should define what knowledge we are looking for. Sometimes our justification for this effort is quite misleading. We point out examples of people who have found something very significant for mankind while looking for something else. We must be careful that from this people don't imply that if you are out spending money looking for nothing that you may accidently happen upon something else. I believe that in most

of these cases, someone was looking for something specific and happened upon something else. We have to avoid the situation where we define basic science as looking for something that isn't useful. A lot of things aren't useful, but are not science nor are they knowledge. You have heard the statement that nothing came out of the program so it must have been basic science.

It seems to me that the Postal Service problem comes in categories A and 2. The responsibility is clear and the management understands that it is their program. However, the solutions are not at all clear and it will take a careful program to find out the optimum solutions, and a good part of that problem is which solution will be acceptable to the customer, to the politicians and to the rate fixers.

I very much liked the people that made the presentation, but did feel they overstated their confidence in the solution they picked because they felt they had to show confidence in order to sell a program in the same way that so many other programs have been sold in Washington.

The Postal Service has many problems. Technology can help in most of them, but

October 12, 1971

NOTES ON ELECTRONIC MAIL

I was very pleased with the enthusiasm and competitive spirit of the Postal Service. Their proposal however sounds like they are committed to electronic mail and they really should be committed to the best possible mail service. This means programs and experiments to solve all of their problems.

Some version of electronic mail I would assume is inevitable, but it will take careful planning and careful experiments to demonstrate what form it will take. It will take a great deal of discipline on the part of the users, and careful selling and introduction to make sure that the results are acceptable.

When the problems of equipment to handle, read and produce on each end are solved, they may, without electronic transmission, solve much of the Post Office's problem.

If electronic mail is readily accepted by the public, it might be that if the bulk of its application is in the production of bills which would be largely local, there might be no need for large transmission facilities.

The system might become easily saturated and therefore very unpopular because it would be so easy to generate personalized junk mail.

If the costs of communications gets very low it would encourage competition, particularly if the Post Office lost its monopoly position. With low line costs, a network system like TELEX that presented facsimile or fast printing might take care of much of the business mail.

The proposal seemed to ask for much technology development to avoid the need for rational rate fixing. If each piece of mail was made to pay its fair share, it would help solve many of the problems of the Post Office.

Kenneth H. Olsen

E. POSTAL SERVICE

1. EXPERIMENTS

2. PURPOSE OF EXPERIMENT

The purpose of the Electronic Mail Handling (EMH) experiment program is to evaluate subsystems concepts, gain operational experience, and provide a performance information bank from which the operational equipment design specifications can be formulated.

3. EXPERIMENT DESCRIPTION

An experimental EMH station will be established to operate an evaluation program. After the EMH system becomes a reality, state-of-the-art equipment technology will be evaluated to enhance the efficiency of the operational system. The station will be divided into four major subsystem areas:

- Input conversion
- Data processing and storage
- Data transmission
- Output conversion

Initial testing will be directed to each major subsystem and will be effected through simulation modeling, actual equipment testing, and equipment interfacing. Overall system tests will be conducted when feasible and early point-to-point demonstration will be performed to gather data on loading factors, based on user acceptance and the progress of system development. The various series of tests that will be performed are outlined below:

a. Input Conversion Subsystem

- Scanning rates
- Paper handling problems
- Rejection and thru-put data rates
- Resolution and data compression performance
- Multifont reading capability

b. Data Processing and Storage subsystem

- Input and output conversion control and monitor functions
- Storage and sorting stage techniques
- Error and reject rates

c. Data Transmission Subsystem

- Determination of acceptable transmission-link error rates
- Refinement of station-to-station transmission specifications

d. Output Conversion Subsystem

- Acceptable through-put rates
- Paper-handling techniques
- Sorting, storage and delivery techniques
- Output device noise levels

e. System Tests

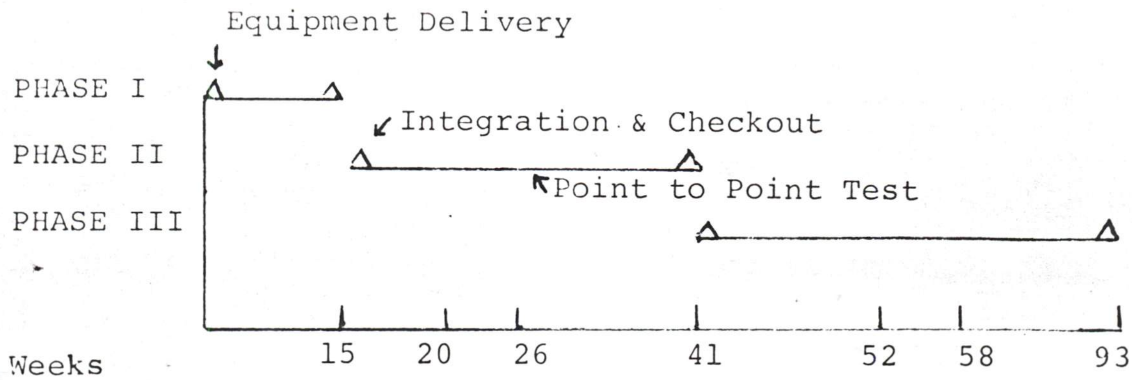
- System loading factors
- Multiple store-to-store transfers
- Overall system capacities
- Overall error and reject rates

f. Module-to-Module Test

A point-to-point demonstration test over a combination of land lines plus satellites will be conducted between two EMH modules to determine the degree of user acceptance and measure progress within the evolving system. The data gathered will be used to refine the operational system loading-design specifications and determine system weaknesses and requirements for further testing.

4. KEY MILESTONES

The point-to-point demonstration can begin 30 weeks after authorization to proceed. The projected schedule is depicted on the following page:



5. REQUIRED COMMUNICATIONS SERVICES SUPPORT

All tests, except the point-to-point demonstration test, are conducted in the EMH experimental station and require no external communications support. However, the point-to-point demonstration test will require communication support. A cross-country loading data base would be useful and would be obtained with a communications hook-up between the East and West Coast EMH modules. One effective low-cost method would be to interface the East Coast module into the Goddard Space Flight Center by land communications, then via the ATS-1 or -3 satellites to the Mojave Tracking Station (California), and from Mojave to the West Coast module by land communications.

6. OPERATIONAL SYSTEMS

a. <u>Description of System</u>

A systems concept which will provide the services required for the postal system is discussed in this section. The approach to technical studies has been highly conservative. All of the technology required for the described system presently exists in operational or demonstrable prototype form. Thus no major technological breakthroughs are required for this system to be feasible. Cost data are conservative; in each case the price used reflects a cost at which the item is presently available in small lots. The types of equipment required for this system are in a field where new developments are presently increasing the ability and decreasing the cost of the individual components very rapidly. No allowance has been made for either technological improvements or cost reductions.

The system described is capable of processing one hundred million letters a day. This adds up to a volume of thirty billion pieces a year, assuming full usage for three hundred days each year. It will accept letters in computer-generated form on magnetic tapes. All handling of input letters will be mechanized so that the original letter can not be read while being converted for transmission. All materials will be finalized in sealed letter form. Thus the letter will never exist in a form which can be read during the time it is in the Post Office, and the sanctity of the mail will be preserved.

The system is sized assuming that 70% of the mail will be originated by business users in computer output form. It further assumes that 20% of the mail will be in printed form which can be read by optical character readers. The final 10% of the mail will be handled by full scanning and will be capable of transmitting handwritten documents and graphics with better resolution than present commercial TV.

Hardcopy letters which are to be transmitted via the Electronic Mail Handling system will be submitted at an EMH served Post Office by the originator. The letter will be submitted in flat open form with the designation ZIP code added in a fixed location by a special Post Office printer. The letter will be inserted by the originator into a machine handling cartridge and will not be handled in open form by any Postal Service employee. Digital data messages will be submitted on magnetic tape reels. High volume users may elect to obtain a direct connection to transfer data via common carrier to Postal Service storage rather than submit tapes.

Hard copy letters are then processed by optical character readers or graphical scanners in accordance with the patron's desires and converted to electronic storage form. The messages will then be processed through a computer which will provide inventory control so that no message can get lost. The message will then be transmitted from an antenna on the postal station to a spacecraft located in a stationary orbit over the United States. The spacecraft will retransmit the message to a receiver in the destination post office. The data is then sorted and automatically printed out in the order the carrier delivers it.

The initial Electronic Mail Handling system will interconnect the 125 largest mail originating locations. One station may serve several closely located cities and thus this system will actually interconnect approximately 180 cities. (A list of the interconnected cities is given in Appendix V. C-5). Several of the cities (e.g. New York, Chicago, etc.) will have a higher daily volume than a single processing unit can handle and thus approximately 160 modules will be required to service the 125 locations.

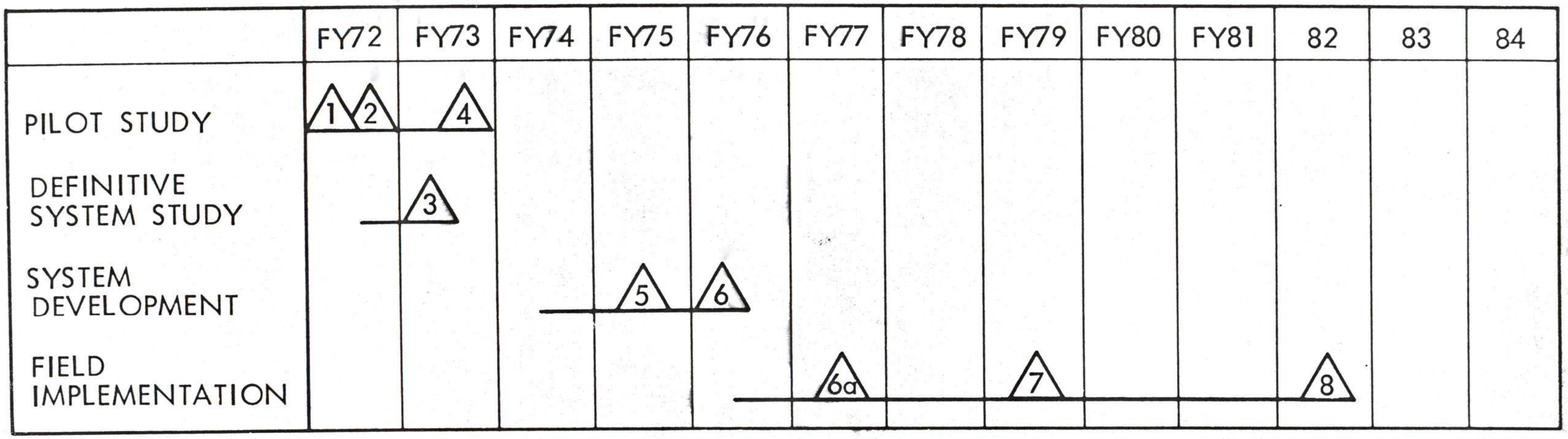
b. Supporting Experiments Required

The experiments program (App. V. C-5-a) will be used to define the operational system requirements, and no supporting experiments *per se* are required. When two stations are operational and the spacecraft is in position (reference introduction schedule, milestone 6), operations tests will be performed to verify experimental data (i.e., station load limits, acceptable transmission error rates, reject rates, etc.) and to gain operational experience prior to implementing EMH service in the next 23 cities. Similar data will be collected once 25 cities are operational and prior to going to the full 125 location system.

c. Introduction Schedule

Figure IV-2 shows the schedule required to develop a fully operational EMH service for 125 cities by 1982. The milestones on the schedule are as follows:

- The funding for the experiments program is approved and the experiments project is manned.
- The East-West coast EMH demonstration takes place.
- The operational EMH program is approved and funded.
- The final specifications for the operational system are approved.
- The first operational EMH station is installed and tested.
- The second EMH station is operational, the spacecraft is launched and operational tests begin.
- EMH service is started between 2-4 cities.



(1) APPROVAL & MANNING

(2) COMMUNICATIONS TESTS EAST-WEST COAST

(3) PROGRAM APPROVAL WITH FIRST YEAR FUNDING

(4) OPERATIONAL SYSTEM SPECIFICATION DEFINED

(5) FIRST STATION INSTALLATION SPACE CRAFT LAUNCH

(6) OPERATIONAL TESTS

(6a) SERVICE BETWEEN 2-4 CITIES

(7) 25 MAJOR CITIES OPERATIONAL (APPROXIMATELY 60 SYSTEMS)

(8) EMH OPERATIONAL (125 CITIES)

Figure IV-2 Program Plan - Electronic Mail Handling System

- EMH service is available between 25 major cities.
- The EMH system is fully operational between 125 locations.

October 14, 1971

Dr. Edward E. David, Jr.
Science Adviser to the President
The White House
Washington, D. C. 20500

Dear Ed:

I have a very negative reaction to the proposed Presidential Initiatives on Communications for Social Needs.

I am sure I am unduly cynical, but my immediate reaction is that this is a way to justify new NASA satellites. I am also suspicious that people might feel that a Presidential Initiative would give such high priority that the projects would not have to suffer the dangers, risks and delays of planned, well-thought-out and open-to-criticism type programs.

The FBI is well organized, and their needs are quite straightforward and hardly in need of a Presidential Initiative to solve them.

The Post Office has many needs and has to study many alternatives, but to concentrate on one could be very embarrassing.

Promising significant help in urban problems by use of communications is an area where angels should fear to tread. Before proposing 13 new channels of educational television, much analysis of previous éxperience should be carefully made before this idea is even leaked to the outside.

We could instead propose bold new experiments to develop the "best mail system in the world" and bold new experiments to demonstrate uses of modern technology in health, education and urban problems.

I would encourage the FBI, but I would not use it for publicity because it does not make for good political propaganda.

The Office of Science and Technology could use these experiments as vehicles to demonstrate how science explores unknown fields. We might start a tradition in government science that could be a more significant contribution than anything else. I am afraid that many of the administrators within the community are confused between buying tools and doing science. In most of these problem areas, we don't know what the answers are and we have to use systematic and probably traditional scientific methods for finding the optimum answers.

We should be sure that they define their problem and that they lay out the alternatives and systematically go about finding the best alternative. After a set of experiments, results should be reviewed and then the next step taken according to the predetermined plan. Above all, the final answer should not be predetermined because the President was talked into making it a Presidential Initiative.

I probably missed the introduction of this set of Initiatives, and because of my ignorance, my comments might be rather naive.

I look forward to seeing you next Monday.

Sincerely yours,

Kenneth H. Olsen

KHO/d

October 12, 1971

FURTHER THOUGHTS ON TECHNOLOGICAL INITIATIVES

Society made some unbelievable organizational mistakes when computers came along. People concluded that the organizations responsible for certain activities, whether they be in the government, in business or in the local high schools, were not competent enough to use computers so they used experts to run the computers. With two groups sharing responsibility, no one could be blamed for failure and no one could fix the problems.

Five years ago, if the local high school consistently fouled up its schedules, they would have fired the administration. For the last four years the schedules have been unbelievably fouled up. Year after year everyone blames the computers and the software. The administration has no responsibility because the school board hired experts from the outside to do the job and the experts, of course, have very limited responsibility. This also goes on in the organization which I run and in almost every organization with which I have any contact.

We now have a wonderful new opportunity to do the same thing with communications. It is clear that HUD is not technically competent to use modern communications to solve their problems, so if we impose new communications experts on them they can have an excuse for failing in their commission and they can blame it on the communications software.

The only dehumanizing result of computers that I will admit to is where responsibility and authority for the solution of a problem is taken away from the only group commissioned to find a solution and given to someone else who runs the computer. We can further destroy this authority and responsibility by taking away the control of communications and giving that to an expert.

....

Every experiment should be considered an experiment with a predetermined checkpoint and an algorithm on which the decision to continue or stop will be made. It is misleading to call something an experiment, but make a commitment to go on indefinitely.

Kenneth H. Olsen

THE WALL STREET JOURNAL, Wednesday, December 20, 1972

Post Haste

The U.S. Postal System Begins to Take Notice Of Speedy Competitors

United Parcel and Others Often Give Better Service, But U.S. Now Fights Back

'We No Longer Throw Stuff'

By TIMOTHY D. SCHELLHARDT
Staff Reporter of THE WALL STREET JOURNAL

WASHINGTON — By now, mailmen hope, you've addressed the last greeting card, licked that final stamp, wrapped and sent the holiday packages. If you heeded the much-advertised plea, you mailed early to "help the people who help bring you Christmas."

For that, Elmer T. Klassen sends you his warmest season's greetings—and so do Paul Oberkotter, Tom Murray and J. Kevin Murphy.

Mr. Klassen, the nation's Postmaster General, captains the 650,000 U.S. Postal Service workers who help bring you Christmas; he's naturally pleased when the holiday mail gets delivered on time. But so are Messrs. Oberkotter, Murray and Murphy, because each also heads a huge mail-delivery service that abets Mr. Claus—and annoys Mr. Klassen.

All three operations are private, profit-making ventures that compete head-to-head with the money-losing public Postal Service, and in this year's holiday mail melee they've been grabbing away great chunks of its business.

A Monopoly on Cards

In fact, this Christmas that package you open probably was delivered by Mr. Oberkotter's United Parcel Service, not by the Post Office. Those Christmas catalogs may well have been left at your door by one of Mr. Murray's Independent Postal Service of America carriers, or couriers from one of 150 firms like Mr. Murray's. And the checks you wrote to pay for gifts undoubtedly were transferred from your bank to a Federal Reserve center by American Courier Corp., a unit of Mr. Murphy's Purolator Services Inc.

(Christmas cards are still delivered by the Postal Service alone, since it enjoys a legal monopoly in delivery of first-class mail. But that monopoly is expected to be challenged in the near future; private carriers plan to ask the Postal Rate Commission and Congress for the right to tote letters and postcards.)

Within the past few years, hundreds of private firms, discovering that the mail business is big business, have sprouted up to challenge the giant Postal Service in one way or another. But the greatest success has been scored by an older outfit, the United Parcel Service, which has actually surpassed the postal goliath in hauling parcel post.

During the past 11 years, the brown-uniformed UPS delivery men, in their familiar dark brown vans, have quadrupled their deliveries of packages weighing one to 50 pounds—to about 600 million deliveries annually. This year's volume will top last year's by about 10%. The Postal Service's comparable business plummeted during the same 11 years to about 498 million parcels from 800 million. (The service still delivers almost twice as many packages as UPS if library materials, catalogs, parcels weighing less than a pound and certain special items are included, but that total has been declining, too.)

Not Playing Dead

Until a year or two ago, before its reorganization into a semipublic corporation, the Postal Service didn't seem to mind losing profitable business to competitors. "We sat back and acted as if they were doing us a favor by taking our business," says Assistant Postmaster General Edgar S. Brower.

But, stirred by Mr. Klassen, the former president of American Can Co. who became Postmaster General last January, the service's yuletide spirit this year is a fighting spirit. "We're no longer going to lie down and play dead," the crusty, 64-year-old Mr. Klassen asserts. And the service has begun to win back some lost business, partly by borrowing some ideas from the UPS success story.

It's readily apparent how UPS overtook the sleeping postal giant. For one thing, the New York-based company, which in effect is owned by its employes, rapidly gained federal and state go-aheads and expanded its delivery territory to include 40 states, parts of six others, and the District of Columbia; in 1971, in its largest territorial expansion, UPS added nine states, picking up 7,500 new shipper accounts.

But the company lured business away primarily because it gave customers what the Postal Service couldn't or wouldn't provide. "As a result of our poor performance, they offered better service at better prices, with less damage," says Mr. Brower, who for the past year has headed the Postal Service's bulk-mail-processing division. "While we were reading regulation books and discouraging business, they were accommodating customers."

Prompt Service Guaranteed

UPS, unlike the Postal Service, offers shippers regular pickup service for packages at a general fee of only $2 weekly, an automatic $100 of insurance coverage for each package, and three attempts at delivery of parcels. Moreover, it practically guarantees prompt, reliable service.

"The Postal Service is quite capable of matching UPS delivery time, but they don't match it consistently; you just never know when to expect a package to arrive," says James Edler, transportation manager of American Greetings Corp. in Cleveland. Joseph F. Santino, traffic manager of Sarah Coventry Inc., the nation's largest direct-mail seller of costume jewelry, finds it takes six to seven days to get a package from its headquarters at Newark, N.Y., to Texas via UPS; with the Postal Service, the time is seven to eight days or longer.

In addition, UPS packages arrive in better shape. The Postal Service admits that until recently its damage rate was five-and-a-half times that of UPS. One reason for the private carrier's gentler treatment: It has installed highly mechanized package-sorting systems in 100 centers around the country; these setups generally eliminate any sharp drops of packages. And when packages are loaded into UPS vans, lighter weight parcels go atop the heavier items rather than underneath.

Perhaps most important to shippers, UPS' rates generally are lower than those of the Postal Service. Avon Products Inc., which uses UPS whenever it can, calculates that the Postal Service rates for parcel post average nine cents a pound, while UPS charges seven cents to 7.5 cents. "Consequently, the Postal Service just doesn't compete," says Wayne Hollowell, the cosmetics company's general transportation manager.

Fighting Back

Despite the rate disadvantage, the Postal Service is fighting back by copying what Mr. Klassen calls UPS' "management flair" for attracting business. In the past year, he has assembled a staff of 61 employes under Mr. Brower just to handle parcel post affairs. Looking ahead, the service is borrowing UPS' mechanized package-sorting and distributing ideas and incorporating them in a $1 billion network of 33 bulk-mail processing centers that will reach full operation in 1975 or 1976.

The mailmen also have begun more immediate efforts to speed parcel delivery, reduce damage and guarantee reliable service. "For a starter, we're no longer throwing packages," admits Mr. Brower. The service has rearranged its processing system to try to eliminate damaging drops, and it has strengthened supervision to see that packages reaching the end of a conveyor line aren't crushed because conveyors aren't halted in time. "Surprisingly, that has been one of the worst areas in the service," says Mr. Brower.

That isn't all. Parcels marked fragile now are being treated as such and handled separately rather than being mingled routinely with other mail. "We're no longer mixing grandmother's cake with William Brothers' four-gallon buckets of paint," Mr. Brower says. The service also is loading its trucks so that some packages won't be crumbled at the bottom of the heap.

The result of all these changes, say the postmen, has been a one-third reduction in damaged packages and a 25% cut in the number of ripped parcels requiring rewrapping.

To speed delivery of parcels, the service has revamped truck schedules and added special trains between Chicago and the West Coast that carry only bulk mail. The Southern postal region has established 10 nonstop truck routes linking Atlanta with 10 West Coast cities; packages from Atlanta now get to Los Angeles in 55 hours, little more than half the 105 hours formerly required.

"Who Are You?"

Furthermore, big mailers are being wooed back with a package pickup service similar to UPS'. The service is considering a built-in insurance arrangement like its rival's. And it has beefed up its sales force of "customer service representatives" and sent them out seeking business—astonishing some corporate executives not used to blandishments from the mailmen.

"When I visited Kodak's advertising distribution manager, other puzzled executives came out of their offices and just stared at me in disbelief. 'Are you really from the Post Office?' they asked," says John Wargo, a postal headquarters official who until a month ago was a postal sales representative.

While concentrating on the parcel post competition, the Postal Service also is striking back at private mail carriers like Independent Postal Service of America which delivers advertising circulars door-to-door, and at overnight-delivery specialists like American Courier Corp. One tactic: an experimental "express mail" service to compete with American Courier in speeding high-priority items such as medicines and company records.

In the parcel post arena, at least, the comeback efforts seem to be working. Parcel post business has risen about 6.5% since July, officials calculate, and some customers have been lured away from UPS.

In Boston, the service has won back some gift-store business by guaranteeing next-day delivery of parcels within that metropolitan area; bright red stars placed on these packages assure expedited treatment. In the West, the service has picked up parcel business of Frederick & Nelson, a Seattle department store, Montgomery Ward & Co. in Oakland, Calif., and Sears, Roebuck & Co. in Los Angeles.

But UPS strategists, retaliating, have wrested away some more of the Postal Service business. For example, D. & H. Distributors, of Savage, Md., has lately gone over to UPS because "the Post Office is slower and damages more of our packages," says a warehouse manager at the firm.

Actually, UPS officials say they welcome fiercer competition, as long as it's fair. But they fear the service will subsidize parcel post and cut rates below costs to win back more business. They may have cause for concern: The Postal Service next month is expected to ask the Postal Rate Commission to permit reduced rates for major parcel post customers who do much of the pre-sorting of packages themselves.

EDUCATIONAL AND HEALTH COMMUNICATIONS

GOAL

- TO REDUCE THE PER CAPITA COST OF HEALTH AND EDUCATION SERVICES CURRENTLY PROVIDED BY THE GOVERNMENT BY INTRODUCING LABOR SAVING COMMUNICATION TECHNOLOGY AND AT THE SAME TIME TO EXTEND THE COVERAGE OF THESE SERVICES TO PRESENTLY UNSERVED POPULATIONS.

ACTION

- DEVELOP AND DEMONSTRATE A SET OF WORKABLE AND COST EFFECTIVE COMMUNICATION BASED DELIVERY SYSTEMS FOR A LIMITED NUMBER OF SPECIFIC HEALTH AND EDUCATION SERVICES.

  A TOTAL SYSTEMS APPROACH COMBINING HARDWARE, SOFTWARE, UTILIZATION PERSONNEL AND RESEARCH IN A SINGLE PACKAGE WILL BE FOLLOWED.

  ALTERNATIVE DELIVERY SYSTEMS WILL BE DEVELOPED IN EACH OF THE FOLLOWING AREAS OF PUBLICLY PROVIDED SERVICE:

  CHILD DEVELOPMENT

  BASIC EDUCATION

  POST SECONDARY AND CONTINUING EDUCATION

  CAREER EDUCATION

HEALTH INFORMATION

HEALTH SERVICES

SOCIAL SERVICES INFORMATION

CULTURAL SERVICES

EACH OF THE ABOVE INITIATIVES WILL INCORPORATE THE FOLLOWING ELEMENTS:

- DEVELOPMENT OF INNOVATIVE SOFTWARE
- CREATION OF SIX TO TEN DEMONSTRATION-EXPERIMENTATION HARDWARE COMPLEXES TO PERMIT LARGE SCALE EVALUATION OF COMMUNICATION BASED APPROACHES TO HEALTH AND EDUCATION SERVICES
- PROVISION OF UTILIZATION SUPPORT INCLUDING TRAINING AND SPECIAL PERSONNEL
- ESTABLISHMENT OF LONG TERM RESEARCH PROGRAM ADDRESSED TO THE BASIC FACTORS INVOLVED IN THE USE OF COMMUNICATIONS TECHNOLOGY FOR HEALTH AND EDUCATION SERVICES

TOTAL COST

FY 72	FY 73	FY 74	FY 75	FY 76
25	98	118	145	166

EVALUATION

HEALTH AND EDUCATIONAL COMMUNICATIONS

IMPORTANCE

- SUBSTANTIAL SEGMENTS DO NOT RECEIVE NEEDED SERVICES
- HIGH COST OF HEALTH AND EDUCATION SERVICES OF CONCERN TO ALL COMMUNITIES

PAYOFF

- VALIDATED COST EFFECTIVE SYSTEM MODEL THAT WILL PERMIT HEALTH AND EDUCATION SERVICES TO BE EXTENDED TO PRESENTLY UNSERVED GROUPS
- IMPORTANT COST REDUCTIONS IN PRESENTLY PROVIDED SERVICES
- MARKET CREATED FOR WIDE RANGE OF PRIVATELY PROVIDED SERVICES
- INCREASED EMPLOYMENT IN BOTH TECHNOLOGICAL (AEROSPACE AND ELECTRONICS) AND ARTISTIC CREATIVE (PROGRAM PRODUCTION) AS WELL AS LOCAL ADMINISTRATIVE AND OPERATIONAL
- USE OF HARDWARE FOR SERVICE COMPONENT AVAILABLE AT MARGINAL COST

PUBLIC IMPACT

- INVOLVEMENT OF DISADVANTAGED MINORITIES THROUGH EXTENDED SERVICES
- EASILY RECOGNIZED EXAMPLE OF HIGH TECHNOLOGY APPLIED TO CIVILIAN PROBLEMS
- IMMEDIATE VISABILITY THROUGH COMMUNICATION INDUSTRY INVOLVEMENT

TECHNICAL FEASIBILITY

- LARGELY STATE-OF-ART. SOME DEVELOPMENT REQUIRED TO REDUCE PER UNIT COST ESPECIALLY FOR TERMINAL EQUIPMENT

POTENTIAL PROBLEMS

- DIFFICULTY OF ENGAGING ACTIVE PARTICIPATION OF TARGET POPULATIONS
- RESISTANCE FROM EXISTING ESTABLISHMENTS PROVIDING SERVICES IN SELECTED AREAS
- UNCERTAINTY IN VALIDATING FULL RESULTS OF SERVICE
- FULL BENEFITS DEPENDENT ON LOCAL REPLICATION AND SUPPORT

Donald L. Schilling (S'56–M'58–SM'69) was born in Brooklyn, N. Y., on June 11, 1935. He received the B.E.E. degree from the City College of New York, New York, in 1956, the M.S.E.E. degree from Columbia University, New York, in 1958, and the Ph.D. degree in electrical engineering from the Polytechnic Institute of Brooklyn, Brooklyn, N. Y., in 1962.

From 1956 to 1962 he was a Lecturer in the Department of Electrical Engineering, City College of New York, a Lecturer in the Department of Physics, Brooklyn College, Brooklyn, and a Member of the Technical Staff of the Columbia University Electronics Research Laboratories. In 1962 he was appointed Assistant Professor in the Department of Electrical Engineering, Polytechnic Institute of Brooklyn, and in 1966 became an Associate Professor. He is currently an Associate Professor in the Department of Electrical Engineering, City College of New York. He is coauthor of *Electronic Circuits: Discrete and Integrated* (McGraw-Hill, 1968) and *Principles of Communication Systems* (Prentice-Hall, 1955). At present he is also a Consultant to several companies in the communication and radar theory areas.

Dr. Schilling is a member of Sigma Xi and Eta Kappa Nu and is currently the Editorial Manager of the IEEE Transactions on Communication Technology. He is also the Technical Program Chairman for the 1971 International Telemetry Conference.

FASTFAX, a Second Generation Facsimile System Employing Redundancy Reduction Techniques

BERNARD M. ROSENHECK, SENIOR MEMBER, IEEE

Abstract—**A digital coded facsimile system has been developed employing redundancy reduction techniques to reduce the time-bandwidth product requirement over conventional facsimile by a factor of 5 to 1 for an average complexity document. Experimental results are presented which illustrate the feasibility of technique using subframe variable velocity raster scanning, fiber optics contact printing, and a simple, but efficient, coding algorithm whose choice was based on the results of an extensive statistical analysis program. The terminal operates at two data speeds 50 Kbit/s and 4800 bit/s and can transmit an average 8½- by 11-inch document, scanned at 135 lines per inch resolution in 7 seconds over group channels and in 70 seconds over voice bandwidth channels.**

Introduction

CONVENTIONAL means of transmission of graphic information by facsimile techniques requires considerable transmission time or bandwidth. In many applications, channel capacity is limited and costly. In others, such as satellite or aircraft to ground transmission, both the time available and bandwidth for transmission are limited. However, despite its time-bandwidth product limitation, only facsimile offers a broad spectrum to the form and content of the graphic source to be transmitted.

It therefore becomes essential to improve the efficiency of transmission if facsimile is to be used. This is possible, since a large amount of graphic imagery is redundant, and theoretically, only the nonredundant or information bearing elements need be transmitted. Applications of information theory have led to studies of a number of systems employing redundancy reduction techniques. None of these systems have achieved widespread acceptance up to the present time. The reason for this was not so much the impracticality of these systems, but the unavailability of economical methods to implement them. Advances in digital techniques and development of integrated circuits has reduced the cost of implementing these systems to the point where they are now economically and technically feasible.

Tyler [1] reports on a black-and-white hard copy communications terminal developed for the digital trans-

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mission and reception of 18 inch wide weather maps over voice band channels. Utilizing a two-dimensional compression algorithm and sonic delay line memories to store a previous scan line, the terminal provides a five-fold increase in traffic capacity over present conventional facsimile techniques. Cherry *et al.* [2] describe a system for gray scale based on run length coding and elastic buffering. Typical compression ratios achieved range in the order of 3 to 1. Gordenhire [3] describes a different system for gray scale based on a first-order predictor and interpolator. Good quality reconstructions have been achieved at compression ratios of 3.5 to 1.

Compression Technique

The choice of compression technique is dependent upon the nature of source material to be transmitted. For black-and-white graphics such as text, drawings, and weather maps, examination reveals that the number of black-and-white changes on a single scan line are but a small fraction of the total number of resolvable elements along the scan line. As the scanner crosses wide regions of constant level, the additional information contained in each successive sample point is extremely low. That is, there is a high degree of intersymbol influence between runs of identical elements, and the probability that each successive element will be the same as its predecessor is quite high. Therefore, there is no need to transmit each element as in conventional facsimile systems. Only the length of the run of elements need be transmitted. This technique is particularly well suited for long runs as the length of the run could be transmitted in digital coded form requiring far fewer bits than the number of elements in the run itself. For example, a run of 100 elements could be transmitted by the binary signal 1100100. As this signal requires the transmission of only 7 bits instead of 100, this run is transmitted with a time compression factor of 14.3 to 1. Since the time compression factor for a particular run depends upon the length of the run, either a variable scan rate capability or a buffer storage must be provided at both the transmitting and receiving ends of the system in order to keep the transmitted digital data at a constant rate.

Buffer Storage or Variable Scan Rate?

In order to achieve a transmission time of 7 seconds for an average complexity $8\frac{1}{2}$- by 11-inch document scanned at 135 lines per inch, an average scan rate of 212 scans per second is required when scanning across the $8\frac{1}{2}$-inch dimension. However, redundancy reduction requires the scanner to operate at considerably higher rates for an on-line system, because the information rate can vary by more than two orders of magnitude in different regions of the document. Transmission of this variable rate information at a constant rate over the digital channel can be accomplished by a buffer memory which will store the high data rate information for transmission during low data rate periods.

Buffer size becomes excessive, however, unless unreduced information is applied to the buffer one scan line at a time. Calculations show that a buffer of 6000-bit capacity is sufficient for both single- and double-spaced typewritten material scanned at 135 lines per inch. Although this technique is applicable for document transmission times of one minute per page over voice band facilities, it is not applicable for higher speed transmission (7 seconds) as the corresponding rate of copy advance would be in excess of 400 steps per second.

An alternate approach is to use a variable scanning speed which will change its speed according to the amount of information present. The variable speed scanner in effect utilizes the paper on which the copy is present as the storage media. This eliminates the electronic storage requirement entirely. As a consequence, the system may be characterized by scanning and recording mechanisms which traverse a fixed raster pattern, but whose scanning and recording rates vary according to the information content of the graphic material.

System Description

A variable scan rate facsimile system employing run length coding for redundancy reduction has been built and evaluated by Litcom. The terminal is a feasibility demonstration model whose prime purpose was to verify the soundness of the design concepts chosen for scanning, recording, and time-bandwidth compression. The system is capable of transmitting a typical $8\frac{1}{2}$- by 11-inch document at a resolution of 135 lines per inch in 7 seconds over a 50-kbit/s group channel and in 70 seconds over a 4800-bit/s voice band channel.

The scanning and recording systems are incremental, permitting data compression to be used without bulk data storage buffers. The scanned document itself serves as the storage medium. The scanning pattern is a standard line-by-line raster similar to that employed for conventional facsimile or television. A digitally controlled cathode-ray tube (CRT) flying spot scanner provides horizontal motion of the scanning spot with respect to the paper. Frame advance is by paper motion, combined with a small vertical CRT spot deflection to compensate for the instantaneous error in the paper position servo. Recording is accomplished with a CRT having a fiber optics faceplate in contact with the recording paper.

Use of paper feed rather than spot deflection for major vertical motion (full frame raster scan) permits a lower resolution CRT to be used for scanning, and allows the use of fiber optics contact printing for high recording efficiency without the extremely high cost of a full page size contact faceplate. Recording is made on high speed oscillograph paper with heat development, and the output copy becomes visible within 3 seconds.

Data compression is accomplished with a simplified run length code, where only white runs are coded. This guarantees a sufficient exposure time for recording, limited only by the transmission bit rate, and still gives significant data compression.

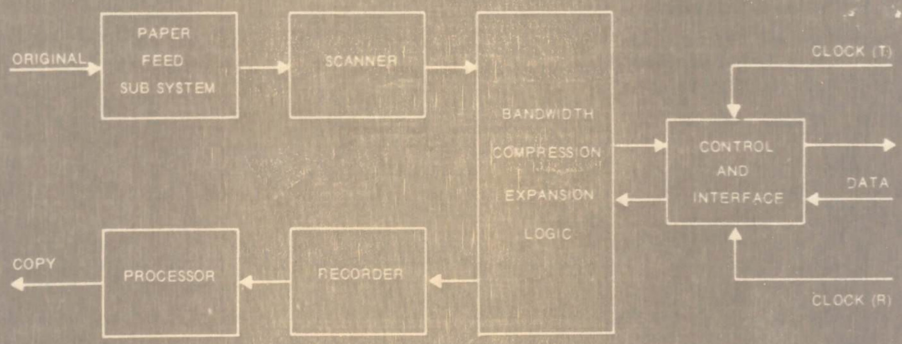

Fig. 1. FASTFAX simplified diagram.

The FASTFAX terminal has six major components as shown in Fig. 1. The original copy is fed past a scanning mechanism which detects the spatial information and converts it into an electrical analog signal whose amplitude variations represent the density variations along the scan line. The output of the scanner is sampled providing a sequence of bits consisting of alternating black and white runs, with varying number of bits per run. Each bit corresponds to a resolution element as determined by the incremental advance along the scan line. The sweep advance is determined by the compression logic which causes the sweep to start whenever data is required, and stop at the end of a run. Thus storage is not required, and data overflow will not occur for any copy.

The data compressor provides a constant rate stream of reduced data synchronized with the transmission link clock. The transmission link reproduces this data stream at the receive destination. The data expander accepts the reduced data and recreates the original data stream of black and white runs.

The recorder exposes the recording paper according to the output data of the expansion logic. The final output copy is therefore an exact duplicate of the original copy at the transmitter.

FASTFAX Scanner

Incremental scanning is achieved by use of a hybrid combination of a fast decay P16 phosphor CRT flying spot scanner for horizontal scan and a servo driven set of rollers for document feed. The major components of the scanner are shown in Fig. 2. A projection optical system forms an image of a raster scanned on the face of a CRT. The document is kept in a dark space, so that the only light falling on it is that from the focused CRT spot. The light reflected from the document at the scanning spot is detected by a photomultiplier. The signal is then threshold detected, sampled at the scanning rate clock, and applied to the compression logic circuits.

The system is basically a line scan rather than an area scan system. In an area scan system, the entire document, while stationary, is scanned by projecting a full frame raster sweep of the CRT faceplate on to the document. In a line scan system, a narrow rectangular area ($\frac{1}{8}$-inch high) on the face of the CRT is projected with its long side across the width of the document. A digital controlled servo system drives the document past this scanning aperture. The subframe raster scanning technique employed in the FASTFAX system has the following advantages over a full frame raster scan method.

1) The resolution requirement of the CRT is reduced. The subframe technique requires 1148 resolvable elements across the tube diameter for $8\frac{1}{2}$-inch width copy scanned at 135 lines per inch. The full frame technique requires 1880 resolvable elements across the tube diameter, corresponding to the diagonal of an $8\frac{1}{2}$-by-11-inch document scanned at 135 lines per inch.

2) The system is capable of handling input copy of unlimited length such as teletype or computer printouts.

3) Access time for consecutive documents is reduced. After scanning, the document need not be removed from the scanning station before inserting a new page. In the recorder, during exposure, developing of the latent image can commence on previously exposed portions. A separate processing cycle is not required.

4) It is easier to eliminate specular reflections from getting into the photodetector. When the scanning beam strikes a glossy document, a portion of the incident light is reflected with an angle of reflection equal to the angle of incidence. This signal contains no information about the printing on the document, and if it is intercepted by the photodetector, it will act as noise which can be many times stronger than the signal obtained by diffuse reflection.

A full frame scanning raster will have a wide specular reflection cone in all directions, and the photodetector would have to be placed far off axis where its efficiency is low. In contrast, a subframe raster scan has a narrow specular reflection cone in a direction perpendicular to the scan lines. A photodetector can be placed near the optical axis, which increases light efficiency and saving space.

5) Contact printing may be employed in the recorder by means of a fiber optics faceplate CRT, resulting in greatly increased light efficiency (by a factor of 50 to 100) over a full frame projection raster.

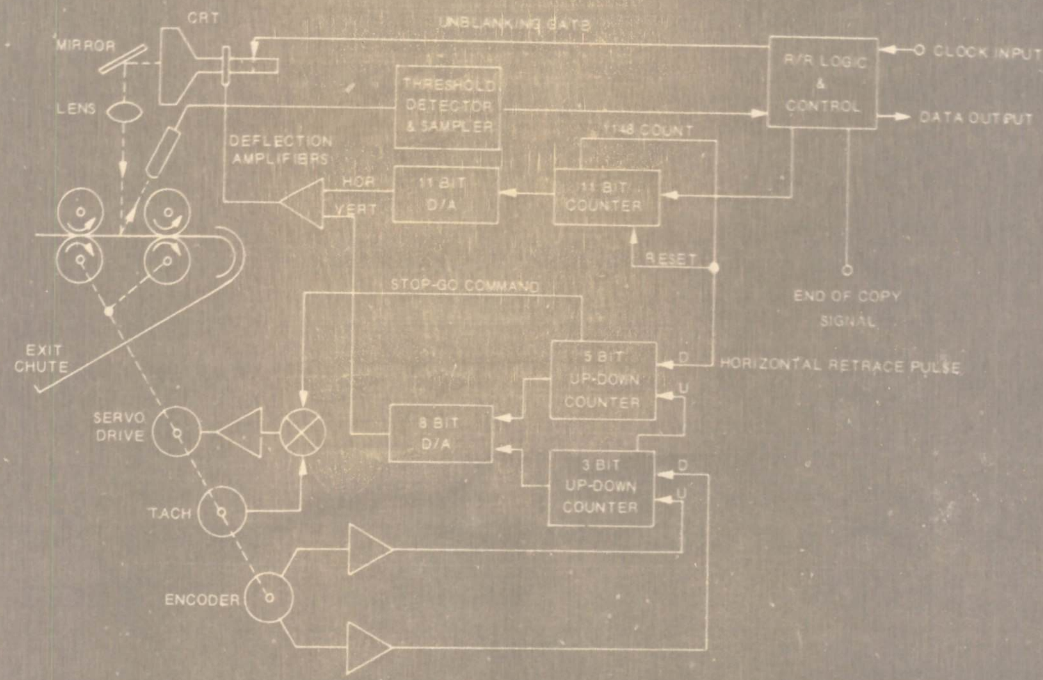

Fig. 2. FASTFAX scanner.

6) The tube and optics introduce distortion in one direction only, and the optical space required is smaller because of the reduced magnification requirements which reduces the length of the optic axis and field of view in the long dimension of the copy.

Step Paper Feed Subsystem

A digital controlled closed-loop servo subsystem drives the document and recording paper past the scanning aperture. This technique allows the subframe raster scan to be used with no sacrifice in variable scan rate capability, which is met by a 10^6 elements per second peak scan rate, interruptable at any resolution element. The choice of this scanning rate is explained later.

The peak vertical scan rate (at 135 lines per inch resolution) is 1/1148 of the peak horizontal scan rate or 872 Hz (assuming an all white area, zero retrace time, and absence of an end of line synchronization character). This corresponds to a rate of movement of the paper past the scanning aperture of 6.5 in/s. This rate is readily provided by the mechanical step paper feed subsystem.

Although the mechanical paper feed easily provides the required peak vertical scan velocity, it cannot provide the acceleration required for starting and stopping due to the sluggishness of the mechanical system. To compensate for this, the instantaneous error in paper position is monitored to an accuracy of $\frac{1}{8}$ of a scan line width, and is applied to the vertical deflection system so that the spot position compensates for this error.

Referring to Fig. 2, the beam deflection is controlled by horizontal and vertical position counters, each driving a digital-to-analog (D–A) converter. The incremental scan is advanced by the horizontal counter, controlled by the reduction logic. When the horizontal counter advances to the end of the scan line (1148 counts) a 5 most significant bit vertical position counter is advanced (by one count) by the horizontal retrace pulse before starting the next sweep. The vertical deflection control of this counter is equivalent to 32 scan lines, and each pulse applied to it will cause the beam to deflect in a down direction by one scan line width.

The paper rollers are driven by a bang-bang type servo, which operates with a binary input, receiving a STOP or GO command at any time. If the GO command is applied continuously, the paper will accelerate to 10 in/s and maintain this velocity by means of a tachometer feedback loop. When the STOP command is applied, the motor will decelerate to zero velocity and remain at rest.

The STOP/GO command is provided by the polarity of the most significant bit of the 5 most significant bit counter (the 16th count position). When the vertical position of the scan line exceeds 16 (midway mark on the subframe raster), the GO command is applied to the servo system and the paper begins to accelerate.

A shaft encoder on one of the paper feed rollers produces a pulse for each $\frac{1}{8}$ of a scan line width movement of the paper. This pulse is applied to a 3 least significant bit counter and causes the beam to move up by $\frac{1}{8}$ of a scan line width. After eight pulses have been applied to the 3 least significant bit counter, this counter resets to zero, and applies an up pulse to the 5 most significant bit counter. The net effect of the 8th pulse is to cause the beam to move up by $\frac{1}{8}$ of a scan line width.

Because the maximum paper velocity of 10 in/s exceeds the maximum peak vertical scan rate of 6.5 in/s, over correction occurs, and the 5 most significant bit counter is driven back past its count of 16 at which time the STOP command is applied to the servo system. Paper movement overshoot is compensated for by correcting in increments of $\frac{1}{8}$ scan line as described previously. The servo has sufficient acceleration capability, so that the vertical beam position is never more than ±16 line widths from its center position on the subframe raster window.

The dynamics of this servo system have been analyzed, and the velocity and distance curves are shown in Fig. 3 based on a 2 to 1 ratio of peak paper velocity to peak vertical scan rate. As seen from these curves the maximum raster displacement from its center position of 16 is ±8 scan lines, leaving a safety factor of ±8 scan lines. The feasibility model actually has a 1.6 to 1 ratio and as a consequence exceeds somewhat a ±8 scan line peak deflection.

Choice of Redundancy Reduction Code

In order to simplify the redundancy reduction logic, a code was selected which would not require bulk data storage such as a delay line or core memory at either terminal, yet would still yield reasonable data compression. With this restriction, the choice of a code became dependent upon the characteristics and limitations of the scanning and recording mechanisms.

The important limitation in the scanner is the maximum elemental area scanning rate. It is possible to sample a single elemental area at a time upon command of the reduction logic. However, the minimum time between samples is limited by deflection amplifier settling time and phosphor persistance. To assure accurate scanning the maximum scan rate was limited to 10^6 elements per second. This corresponds to a peak scanning to line transmission rate of 20 to 1 at 50 kbit/s. This ratio is sufficient to yield a compression ratio of 5 to 1 for average documents.

The critical limitation in the recorder is elemental area exposure time. This is the time necessary for the beam to be on in order to expose one black elemental area. Although the high speed oscillographic paper employed in the feasibility model can be exposed in less than 5 μs per elemental area, of interest was a more permanent but less sensitive recording medium (dry silver or electrophotographic paper) which requires longer exposure times.

Statistical analysis indicated that close to optimum compression could be obtained by coding the data represented by the white elemental areas and transmitting black elemental areas at the line clock rate, on a one-for-one basis. At a 50-kbit/s transmission rate, each transmission bit takes 20 μs, insuring that sufficient time is available at the recorder for settling and exposure time regardless of the number of black elemental areas or their distribution.

In the scanner, the beam steps along in 1 μs steps per white elemental area. Horizontal spot deflection is controlled by an 11-bit position counter driving a D–A converter. The use of an 11-bit counter allows division of the $8\frac{1}{2}$-inch wide scanning dimension into 1148 elemental areas corresponding to a resolution of 135 lines per inch.

After the first black elemental area is reached, the beam advances one more elemental area, and if it is black the beam stops and waits 19 μs before it advances to the next elemental area. If it is black the preceding process is repeated until a white elemental area is reached. The net time per black elemental area is thus 20 μs.

All of the black elemental areas are transmitted as a logic one except for the last black in a run, which is transmitted as a zero. The zero bit instructs the recorder-decoder logic that this bit is the last in the black run, and that the next bits represent a white run.

White runs are coded using a five-unit binary code for runs up to 30 elemental areas in length. For white runs longer than 30, i.e., 31 to 284, an eight-unit overflow code is sent. For run lengths longer than 284, the combination of five- and eight-unit codes are repeated as often as required.

The maximum white run length that can be transmitted in a five-unit code is equal to 30, since the code word for 31 (5 ones) is used to inform the decoder that an eight-unit overflow code word will follow. Similarly, an all one eight-unit code is used to inform the decoder that a five-unit code will follow.

Specifically, during the time that the last black elemental area is being transmitted (20 μs) the sweep must advance enough to detect the most significant bit of the white run length code. Since the most significant bit of a five-unit code is 16, there is ample time for the scanner to step 16 elemental areas in 20 μs at a 1-MHz stepping rate.

Scanning in the recorder is similar in that it also uses a digital controlled incremental deflection system. However, the recorder beam does not have to come to rest on every elemental area scanned, but only on the black elements which are to be recorded. To simplify the design of the data expander, the horizontal position register is a parallel accumulator rather than a counter. The data indicating white run lengths are added to the contents of the register as they are received, and the beam jumps from the last black elemental area of a previous black run to the first black elemental area of the next run. Since the most significant bits of the white runs arrive first, the large steps occur first allowing additional settling time prior to recording the first black elemental area after each white run.

This coding method, consisting of self-adaptive coding for white runs, and transmitting black runs in uncoded format compares favorably to the theoretically best possible Huffman [4] coding method. However, unlike the Huffman code, the FASTFAX algorithm is more easily implemented and suited for a finite speed scanning

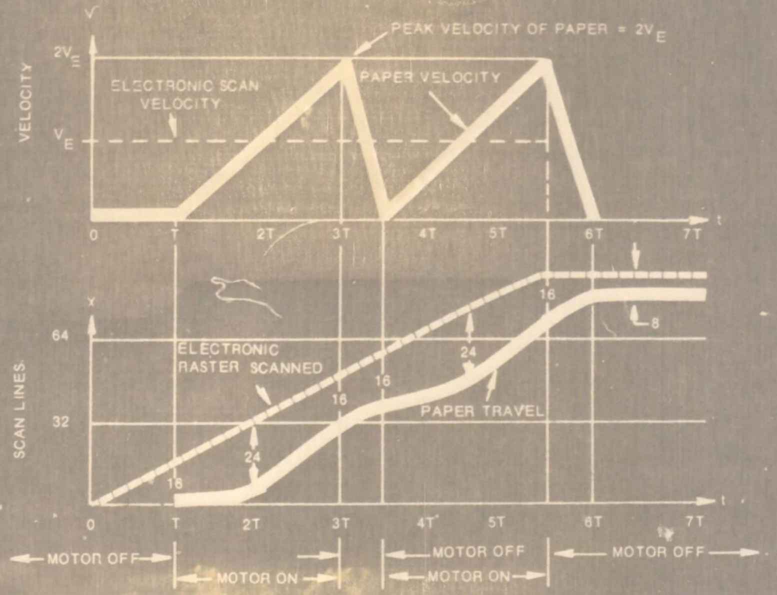

Fig. 3. FASTFAX step feed subsystem velocity and distance curves.

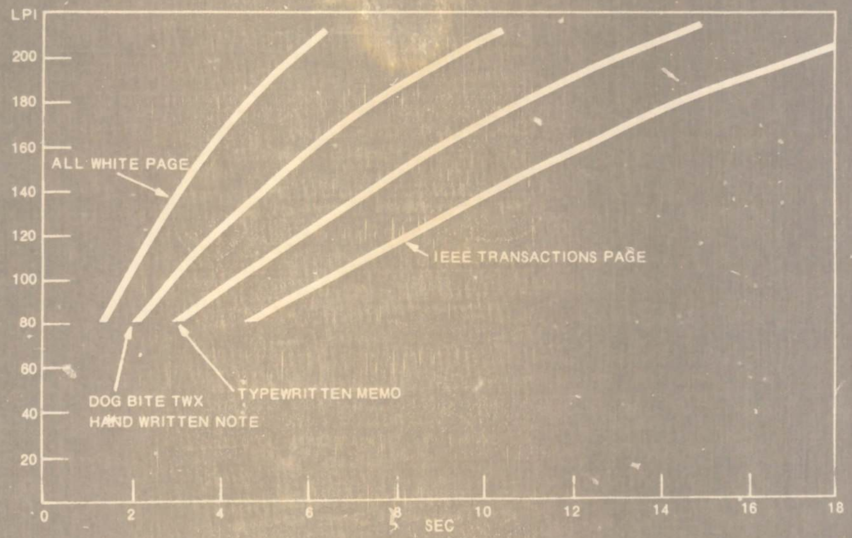

Fig. 4. Transmission time versus resolution for 8½-by-11-inch pages, ⅜ white run length code, 1.0-MHz scan rate, 50-kbit/s transmission rate, 31-bit retrace character.

system. In fact, of all the one-dimensional coding methods considered, the FASTFAX method is one of the simplest, with very little sacrifice in compression efficiency. For a typical typewriter memo (single-spaced) the compression factor achieved with the FASTFAX algorithm is 5.1 as compared to 5.7 using a Huffman code.

Error Control

Although facsimile signals are highly immune to noise, because of the two-dimensional spatical correlation of graphic data, redundancy reduced signals are much more susceptible to noise. Facsimile signals can tolerate error rates as high as $1/10^2$ or $1/10^3$, the effect of noise appearing as speckling which does not destroy legibility. Redundancy reduction signals, however, require error rates of $1/10^4$ to $1/10^5$ in order to limit the effects of noise, as a single-bit error may cause many bits to be in error on the recorded output. One method to limit the effect of errors is to ignore these errors, but limit their effect to one scan line, or fraction thereof. This results in black or white streaks in the recorded output whenever an error occurs, but will normally not make the copy illegible if their number is kept low.

The transmitter adds, at the end of each scan line, a 31-bit pseudorandom end of line sync character [5] of the Barker type (maximum run length sequence) having an autocorrelation ratio (in the absence of errors) of $+31$ to -1. This sync retrace character is highly immune to data errors, and has the following properties.

1) The probability of false recognition of the sync character due to two or more errors in the received sync word is:

a) 1/10 000 documents for $E = 10^{-5}$
b) 1/100 documents for $E = 10^{-4}$.

Thus one scan line will not retrace in every 100 documents transmitted at a communications line error rate of 10^{-4}.

2) The coded source data may itself appear as the sync character, resulting in a spurious abort of the recorded line. The probability of this occurring, that is, the source data being identical in 30 or 31 bits of the code word is once per 2793 documents.

The disadvantage of using a 31-bit sync word is a slight loss of compression efficiency, as a sync word is sent for each of the 1485 scan lines comprising an 11-inch document. Of the total of approximately 7 seconds required for the transmission of a typical typewritten single-spaced letter 0.92 seconds (13 percent) is spent for the sync words. This method is more easily implemented than forward error correction, for example, and does not have as high a loss of compression efficiency associated with it.

Performance Summary

The compression efficiency achieved for a number of different type documents is shown in Fig. 4 as a function of document resolution. At 135 lines per inch each of these $8\frac{1}{2}$-by-11-inch documents would require 35 seconds transmission at a 50-kbit/s rate using conventional facsimile methods. As seen from Fig. 4, a typical single-spaced typewritten memo (at 135 lines per inch) requires 7 seconds yielding a compression factor of 5 to 1. A typical IEEE Transactions page requires 9.7 seconds yielding a compression factor of 3.6 to 1.

Of particular interest to note is that the compression efficiency increases with resolution. At 200 lines per inch, the typewritten memo requires 13 seconds compressed as opposed to 77 seconds normal, a compression ratio of 5.9 to 1. The reason for this is that the length of white runs increases with resolution yielding more efficient coding. Actually, at 200 lines per inch resolution, a 6/9 code for white runs would yield even higher compression than the 5/8 code depicted in Fig. 4. Of interest also is that an all white page requires 3 seconds at 135 lines per inch resolution, where in theory, an all white page containing no information should not require any time to transmit. In practice, however, as a minimum, the sync retrace character must be sent every scan line, thus accounting for a finite transmission time of 0.9 seconds. The balance of time 2.1 seconds could be eliminated by storing one scan line of data, observing that it is all white, and sending the retrace character instead of coding the all white line.

Experimental Results

Resolving power was measured with a set of United States Air Force tribar test targets. The average resolving power over eight targets at various orientations was 80 lines per inch. The fundamental limitation on resolving power was due to the recorder employed in the feasibility model. Although the sample spacing and line feed in both scanner and recorder were adjusted for 135 lines per inch, the CRT employed in the recorder could not be focused for this resolution, as its original design intent was to serve as a high speed alphanumeric line printer.

The Kodak linograph paper used in the feasibility model belongs to a family known as "direct print paper". Paper of this type is characterized by very high sensitivity, low contrast, and rapid development. In addition, the contrast becomes worse after exposure to room light unless it is chemically processed. Because of this low contrast, sample output of the feasibility model could not be reproduced for inclusion in this paper.

Conclusions

The incremental CRT scanning and recording technique employing subframe raster scanning and redundancy reduction has been shown to be feasible for a high speed (less than 10 seconds) graphic communications terminal. Because a 5 to 1 compression ratio can be achieved, transmission is now possible over group channels where before super group channels were required. The consequent savings in line toll charges of $20.50

per mile per month for hauls greater than 500 miles readily justify the cost of the terminal over conventional facsimile units. In addition, the data compression achieved by the terminal is applicable to reducing computer data storage requirements of complex imagery.

References

[1] V. M. Tyler, II, "Two hardcopy terminals for PCM communication of meteorological products," *Proc. 1969 IEEE Int. Conf. on Commun.*, pp. 11–21.

[2] C. Cherry, M. H. Kubba, D. E. Pearson, and M. P. Barton, "An experimental study of the possible bandwidth compression of visual image signals," *Proc. IEEE*, vol. 51, pp. 1507–1517, November 1963.

[3] L. Gordenhire, "Eliminating redundancy in fixed frame television," presented at the 1966 Goddard Space Flight Center Conf. on Adaptive Telemetry.

[4] D. Huffman, "A method for the construction of minimum-redundancy codes," *Proc. IRE*, vol. 40, pp. 1098–1101, September 1952.

[5] S. Golomb, *Shift Register Sequences*. San Francisco, Calif.: Holden-Day, 1967, pp. 24–36.

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Mutual Coupling Effect on Maximum-Ratio Diversity Combiners and Application to Mobile Radio

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Abstract—The mutual coupling effects on an M-branch maximum-ratio combiner with correlated signal fading in general are considered. The results in the mobile radio case show that the average power delivered to the receiver becomes less as the antenna spacing of an antenna array decreases (i.e., the mutual coupling increases) with either an optimum load network or an optimum resistive load network connected to the antenna array at the front end of the receiver. However, there is not much effect on the power as long as the antenna spacing is equal to or greater than a certain value dependent on the number of the branches M. For $M \leq 4$, the required antenna spacing is equal or greater than 0.2λ. The value for $M > 4$ increases gradually as M increases. It can be obtained following the same technique. The mutual coupling effect on the cumulative distribution of the signal from an M-branch mobile diversity array is also small. Hence for an in-line array with $M \leq 4$, the antenna spacing of 0.2λ can still provide most of the usual diversity advantage.

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I. Introduction

A DIVERSITY combiner has been defined as a linear combination of all the branch signals of a multibranch receiver. In general, different branch signals may be weighted by different gains. The maximum-ratio diversity combiner [15] is defined by the property that among all diversity combiners, it yields the maximum signal-to-noise ratio (SNR) of the combined signal at the output. The maximum output SNR is realized if and only if the optimum weight for each branch has a magnitude proportional to the rms signal and inversely proportional to the mean-square noise in that branch. In this paper we are considering the mutual coupling effect on the maximum-ratio diversity combiner due to the mutual impedances among the branch antennas when the adjacent antenna spacings become small, say, less than 0.5λ.

Without taking the mutual coupling among the branches of the combiner into consideration, it has been found that a 70 percent correlation between two received signals in

Picture this: point-to-point paper from the next big-time black box

● The reception area of a small company in Danbury, Conn., swarms with activity these days. The firm is Graphic Sciences Inc., a young company that aims to dominate the graphic traffic market the way the International Business Machines Corp. dominates computers.

Every desk has a white sign that says, DECIDE. "Not THINK," says Graphic Sciences' chairman, Dr. Sullivan Campbell. "DECIDE! THINK also implies procrastinate."

Right now Graphic Sciences has a single product, dex-I. "Dex," says Campbell, "stands for decision expediting, and that's precisely what dex-I is intended to do." The unit is, in fact, a telephone-attached facsimile transceiver. "We don't like it when people call dex-I a facsimile transceiver," says Campbell. "It's a graphic communication unit!"

If dex-I is a graphic communication unit, it could be the hottest new black box to come out of the communications industry since the IBM 360. There are at least ten devices like it on the market and most of their manufacturers claim to be sweeping the field. But when you try to pin them down on figures, they are extremely evasive; a little checking into actual sales turns up mostly zeros.

"We have over a thousand in the field now," Campbell says bluntly, as his assembly line cranks them out and tests them. Out behind the plant, workmen are building another wing that will almost double plant area. Orders are running well ahead of production, but the assembly people are hanging in there. Orders for units are even rolling in over facsimile transceivers—oops, graphic communication devices—in the hallway alongside the executive offices. Luckily, there are enough dex-I's around to handle them.

There are several reasons customers are flocking to Graphic Sciences: dex-I is a facsimile device that was engineered with great sensitivity to the customer's problem as well as to the general problem of getting good transmission over some pretty awful telephone circuits. "We designed the dex-I to operate satisfactorily on any connection you can hear voice over," says Campbell, "and it'll work anywhere—on any a-c line from 40 to 400 cycles, and from 80 to 140 volts."

Another secret to dex-I's popularity is that many of its competitors have bad breath: current passing from a stylus to the conductive paper on a rotating drum darkens the paper according to current density. The process is rather smoky and an odor like that from a cap pistol issues forth from most facsimiles. In dex-I, a high-speed turbine vacuums the smoke from the stylus through a filter. Says Campbell, "There was a very simple spec for that filter: the air must come out of the machine cleaner than it went in."

By designing the optics with a spectral response that mimicked the human eye, Campbell and his engineers

Plug-in graphic transceivers, built to operate over telephone lines, solve the problem of signal noise and fading to produce clear images, and promise to turn decision making into a see-for-yourself proposition

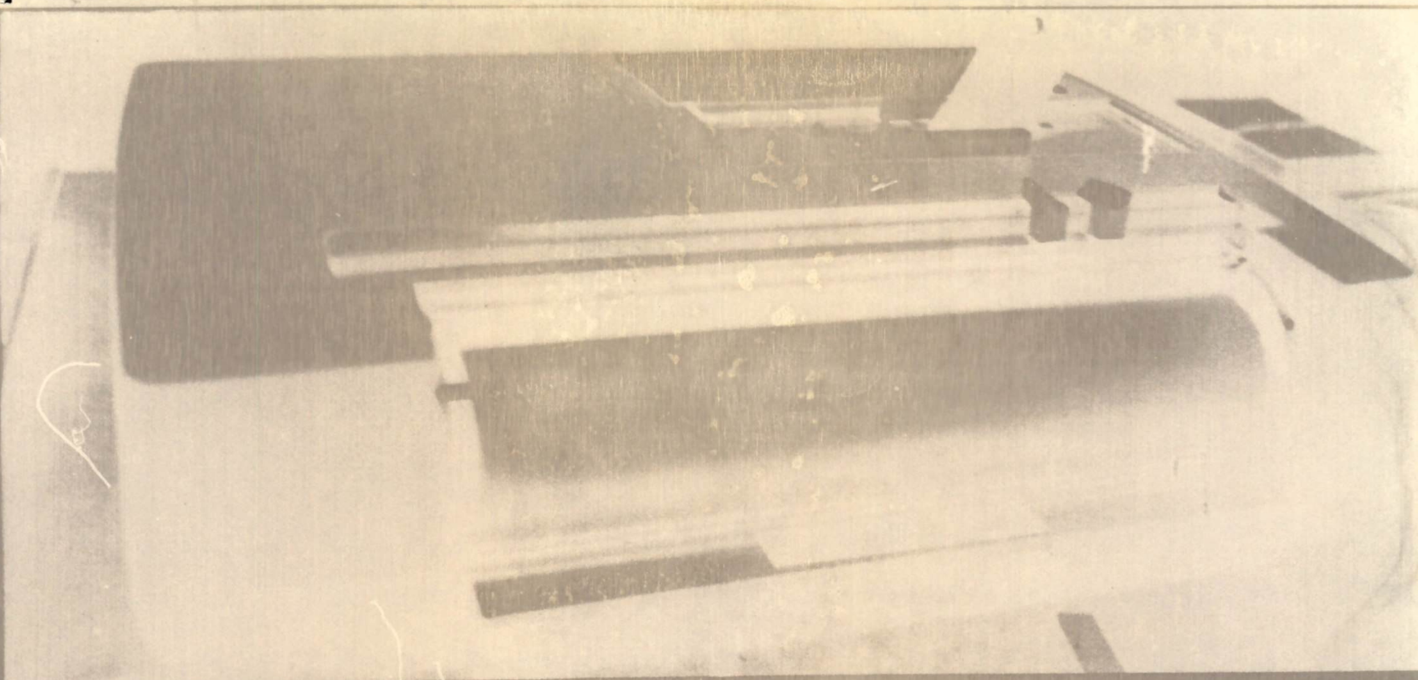
Decide, don't think. Graphic Science's chairman Sullivan Campbell contemplates the many ways his firm's new facsimile equipment will help executives avoid procrastination. The first unit, called dex-1, is rolling off the production line now, and rents for $75 a month.

were able to make sure dex-I wouldn't be "color blind" —that is, colored material would not wash out and fail to appear at the other end.

To work out dex-I's mechanical designs Campbell hired one of the best graduate students in mechanical engineering at MIT, Eric von Hippel. "Simple mechanical difficulties can make it hard to sell machines," says Campbell. "Like if a secretary breaks her fingernails every time she tries to load a paper drum, you've got a problem. She'll get to dislike your equipment." In von Hippel's design, the paper is dropped into a sliding tray, which feeds it right on to the drum, perfectly, every time.

However, dex-I's best feature is not in its optical or mechanical design, but rather in its circuit design. Like his competitors, Campbell had to solve the problem of line interference in the telephone network. His competitors, reasoning by way of analogy with broadcasting, chose acoustically-coupled f-m signals to carry the image. "Give me 50 khz and I'll give you the damndest f-m transmission you ever saw," says Campbell, "but for 3 ktz, a-m is far more suitable."

For a-m transmission, the telephone line presents two problems: noise and fading. Line-noise, and all ambient noise, except that which looks just like a signal, can be filtered electronically. Fading, Campbell controls with an acoustical single-sideband technique. For every scan,



black and white test bars are sent along with the information signal to the receiver, which readjusts the level of stylus current appropriately. Thus, as the telephone line voltage ebbs and surges, the test bars riding in on the single sideband is analysed by special circuitry, which adjusts signal level to achieve a uniform image.

"The alternative was to put up with the problems of audio-frequency f-m," says Campbell, which puts a watery effect on the copy due to phase distortion of the telephone lines. In the end, dex-I used 27 integrated circuits to filter the a-m signal, detect and analyse the ssb, control recording level, and synchronize drums.

Appropriately, according to Campbell, Graphic Sciences got into DECIDE business because it knew what it wanted. The dex-I is based on a machine developed by the H.L. Morgan Co., which was set up as the industrial products division of KLH to generate a family of acoustical industrial products. One product was an acoustically-coupled graphic transceiver.

The intention was to build the machine with high fidelity KLH parts. But then KLH was bought by Singer, which, according to Campbell, did not appear to be interested in marketing industrial products. The Arthur D. Little Co. was down the block, and tried to help Morgan market this electrical writing process.

"Most companies turned the idea down because they didn't believe that the patents, which seemed so general, would in fact be issued. Other companies didn't reject the idea, but didn't make up their minds, either. We walked in and we knew we wanted that machine. We offered to buy all the rights to it for a half-million dollars—$150,000 cash, the rest over seven years. We were there with a solid offer and they took it."

Thus, Graphic Sciences was born in May 1967. The minute the agreement was signed, Campbell and his partners started redesigning the box and weaving a web of patents around it. "The only components left from the original design," he says, "are the photodiode and the light bulb."

Now, Graphic Sciences is working on other machines. Its dex-II attaches directly into the telephone system (or two units can be connected with lampcord). When dex-III arrives, it will automatically answer the telephone to take a facsimile, record the image on magnetic tape, then hang up. And dex-IV will be either a three-minute machine (dex-I takes 6 minutes), a 45-second machine, or an attache-case unit that would converse with computers, rather than other dex models.

"Of course," Campbell pointed out, "it doesn't make sense to introduce a portable dex-IV until there is a well-established number of machines for it to talk to." As he finished, he was informed that three people were waiting to see him, and four were trying to call him.

Sullivan Campbell smiled.

Is this next? Charging into the facsimile market is dex-1, a smokeless, easy-to-load unit that couples acoustically to the telephone network.

Wired lady. The girl on the standard IEEE facsimile test chart, reportedly the secretary of a Kodak executive, undoubtedly is the most widely reproduced woman in the world. A good way to compare the quality of a pair of transceivers is to send the original (above) to a receiver, which rolls out a copy (below). The Graphic Science unit, dex-1, produced this result over an ordinary telephone connection. Telephone receivers were locked in the dex-1's acoustically insulated compartment and the receiver was loaded with current-sensitive paper. Within a few seconds, the rotating drums synchronized and transmission proceeded. Most facsimile units communicate over the telephone network with a similar acoustical coupling arrangement. Usually, the audio signal is frequency modulated. But dex-1 uses a-m modulation to provide a clear image free of the watery affect that is seen on some f-m modulated transmissions.

• Even good communications, designed, built, maintained, and used by humans, is fallible. But when a communications system is put to a use for which it was not intended, frustration is almost inevitable.

On East 76th Street on Manhattan's Upper East Side, just such a communications system exists. There, Hertz operates one of its many automobile rental stations. In general, Hertz is very efficient in dealing with customers; all over the country, and at other stations in New York, a client can walk into Hertz confident he will drive away in a clean, late-model car in a matter of minutes.

But at the 76th Street location things are different. There, a small, round man named Mr. Levenson stands behind a desk, surrounded by electronic communications equipment—a Telautograph, a computer console, a telephone—and, on more hectic mornings than he cares to remember, a group of very irate customers.

Reservations for Hertz cars in Manhattan are made by dialing a central telephone number—661-7100. Between 40 and 50 "reservationists" handle incoming calls. As each request is filled, the reservationist tells the customer he has a "confirmed reservation," then sends the information—the customer's name, intended time of pick-up, and any special instructions—directly to the Telautograph in the appropriate station. There, as cars come and go, the clerk behind the desk enters rental transactions into the computer's memory using a CDC time-sharing terminal designed for the purpose. A CDC-8081 computer, located at 645 First Ave., maintains an up-to-the-minute inventory of cars at all metropolitan stations.

The CDC system was designed primarily for "car control"—that is, it keeps inventory and mileage data on cars to locate those that are not returned and to insure that all cars get periodic maintainance. It was not designed for on-line reservation checking. However, by using printout from the computer off-line, Hertz found it could put the expensive system to work updating records of availability.

The Hertz reservation system has three flaws. One is inherent in car rentals; the other two derive from the fact that the CDC system wasn't intended for reservations.

The central—and unsolved—problem in car rentals is that the company obviously must make reservations sometimes days or weeks in advance, but it cannot possibly know which cars will return to what stations, and when. So when the reservationist says a customer has a confirmed reservation for 9 a.m. Thursday at the 76th Street station, he is really betting that at least one car will be there by then, or that he will have time to get one there from a nearby station.

The snag in using the computer for reservations is that the system was not intended for on-line display of inventory. Presently, a city manager gets a printout from the computer every half hour. He checks to see if any station is low on cars, but the score sheet is always behind by a few minutes to a half hour, and there are too many variables to guess right every time.

Finally the computer has no feedback for reservations. It knows only whether cars are checked in or out; not if customers are getting into them and driving away.

At most Hertz stations these flaws aren't evident, and the system works fine. But at the East 76th Street sta-

Hertz puts a black box

Even the best-laid plans of men go astray if they're put to unintended uses;

Going awry. Under pressure from several irate customers and surrounded by electronic equipment, a Hertz employee can do little more than fill out rental forms by hand and pile them up on the Control Data Corp. custom terminal while additional "confirmed reservations" stream out of the Telautograph mounted on the wall at the left.

tion the effect of the flaw often is painfully obvious.

Each morning a number of "confirmed reservations" are made and customers start arriving to claim their cars. But cars are not always forthcoming, and Levenson tells customers that there is a delay of perhaps 15 minutes and asks them to have a seat. By 9:30 on some mornings there are as many as eight or 10 disgruntled customers packed into the small seating area—some already waiting for over an hour. Levenson periodically leaves the desk, exits through the door at the rear of the waiting room—and reappears looking even more concerned than when he left. Meanwhile, confirmed reservations continue to spew forth from the Telautograph, and customers, expecting them to be honored, continue to arrive. "I keep telling them about this," Levenson says nervously, "but it doesn't seem to do any good."

The root of the problem, according to an informed source, is out in back. Some days the station is shorthanded; there may be only one man to wash, clean out, and fill up cars with gas. In addition, says the observer, the company only rents space in a garage at 355 East 76th St.—and garage employees have priority over Hertz people in using automobile elevators. So once a car is prepared for a customer, the Hertz employee may have to wait while elevators carry cars to garage customers.

Under these circumstances, the computer only compounds difficulties. With no way of knowing that cars are not getting to customers, the computer merrily continues to indicate their availability, and clerks, assuming all is well, make confirmed reservations, which keep pouring forth. In the middle of all this is Levenson, surrounded by exotic communications equipment, yet unable to tell the computer that the situation no longer fits its simplistic view of how cars are tallied, or to reach the reservation clerks who are making confirmed reservations on the basis of the half-hourly computer printout.

Ironically, Hertz is owned by RCA, one of the giants of the information business, yet the auto-rental company's 76th Street station hardly reflects the spirit of this alliance. Irate customers are not told how long they are likely to be kept waiting. Calls to manager usually are to no avail.

Perhaps most ironic is this paradox: the only hope for solution hinges on the ability and willingness of the companies involved to communicate the nature of their problems to those who can do something about them. Communications difficulties are not unique to car-rental firms or other companies—they're the problem of the electronics industry.

Unfortunately, the companies that do jump into new communications systems tend to shovel any bugs under the carpet. Executives who recommend acquisition or development of an electronic system usually aren't inclined to talk about its shortcomings—not even to other executives in their own firm. Often a company doesn't believe that it should discuss difficulties that subsequently develop, even with the consultants who designed the system, for the next client might well be a competitor. And rarely will any firm wash what it considers to be dirty linen in public—so the press is often shut out of any investigation of a system problem. Hertz, for example, refused to discuss its reservation system.

in the driver's seat

when inventory control system doubles as reservation-checker, trouble ensues

A postscript

● Historians may someday credit three men—David Sarnoff, Claude E. Shannon and Edward R. Murrow as having the greatest influence on the development of the communications industry during this century.

Sarnoff, who first gained fame as the wireless operator whose messages sent ships to the aid of the doomed Titanic in 1912, brought to the industry a verve that it has never lost. It was Sarnoff who, in the early days of broadcasting, risked funds to popularize radio by putting on the air a blow-by-blow account of the Carpentier-Dempsey prize fight. It was Sarnoff who pushed tv and tv programing just after the second world war. And it was Sarnoff who made color what it is today. Indeed, it was he who forced the communications industry to be bold and imaginative.

Shannon, in his paper "A mathematical Theory of Communication," formalized the notion of information transfer the way James D. Watson and Francis H. C. Crick formalized genetics, or as Albert Einstein formalized the relationship between mass and energy. Shannon, in his 1948 paper, examined everything from pulse-code modulation techniques and Markoff chains to crossword puzzles and James Joyce's "Finnigans Wake." In the end, he reduced the entire question of the theoretical capacity of a transmission line—any transmission line—to a mathematical relationship between nothing more than bandwidth and signal-to-noise ratio.

But it was Murrow who gave communications perhaps its most valuable gift—good content. He was an electronic journalist who first gained fame on radio, then tv. To him, actors imitating famous politcal figures and reciting hypothetical, even mythical, conversations, and movie projectors showing recent events in which much of the footage and the entire sound track were actually dubbed in—these were travesties of journalism. It was Murrow, more than any other individual, who provided the conceptual framework and intestinal fortitude by which mere news readers were replaced by the Chet Huntleys, the David Brinkleys and the Walter Cronkites; white boutonniers and still slides of people in the news were replaced by live, on-the-scene, tv coverage.

Murrow addressed himself to the question of communications content, a question that engineers and executives must start addressing themselves as distinctions between hardware and software become increasingly blurred. For it is they who must take on some of the responsibility of what is communicated, not just how.

Perhaps these men—the engineers and executives—would do well to be guided by what Albert Einstein once said:

"Never let the container be more valuable than the contents." ●

Reprints of this special report are available at $1.75 each.

The goal: a communications system that

The tools: satellites, facsimiles,

● The great bulk of today's communications [illegible] essentially those that have been in widesp[illegible] last three decades. But the character of [illegible] is about to change. How quickly will depend [illegible] on how quickly the electronics industry [illegible] man—corporate man in particular—is hindered by [illegible] can be described best as a 50-foot communications gap. (In the context of the modern office, 50 feet is the distance at which direct contact becomes less convenient than, say, the telephone.)

Consequences of this gap are readily apparent everywhere. Today, almost all corporate endeavors are broken down so that they are handled by clusters of employees, with members of each cluster dealing directly with one another. If some provision could be made that would enable people to operate effectively without physical proximity, then it would no longer matter whether members of such clusters had offices that were adjacent or hundreds of miles apart.

To cross the 50-foot gap, the business community needs electronic substitutes for travel. Bell Labs' John Pierce puts it this way: "The telephone is just fine if you want to communicate with your grandmother, but not when it comes to your mistress."

Just where the cutoff point comes between physical travel and electronic communication is a moot issue. But one thing is certain: the telephone, by itself and as it appears today, is inadequate as a substitute for travel. Something is lacking in communications, says Pierce, when an executive must fly from New York to the West Coast and back just to attend a three-hour conference. One logical corrective measure would be to add vision to the telephone. This, conceivably, could cut down some business travel, because it would afford users face-to-face contact of sorts; hence, the Picturephone.

But the Picturephone, even if it were to find widespread use, still couldn't be a complete solution. Clearly, electronic substitutes must be developed for everything two people can do in a room, save physical contact and the exchange of solid objects. This means high-fidelity telephones, high-resolution color Picturephones, high-resolution color facsimile, and devices for manipulating machinery. There must also be provisions for storing, transmitting, and routing information. Not only must all these be developed, they must be marketed at a price the public would be willing to pay.

[illegible] needed [illegible] [illegible] make a multitude of high-quality [illegible] plentiful and enough transis[illegible] [illegible]

[illegible] the only thing that resembles a real [illegible] through electronic communication is the telephone system, which includes some 112 million telephones and is worth, according to AT&T, $55 billion.

Unfortunately, for many years the telephone system was, in effect, a closed network. AT&T and the smaller independent telephone companies jealously guarded their lines and waged a war against the use of "foreign attachments." Their battle was waged successfully until in June 1965. California's Public Utilities Commission handed down a landmark decision: a hospital could choose to install in its wards the one-piece Swedish Ericafone—a foreign attachment in the literal sense—rather than the two-piece instrument supplied by the Bell System. The Ericafone, argued the hospital, was sterilized more easily than its Western Electric counterpart and this the California board accepted. This was the first major setback for the telephone companies. A second came about last year, and was a far more telling blow.

In June 1968, a tiny Texas firm that had made a mobile radio-telephone called the Carterfone, won a decision from the FCC enjoining AT&T from preventing attachment. The unanimous decision, authored by Commis[illegible]

Console syndrome. Bernard List, director of Texas Instruments' Systems and Information Science Laboratory, is among those trying to figure out how to eliminate the 50-foot gap electronically. One problem that is often overlooked, he believes, is the fear many executives and even engineers have of a computer console. "Nobody," says List, "likes to be known as the man who made the system go down, and many who were not raised on computers don't enjoy fumbling with them in public."

replaces person-to-person contact

computers, telephones, microwave...

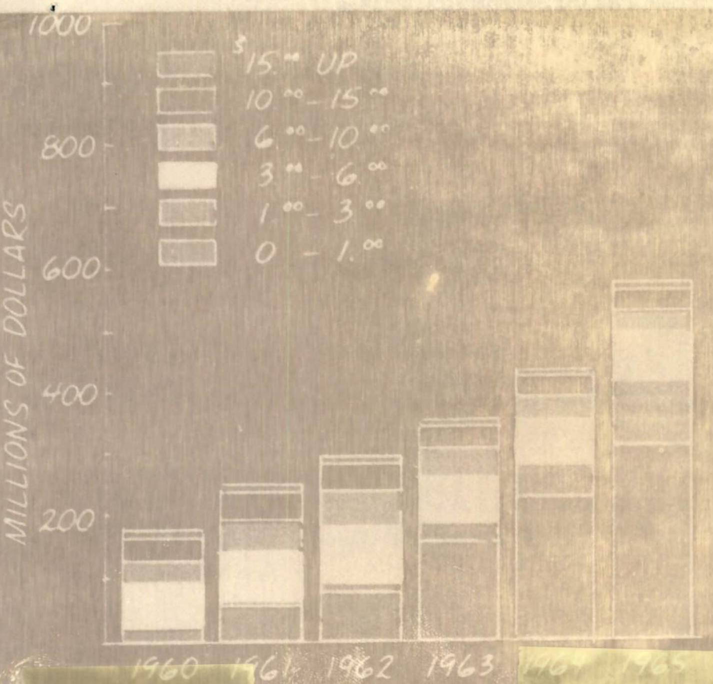
sioner Nicholas Johnson, paved the way for the attachment of everything from decorator and antique telephones to data devices, line recorders, home-made computer terminals, and just about anything else that could be connected to two wires. The $30-per-month Data-phone, which the Bell System had insisted be used as an interface between private equipment and the telephone lines, was superseded by a small $2-a-month adapter. Even that need not be used if the output of the private equipment falls within prescribed limits in various bands of the audio spectrum.

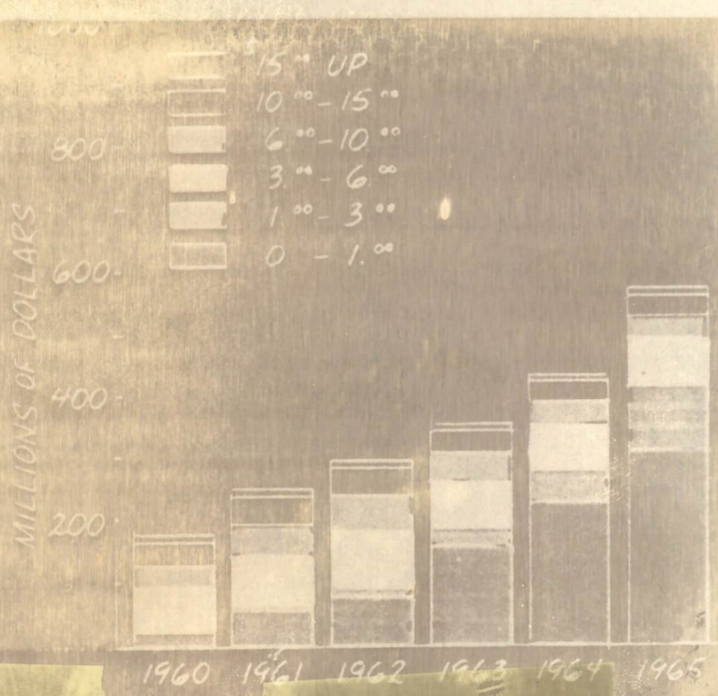
As long as the devices meet the restrictions imposed by AT&T, they can be connected directly, inductively, or acoustically to the telephone system. For example, the output of a directly-connected device must not produce power levels at the central office exceeding 12 decibels below 1 milliwatt when averaged over any 3-second interval. (Basically, the amount of power a unit is allowed to put out depends on the distance it is ultimately installed from the central office, but, as a rule of thumb, it should never put out more than 1 mw.) Rolloff should keep the signal at least 18 db down between 4 and 10 kilohertz; 24 db down between 10 and 24 khz; 36 db down between 25 and 40 khz; and 50 db down beyond 40 khz. In addition, the equipment should not deliver energy solely in the band between 2,450 and 2,750 hz. If this band, which is normally reserved to effect disconnection, is used at all, the power in it must not exceed the power in the 800-2,450 hz band.

Once these restrictions are observed, the $55 billion telephone network is yours. If it's data you're pushing, this network can handle 2,000 bits per second now, 3,600 bits in a year or so, and 4,800 bits by 1975. If it's analog signals you're after, you've got about 3,000-hz bandwidth, but experienced users suggest you forget about the bottom 500. These figures apply to the unadulterated pair of conductors as they now exist in the walls of homes and offices. However, AT&T has found that the addition of amplifiers to an ordinary voice-grade line can forestall high-frequency attenuation and thus boost the useful bandwith to around a megahertz for a few miles—more than sufficient if the central office is nearby. This is how the Picturephone, which requires about 100 times the bandwith of an ordinary telephone, will be connected to switching stations. And this is how the system will ultimately provide 50-kilobit data service, which is presently being tested in several U.S. cities.

As for voice service itself, the Bell System and the independent telephone companies should be able to handle the increasing load over the next few years—today's reports of poor service notwithstanding. There are, however, two distinct questions concerning future service for data transmission: whether the telephone system will be able to handle the heavy flow of data expected by the end of the 1970's and whether the small, suburban telephone companies, will cope with the data boom as it spreads to the suburbs during the next five years.

There seems to be a considerable disparity of opinion when it comes to answering the first question. Data users contend the telephone system in general, and AT&T in particular, hasn't properly prepared for the computer boom in metropolitan areas. They cite Wall Street as a classic example. Unanticipated data flow at the nation's No. 1 and No. 2 financial centers—the New York Stock Exchange and the American Stock Exchange—caused such havoc that telephone service in the entire Wall Street area was disrupted. And if the Bell System was unable to cope with a sudden surge of data in the very heart of New York City, what can be expected from the independent suburban companies? There is no question that these companies will find themselves in the midst of a data boom as more and more computer centers and [illegible]-based firms spring up in suburbia.





A great deal depends, of course, on whether AT&T does indeed anticipate a dramatic surge in data traffic; if it does, it will prepare for one. But apparently the company doesn't expect such a surge. An increase in data traffic yes, but a surge, no. William Quirk, AT&T's marketing director of data communications, puts the present level of data traffic at about 3% of all telephone time consumed in the U.S. "By 1980," he says, "we figure it will probably grow to between 5% and 10%."

Many users put the 1980 estimate considerably higher than 10%. Consequently, they don't believe AT&T will be able to handle the data traffic of the late 1970's and beyond. Louis Clapp, president of Dial-Data in Newton, Mass., warns that unless drastic measures are taken now, national telephone blackouts will become commonplace by 1972. Clapp points out that not too long ago when his company was planning a computer center in the New York area, "we were advised confidentially by people within the telephone company that a serious overload problem was developing in Manhattan." His firm finally located in suburban Englewood, N.J., rather than in New York City itself.

Perhaps the most impartial assessment of data traffic comes out of an inquiry made some time ago by the FCC in which opinions were solicited from the data-processing industry, the communications industry, industrial users of data communications, and various governmental and independent organizations. The opinions were turned over to the Stanford Research Institute, which then prepared a series of seven reports. One of the reports is at serious odds with AT&T's estimate of "5% to 10% by 1980." Taking into account predictions of cost-trends in both computers and communications, the report says, in part:

"Over the next decade, the fraction (of total terminal hours) accounted for by data is likely to increase to between 10% and 50%."

This projection was based on the continuing growth rate of low-speed data—about 70% per year. Equally important, the report pointed out that "in future years, expansion of industry into the suburbs and related factors are likely to result in demand for data services from the smaller independents that are not now [illegible] providing these [illegible]

In the end, the Bell System and the independent companies may not have to conquer the problem of data [illegible]

[illegible] point-to-point wideband communications are now on the horizon in the form of domestic satellites, independent microwave links and community antenna television cables.

Microwave Communications Inc., thanks to the FCC, will become a common carrier when it installs a microwave link between St. Louis and Chicago. The company will lease channels in the same manner as AT&T, but at rates far lower—as much as 94% lower—than those of the communications colossus. Now, Microwave Communications of America Inc. (Micom), MCI's parent firm, is seeking links that will string towns and cities together with wideband communications in much the same manner as Morse's Magnetic Telegraph Co. strung them together with telegraph wire. Micom's prime interest is the big industrial firm which must move mountains of data, not the home. It's the CATV companies who are concerning themselves with the home. Thus far, these companies have fed coaxial cable into some 3½ million homes, providing them with ghost-free tv viewing.

From a technological standpoint, the installation of wideband-switching gear at CATV central stations for use with a microwave network to provide point-to-point, nationwide wideband service poses no great difficulties. The present FCC mandate to CATV makes no explicit provision for such service. But the likelihood of such service is a distinct possibility as CATV's role in the com-

Color it ready. Unable to immediately formulate marketing plans, Xerox continued perfecting its color process while searching for a major application area. Now executives believe they have isolated a huge latent market, although they won't identify it just yet. The process they introduce will work very much like present electrostatic copying and will produce results at least as good as the state-of-the-art color Xerox copy on the left. The original is at the far left.

municative society expands in the 1970's.

Domestic communications satellites, of course, will undoubtedly play a major role in future wideband links. Originally, such satellites were planned to operate on two relatively low microwave frequencies—6 gigahertz, ground to satellite, and 4 Ghz, satellite to ground—which could provide just about 14,000 voice-grade channels. Ray Tillotson, a scientist at Bell Labs, suggested that two higher frequencies be used instead—30 Ghz, ground to satellite, and 18 Ghz, satellite to ground. These higher frequencies could accomodate 75,000 voice-grade channels, about five times that of the lower frequencies. Tillotson's proposal would make satellites far more attractive than Bell System's 4-Ghz, ground-based microwave system, the TD-3, which can provide 12,000 channels. And, it would be far more attractive than the company's L-4 microwave line, which consists of 20 coaxial cables and is capable of providing 30,000 channels.

Still another advantage of communications satellites is that they would be placed in synchronous orbit, which means they could be deployed on a moment-to-moment basis to handle overloads as they occur. The L-4, on the other hand, if buried underground between Miami and New York, would be of little value should an unusual peak suddenly occur between Philadelphia and Chicago.

There are, however, two problems posed by satellite communication. Firstly, synchronous orbit, an altitude [illegible] they [illegible] costly echo suppres[illegible] communication and introduces a quarter-[illegible] which could prove annoying to the public. Secondly, at the higher frequencies—18 and 30 Ghz—transmission signals could be wiped out by heavy rain.

Since delay and echo are inherent, perhaps it would be best to use domestic satellites principally for data and television feeds; voice traffic could be minimized to, say, handling unexpected peaks in long-distance telephone service. As for rain wiping out high-frequency signals, this can be alleviated by redundancy at each transmitter and receiver site. Heavy downpours are often highly localized. Thus, if transmitters are placed several miles apart, at least one, and possibly more, should be able to transmit to a synchronous satellite very nearly all the time.

A millimeter-wave experiment to prove feasibility of such an antenna redundancy scheme is already under way on a satellite, aboard the Advanced Technical Satellite-5 launched four months ago by the National Aeronautics and Space Administration. Signals have been going up on a 31.65-Ghz carrier and coming down on a 15.3-Ghz carrier for two months. Sufficient data should be available within a few months to determine the effect of atmospheric attenuation on the millimeter waves.

Satellites should prove valuable for moving data and video signals for many decades, but, ultimately, total saturation of the entire broadcast spectrum could exhaust the theoretical capacity of all satellites. Pierce anticipates total saturation sometime within the next 50 to 100 years. And when this happens, of course, the communications industry will have no choice but to return to ground lines. Under such circumstances, AT&T would quickly fall back into everyone's favor by moving information from point to point, this time with millimeter waveguides and lasers—possibly with a system of millimeter waveguides that also carry laser light. Bell Labs scientists insist that no two points in the U.S. exchange enough information at this time to justify installation of a millimeter waveguide. But AT&T, according to the FCC, shows no serious interest in instituting dramatic rate cuts that would encourage massive traffic, which, in turn, could fill up such a waveguide.

Eventually, of course, millimeter waveguides will be used extensively and telephone executives will sit around a conference table debating whether the time is ripe for lasers. Though these are now expected to be about 10 times the cost per mile of waveguides, lasers will carry 100 times the number of voice-grade channels—the equivalent of 24 million telephone conversations. Although it's a bit difficult now to imagine 24 million conversations going from any one point to any other, Picturephone service uses the equivalent of 100 voice-grade circuits; television, 1,000. High-resolution color tv may use an order of magnitude or so more than black-and-white tv.

Adequate lines, links, and satellites are not enough in themselves. Man still must put the transmission facilities to use. And to do so, a variety of input-output equipment is needed.

Much of what will be needed tomorrow doesn't exist today in any form. And what does exist, will have to be upgraded.

Broadly speaking, there are three kinds of terminal or input-output devices:

- Those that allow people to communicate [illegible] like the telephone and Picturephone;

- Those that communicate with each [illegible] machine), such as computers and facsimile [illegible];
- Those that enable man to communicate with machines, such as speech recognizers.

The ubiquitous telephone is, of course, the primary instrument for people-to-people communication. Today, there are 220 million telephones in the world. And for more than 100 years, telephone companies have been trying to make Alexander Graham Bell's basic device more and more efficient, reliable, and less costly. Consumer acceptance of the instrument is higher than that of any device in history. Users have come to expect the "telephone sound" and complain only when connections are hopelessly riddled with static or signals are so faint as to be imperceptible. Restricted bandwidth, intermodulation and phase distortions, fractional-second delays in transmission, bursts of data in speech gaps, switching sounds—none of these seemingly bother individual users. Still, a portion of the public doesn't like to talk on the telephone. And as the public becomes technologically more sophisticated, a significant market for a high-fidelity telephone will almost surely develop.

There are two major obstacles in the path of the hi-fi telephone. The first is the present state of the network itself, which normally uses only about 20% of the audio spectrum. But the network's bandwidth is going to be upgraded for data and Picturephone use, and a solid state line amplifier in the base of the instrument could probably push the entire 20-kilohertz audio bandwidth to the central office anyway. The other obstacle is the carbon-granule microphone, which limits faithful sound reproduction. However, the microphone is rugged and inexpensive, it suppresses low-level background sounds, and it doesn't require an amplifier. The telephone company has been trying to get rid of the carbon microphone for years, according to Pierce, and the telephone of the 1970's may not have one. Last year, Bell Labs revealed one futuristic touch-tone telephone in which tantalum thin-film integrated circuits are used for amplifying the signals of an electromagnetic microphone. A "ring" is produced by an oscillator-driven speaker that substitutes for the bell in the base of the telephone. In the end, the carbon microphone will probably give way to the Electret—a condenser microphone developed by Bell Labs that has as its working element a permanently charged dielectric material. Also in the works at Bell Labs is a cordless extension-phone that can be toted about easily.

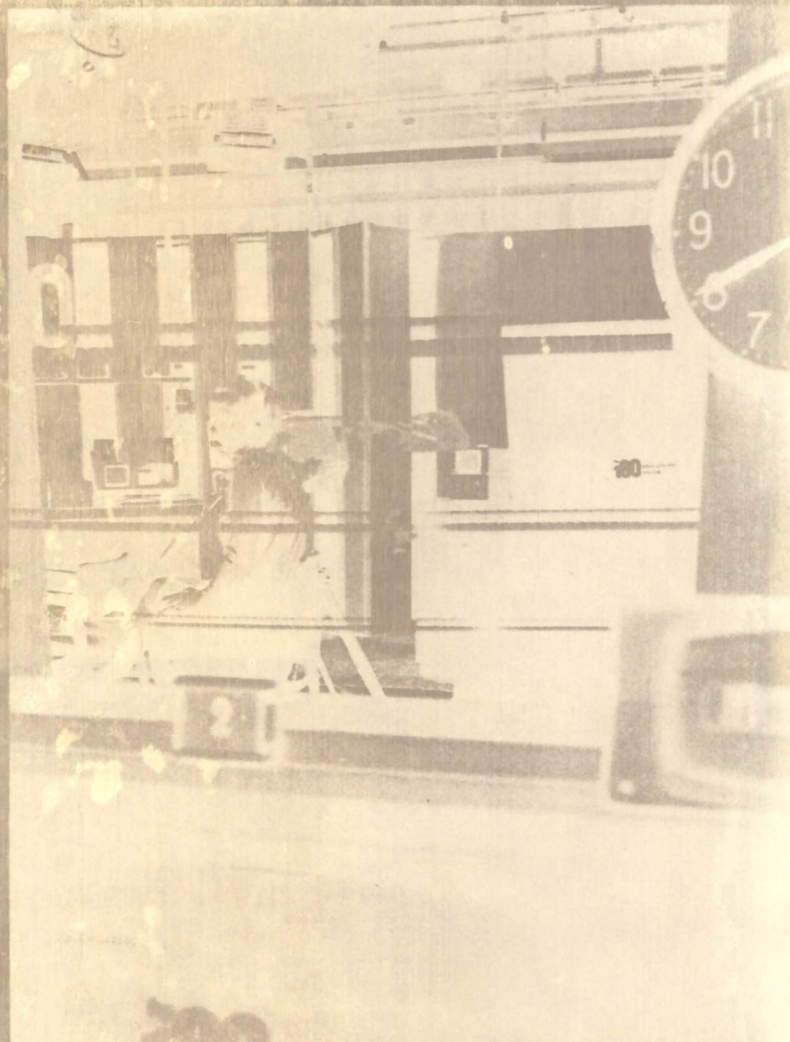
For video communications, the Picturephone is but the first step. At an anticipated monthly cost of $100, Picturephone service in the U.S. will be quite a bargain compared to the British Confravision—an intercity closed-circuit tv service for businessmen that will cost from $280 to $480 an hour! But high-resolution color Picturephone will have to await development of an appropriate display panel and solid-state vidicon.

Finally, the entire process of man-to-man communication can be enhanced by a telephone system designed from top to bottom to provide person-to-person, rather than of point-to-point, service. Here, a great deal rests with a software approach to electronic switching, which would replace the hardware necessitated by electromechanical switching. Several electronic-switching systems are already being installed, but none have the call-forwarding feature—essential if the subscriber is to have calls to his number automatically rerouted to another telephone when he is away from his own. For a good idea of what should be possible with electronic switching, one has [only] to examine the IBM 2750, a voice- and data-switching system built at the firm's laboratory in La Gaude, France.

The IBM 2750, designed for use by banks, insurance companies, and similar institutions, can handle upwards of 700 extensions and 80 trunk lines, and rents for between $2,500 and $5,000 a month. All switching is done electrically, including connection of lines. Changes in extension numbers are simply typed into a keyboard; no manual reconnections need be made.

From his telephone, the user can now do the following:

- Dial two digits to call frequently-used numbers, which are stored in a table and could have as many as 14 digits;
- Dial three-way conference calls without operator assistance;
- Dial a single extra digit to get automatic recall of an outside number that is busy when first dialed;
- Signal a busy extension by dialing a single digit that injects a "beep" in the conversation in progress;
- Get a complete record of data, time, and duration of all outgoing calls from his extension;
- Scan automatically all extensions in a given department for a free one, thus avoiding a busy signal;



On the tape. The Hewlett-Packard television system makes video tapes that illustrate how to use the company's products. Such tapes would be considerably more useful if video tape recorders were compatible. There are about 75 on the market and none can play tapes made on any other.

- Have calls forwarded automatically to another extension where the user plans to be;
- Have the 2750 monitor the contacts of a relay, then dial a previously arranged telephone number and issue a prerecorded voice announcement. (Thus, the system can be triggered by a thermostat to alert the fire department with a voice-message that tells the location of the thermostat.)

Without sophisticated electronic switching, the telephone system, which was intended expressly for conversations between people, is far more suitable as a switching network for point-to-point communication of the sort normally engaged in by machines. Appropriately, machine-to-machine communication promises to account for an increasing percentage of telephone traffic during the next several decades.

Right now, the machine that talks most to its brothers is the computer. Last year, 15% of all the central-processing units made by IBM were attached to a common carrier. This percentage climbs each year by 3% or 4%. But such figures could be misleading, if they are correlated with telephone network usage. Computers that are now being equipped with provision for connection to common carriers feed many more terminals—perhaps dozens, or even hundreds—than computers of the early 1960's. And at least two of IBM's competitors, General Electric and RCA, are aiming primarily at time-sharing

Multiple Gear. Walter Robson, Jr., manager of H-P tv activities, points out that several pieces of equipment are needed to help video tape centers gain a wider role in the distribution of industrial information. One is a video tape editing machine comparable in cost to its film counterpart. Another is a portable, inexpensive color playback machine, which a salesman could take with him to demonstrate products.

Listen here. Raj Reddy talks to a computer set up for speech recognition at Stanford University's Artificial Intelligence Project Laboratories. In a marginally successful experiment, the computer—a PDP-10—analyzed Reddy's speech, figured out what the words were instructing it to do, and then, with the aid of its own optical system, controlled the arm at the left to execute some relatively simple tasks, such as picking up blocks and piling them one on another according to Reddy's commands.

the same model by the same manufacturer. This, he says, is especially true with slant-head color video recorders, in which head alignment is critical.

The latest machine-to-machine incompatibility strikes the consumer directly. Those two old rivals CBS and RCA introduced two systems for playing back prerecorded tv programs over an ordinary tv receiver. The CBS method, called EVR, for electronic video recording, puts images on high-resolution black-and-white film with the color coded on adjacent frames. The RCA method, called SelectaVision, stores the color frames in the form of holograms, which are embossed on clear vinyl tape. EVR adapters will cost $800 initially; SelectaVision adapters, $400. Neither unit allows the viewer to tape his own choice of broadcasts, and neither can play the tapes of the other. The two systems represent the first incompatible additions to the home entertainment market.

All is not quite as bleak as it may seem. One consumer item virtually became a standard by virtue of marketing strategy that could work with other products. The Philips Co. developed a compact cassette for magnetic tape, then let anybody who wanted to make it or use it for their own machines do so without cost. The company did this on the theory that easy availability of its cassettes would help sales of its recorders; and the presence of other recorders would help sell cassettes. The result was a booming market. And Philips is doing a great deal better with both cassettes and recorders than it would have had the firm jealously guarded the cassette.

Probably the least investigated and least developed area of communications is people-to-machine communications. Page reading, spearheaded by firms like Recognition Equipment Inc. and the Control Data Corp.'s Rabinow Laboratory, has become a profitable pursuit largely because the literate world can supply monumental reading assignments—tasks so big, in fact, they justify development of special machines suited only to a specific job at hand, such as zip-code reading.

Consequently, optical-character recognition has primarily bitten off two small parts of the general problem of page reading. The machines read either a few alphanumeric characters in a wide variety of fonts, or all the characters in just a few predetermined fonts. Either way, optical-character recognition machines operate at speeds of hundreds or even thousands of characters a second with accuracies of about one error in 10,000 characters

Such performance is truly admirable, but left by the wayside is a more general machine that could sacrifice a bit on speed and accuracy—and read almost any font or combination of fonts. There is an OCR unit that more or less fits this description made by a small New Jersey company, CompuScan. The machine however, sells for $900,000, which includes a modest-sized computer in the price. This points up a major drawback of today's OCR's—they tend to be very expensive, too expensive in the opinion of potential users.

Another approach, taken by Recognition Equipment Inc., is to link an OCR machine to a facsimile device, which can be located at any remote location. Thus, a document can be forwarded by facsimile to the batch-reading unit. In effect, the facsimile device enhances the OCR machine's reading range.

Another area of embryonic development in people-to-machine communication can be found in information retrieval. Again, some impressive systems have been created for specific problems. Successful application of computer-based retrieval was first accomplished for both the petroleum industry and the military. Other industries, which can tag information blocks with singular labels—the names of salient chemicals in the drug industry, for example—followed. Now publishing institutions, such as Time Inc. and The New York Times, are developing computerized information-retrieval systems. The goal, of course, is to approximate the effect of a human mind that happens to remember instantly where the desired information is. But if one is willing to trade off computer time, speed of retrieval, or accuracy, retrieval schemes can be extremely useful. For example, Aspen Systems of Pittsburgh put all the laws of the U.S. into a single set of disk files to aid in legal searches for precedents. The tradeoff: time. A complete search can take up to 8 hours of computer time. Such a search can easily be valuable enough to a litigant and his attorney to more than justify the computer time and cost. But this system is not necessarily suitable to the problem of quickly locating relevant text published during a 20-year period in a group of magazines.

Then, there is always the controversial issue of speech recognition as a solution to the problem of man-machine communication. Bell Labs' Pierce, for one, goes so far as to question the motivation of those doing work in this field: "It would be too simple to say that work in speech recognition is carried out simply because one can get money for it," he wrote in a paper on the subject. "That is a necessary but not a sufficient condition. We are safe in asserting that speech recognition is attractive to money. The attraction is perhaps similar to the attraction of schemes for turning water into gasoline, extracting gold from the sea, curing cancer or going to the moon. One doesn't attract thoughtlessly given dollars by means of schemes for cutting the cost of soap by 10%. To sell suckers, one uses deceit and offers glamor."

In response to Pierce's observation, John McCarthy of Stanford University's Artificial Intelligence Projects Laboratory says: "I don't think Pierce knows what he's talking about in computer science—he's a physicist who thinks he knows everything. Sure, a number of people had premature hopes, but despair in the face of early difficulty is also unjustified."

Many scientists share McCarthy's feeling that early difficulty in speech recognition should have been expected, especially since there is no usable mathematics to describe the problem or to help bring about its solution. RCA's Harry Olson is one such scientist. "Years ago, when speech recognizers could recognize only a few words, the future looked pretty doubtful," he says. "But we've already built a device that approaches a 200-word vocabulary. When you get to 500 words, you've got it!"

At the Stanford laboratory, one scientist, Raj Reddy, has already designed a 500-word speech-recognition system. To be sure, the system did not come easy. At the heart of the system is a PDP-10 that has devoted about one-quarter of its time for two years to the problem of trying to figure out what humans are saying to it. Words are spoken into a microphone; the computer program does the rest. First, the machine decides what constitutes a word and where the word seems to start and stop. Next, the machine analyzes each utterance in terms of phonemes—fricatives, vowels, stops, syllables, and so on. The program looks up the dissected utterance in its memory and attempts a match. If it believes it has found one, it writes on a cathode-ray tube: "You said, - - - - -," and prints what it thought it heard. If it comes up with nothing, it simply prints, "Eh?" The speaker can say the word again, or he can enter it as a new word by typing the word on the console's keyboard. The system performs surprisingly well, even handling with ease phrases from voices it hears for the first time. Some accents throw it, of course, but they can be entered as a kind of new vocabulary.

Reddy believes that speech recognition, when it's good, would be enormously useful. "It would make each telephone a computer terminal," he says. "Of course there would have to be a lot of checking to make sure the machine understands each group of words."

For example, if the speech recognition equipment were used to let depositors talk to a bank's computer about financial matters, there would have to be extremely close checking. A typical conversation might go like this:

Customer: "What is my bank balance?"

Computer: "You said: 'What is my bank balance?'"

Customer: "Correct."

Computer: "You said: 'Correct.' (pause) "Your bank balance is eight hundred . . . and . . . five seven dollars, precisely."

In cases where exact transmission isn't critical, the computer could plunge ahead and possibly make some mistakes; should it get confused, it could always go into the "protocol" mode in which each phrase is checked out. Should all else fail, the caller could say "help" and the machine could summon a human.

Reddy says that even now a lot can be done within the confines of the five speech-recognition tradeoffs—vocabulary size, response time, cost, complexity of

Hard-copy broadcasting. Information about everything someday may be put on home television, if RCA ever provides a major marketing effort for its Homefax, which it announced in 1967. But the company has not yet committed itself to a big push for instant publishing. If and when it does, Homefax will ride into homes on the otherwise unused bandwidth presently generating the black bar between tv frames. A number of potentially valuable systems, like Homefax and Sylvania's Educast, languish on shelves waiting for manufacturers to figure out how to tap a sizable latent market.

Probably the largest single untapped resource in all of communications is the uhf dial on each tv receiver. A great deal of future network broadcasting is almost certain to center on the now little-used channels 14 through 83.

words, and accuracy. For example, he believes the present state of the art could yield a black box capable of handling 40 to 50 sounds in English at a cost of only $500; a yes-no recognizer, for only $10. By relaxing one parameter, results often can be quite surprising in remaining parameters. For example, a $1 million machine handling 1,000 words might take 20 seconds to answer with a 90% to 95% accuracy. Allowing an 80% accuracy would speed response time to two seconds.

Reddy hasn't built devices that perform to these specifications, but his experience with the 500-word program suggests that such devices are now possible. As to what may be ahead, he says: "The duty cycle for most applications you can think up is quite low, so the machine could spend considerable time mulling over previous sources of confusion. We could program into it associations that could trigger past phrases and sentences the machine couldn't understand when first it heard them. Interrupt mechanisms operating on various levels of priority would bring the machine back into immediate action if needed. Of course, if you had a large number of ill-defined priorities, the machine could get hopelessly confused."

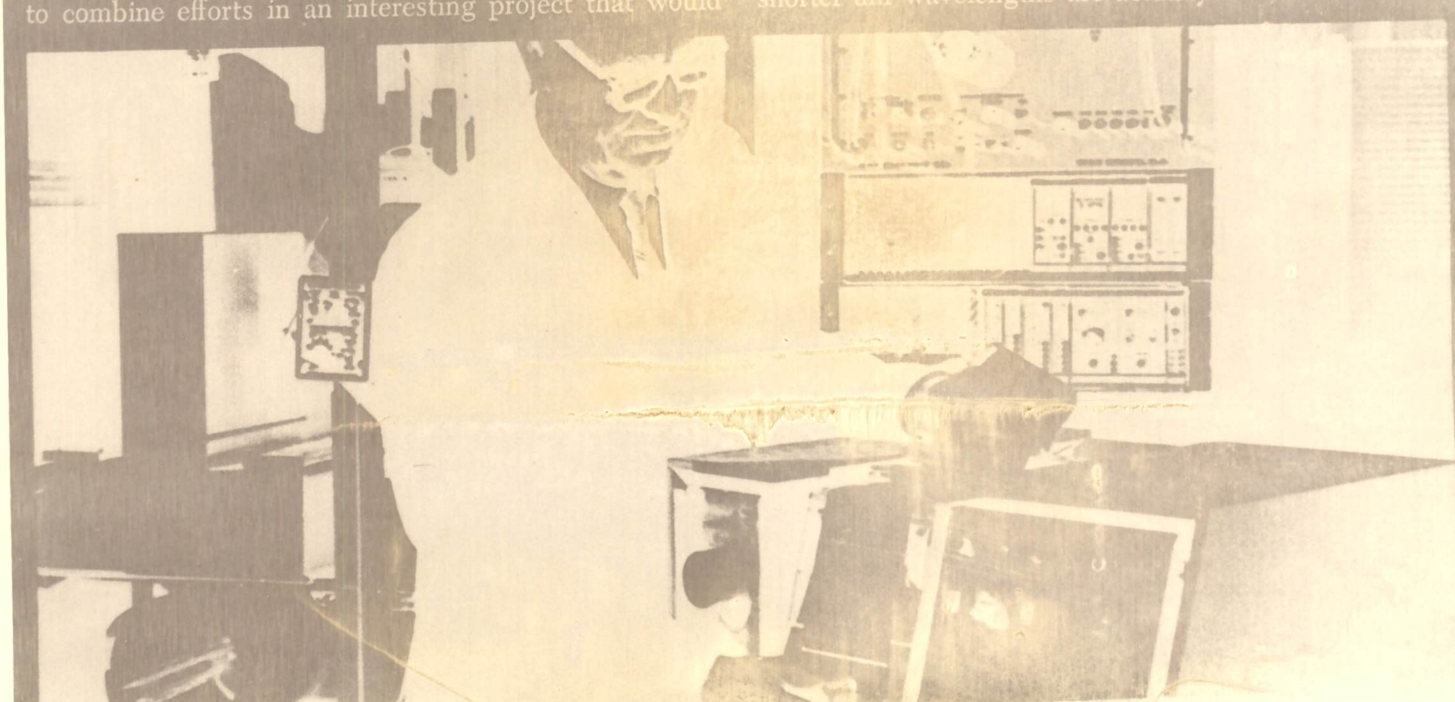
Should this happen, the machine could suffer a human frailty—a nervous breakdown.

Recently, Reddy and two graduate students decided to combine efforts in an interesting project that would combine the mechanisms of each. Karl Pringle had been experimenting with vision; Jeff Singer had built a powerful computer-driven hydraulic arm. The three attempted to put together a system that could take spoken instructions from a human and, under the supervision of its own vision, do what it was told. The resulting automaton was a nominal success.

For a typical command such as "pick up the large block at the right and put it on the block on the left," the computer would labor over each word—checking the program to see how the word functioned in the sentence and what it meant—then the arm would move to the block, slowly lift it, and carefully place it on the other block as instructed.

Toward the end of the coming decade, speech recognizers may become a factor in bridging the 50-foot gap. But there are many systems and devices, either in use at present or further along in their development, that could play an important role in the early 1970's. Among the approaches that are likely to play major roles:

- Ultrahigh-frequency tv broadcasting. Probably the largest single untapped resource in all of communications is uhf. A great deal of the future of network broadcasting is almost certain to center on the little-used channels 14 through 83. Though uhf waves are more prone to reflection and interference than very-high frequencies, the shorter uhf wavelengths are actually more suitable than



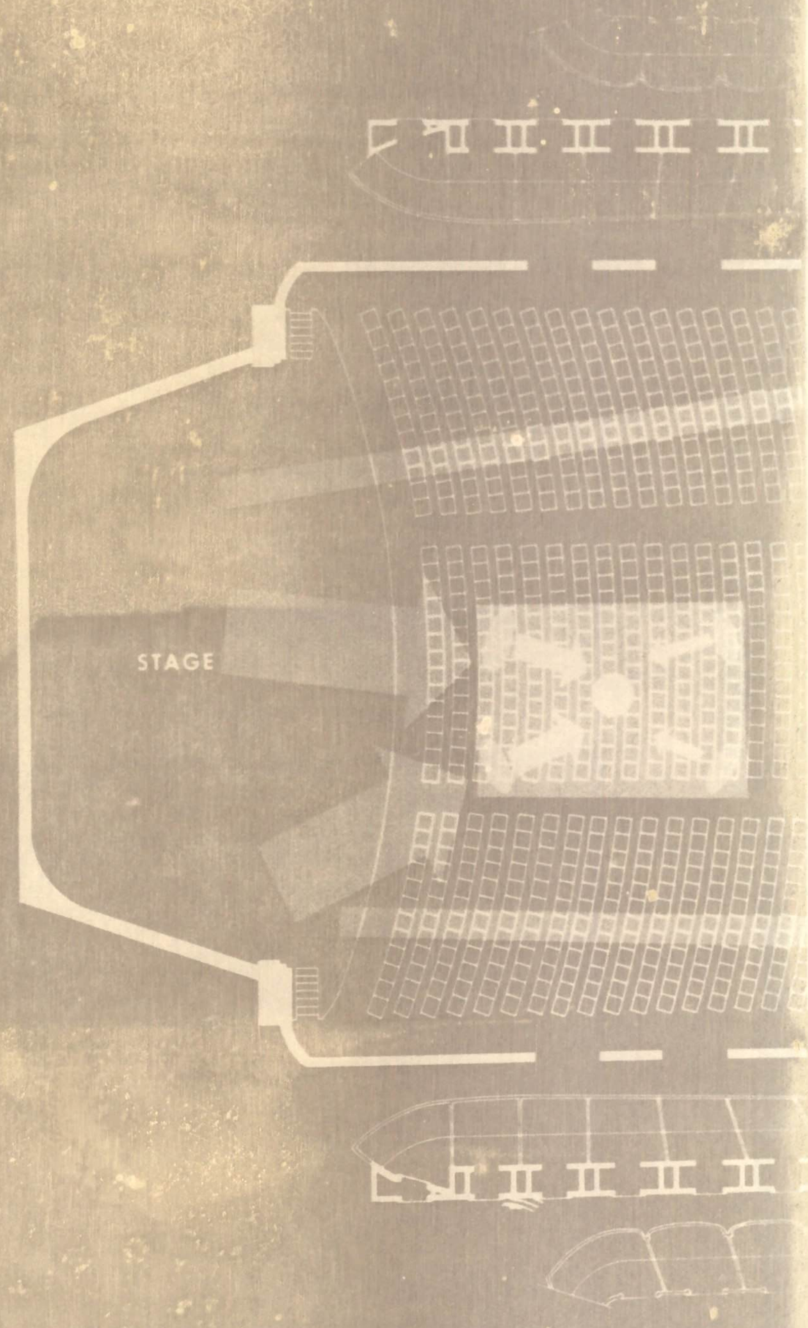
the longer vhf signals for transmission from broadcast satellites to small roof-mounted dish antennas. Direct broadcast satellites operating in the uhf band could not only free vhf for local broadcasting, they could also make possible a number of new networks.

With uhf signals impinging from an overhead satellite onto a small parabolic antenna, reflection and interference problems would be minimal. And every home in the U.S. equipped with a transistorized dish could have access to dozens of national broadcast "networks."

▪ Responsive broadcasting. Several years ago Sylvania announced a system of f-m broadcasting that allowed listeners to respond to questions posed by the broadcaster. This system, called Educast by Sylvania, was aimed primarily at the educational market, as the name implies. With Educast, four subcarriers are multiplexed on the main broadcast frequency. The listener is asked to push one of four buttons in answer to a question. Each button corresponds to one multiplexed channel, which delivers instructions appropriate to the listener's response. Sylvania still hopes to capitalize on Educast, but the system has been awaiting a precise approach to the problem of marketing.

▪ Hard-copy broadcasting. Television, despite its pervasiveness, lacks the impact of the written word and knowledgeble observers attribute this Achilles heel to the transient nature of broadcasting—the lack of permanent record that can be referred to should a broadcast (or advertisement, for that matter) warrant further serious consideration. One attempt to add hard copy to tv broadcasts was announced in 1967 by RCA. Called Homefax, the system is essentially a one-way facsimile system. Signals are transmitted in the blank space between video frames on spectrum that otherwise would be wasted to generate that black bar seen on the screen when the horizontal hold is thrown out of adjustment and the picture starts rolling. Thus carried along in the pouch of a normal transmission, the Homefax signal enters the home by way of the ordinary tv antenna and is decoded. Such a system enables the viewer to get an electrostatic printout at the mere push of a button. Although the system works well, it has been temporarily shelved by RCA. For now, the company can't figure out how to market what can best be described as instant publishing. But tomorrow may be another day.

▪ Data/Picturephone. With the arrival of the home communications center, ancillary information that is germane to a broadcast may be handled in a number of other ways. It may be stored on magnetic tape for subsequent conversion into readable form. Printout may be on either microfilm or the even more diminutive microfiche. It someday may be pumped automatically into a magnetic-bubble memory. In any case, what is clearly needed is a data version of the Picturephone: a cathode-ray tube system designed expressly for the purpose of information retrieval and display. There are, of course, a great many such displays on the market or under development. One unit, at Bell Labs, uses a simple keyboard containing Hall-effect switches that have no contacts whatever; five additional blank buttons are arranged around the bottom of the viewing screen. Thus, the screen itself can label the buttons, which can then be pressed to summon new material to the screen. The entire unit, which fits atop a desk, is barely larger than its medium-size crt.

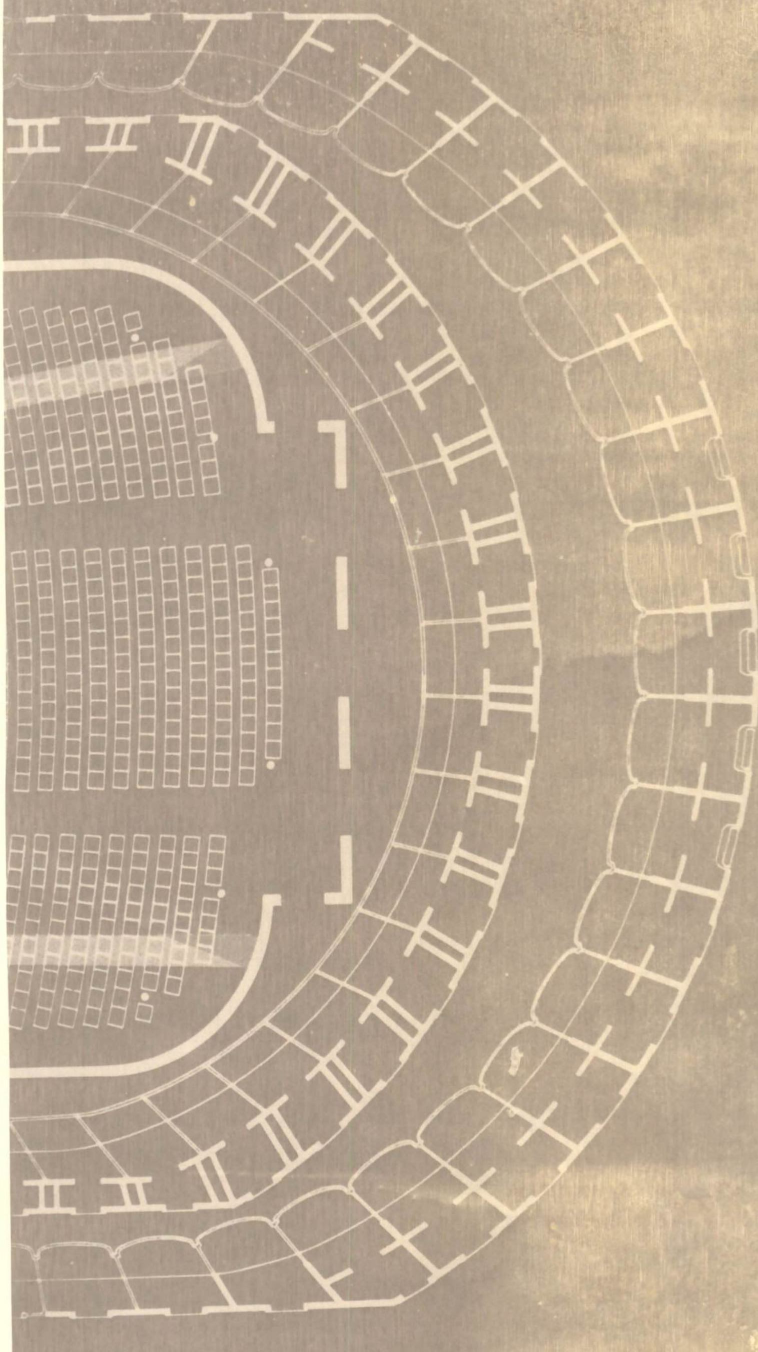


[illegible] graphy. In keeping with the trend toward [illegible] ty, and newspapers, Xerox has been [illegible] several years with color Xerography. [illegible] nature of marketing communications [illegible] crops up. From a technical standpoint, [illegible] Xerography is within easy reach. But ordinary black-and-white Xerography has become so pervasive that nearly all printed communications takes it into account. Accountants, for example, put red figures in parentheses. The company has been perfecting the quality of color Xerography, meanwhile trying to identify a big, latent market. In addition to color, Xerox is pursuing methods of manipulating hard copy from just about any form into any other form—magnetic tape or disk to paper copy, microfilm to paper copy, print to microfilm—indeed, every possible way to transfer information.

▪ F-m broadcasting. The next big trend in home entertainment is entering the communications industry by way of f-m radio stations. That trend is quadrophonic sound or four-channel audio. Two stations in New York, WKCR and WNYC, and two in Boston, WGBH and WCRB, are about to broadcast quadrophonic sound experimentally over two stereophonic f-m channels. A New York engineer, William S. Halstead, has developed a system for multiplexing four channels over one carrier. Halstead's system and several others are under consideration by FCC. In anticipation of the quadrophonic boom, H.H. Scott has developed a four-channel amplifier, which the company is prepared to incorporate into a design with appropriate tuner and multiplex circuitry the instant FCC decides in favor of one of the available multiplex systems. Quadrophonic sound has several advantages over stereophonic sound. Quadrophonic sound is relatively independent of room acoustics, speaker placement, and listener location. And it is better suited for reproduction of both symphonic and rock music. For the former, the back two channels can reproduce the reverberative envelope of sound one would hear in a concert hall; for the latter, four speakers can conjure the dizzying spatial effects a teeny-bopper would encounter in a discotheque.

Thus far, neither CBS nor RCA has given any indication as to what it plans to do about quadrophonic sound. But scientists at the two companies have been thinking along the lines of multichannel sound for some time. Both companies are undoubtedly awaiting FCC adjudication of quadrophonic f-m, applying themselves in the meanwhile to the task of devising a compatible quadrophonic phonograph disk. The adaptation of Stereo-8 tape cartridges to quadrophonic sound should be no problem at all, obviously. And plenty of quadrophonic program material exists already: nearly all recording sessions are taped on four-track half-inch masters.

▪ Portable paging devices. For years some men have carried in their pockets little devices that sound a beep upon receiving a coded broadcast signal. These small paging devices are really nothing more than the portable extension of a telephone bell: upon hearing a beep, the user goes to the nearest telephone and calls a prearranged number, usually that of his office. Paging systems have had limited use because very few firms could justify the cost of an entire system. Recently, however, the FCC handed down a decision that explicitly permits collective paging systems, which can be shared by many companies or people. Now remote paging can be offered to the public as a service. The most likely market for such sys-



Quadrophonics ahead. To electronically whisk the listener in his blue-carpeted living room to a choice seat in Carnegie Hall, future hi-fi systems will add the reverberative envelope of sound he would normally hear coming from the back of the concert hall. Quadrophonic, or four-channel, sound system—the natural successor to monophonic and stereophonic setups—will recreate reflected sound returning to the listeners on two additional channels, which will fill the rear of the room with sound from two additional speakers. Quadrophonic sound also captures the spontaneity of a pulsating discotheque and adds another dimension of motion in modern electronic music.

tems are the telephone answering services, which are already in a position to offer their own subscribers the additional service of remote paging.

▪ High-resolution facsimile. There are many systems that transmit high-quality photographs quickly from one point to another, but they all require bit rates considerably in excess of an ordinary voice-grade telephone circuit. Most transmit over microwave links, but the overwhelming majority of potential nonmilitary applications—such as those centering around the publishing industry, for example—do not justify the cost of setting up special links. Widespread availability of the Bell System's 50-kilobit service, Data 50, and other still wider band services could be accompanied by a proliferation of high-resolution facsimile equipment, if manufacturers would only settle the question of compatibility. High-resolution facsimile and, subsequently, high-resolution color facsimile could become substantial markets if only each user didn't have to set up his own transmission links as well as to lease or own every unit with which he wants to communicate.

▪ Mobile radio-telephones. Mobile radio-telephones, although they have been around for years, have proved inconvenient. The user had to push a button to talk, then say "over" to signal the other person to speak. The Bell System, however, has been conducting experiments in several cities with a more convenient radio-telephone that allows users to dial directly and communicate in much the same manner as with an ordinary telephone.

▪ Speech synthesis. Scientists at Bell Labs and RCA have long known that speech is a highly redundant and rather ambiguous method of communicating—that encoding at the source and decoding at the point of delivery could drastically reduce the bit rate needed to converse in real time. RCA's Olson conducted tests that determined that as few as five bits per second are sufficient to transmit intelligible speech. Bell Labs, working along similar lines, developed what it calls the Vocoder—voice encoder and decoder—to counter what would have become an escalating cost of long-distance lines had the company been forced to stick with pairs of copper wire forever. As it turns out, coaxial cables, microwave links, and, ultimately, satellites, millimeter waveguides, and lasers place the per-mile cost of providing voice circuits on a decreasing, not an increasing curve—one that decreases faster, in fact, than the cost of corresponding Vocoder circuitry. Thus, AT&T chose to put capital into long lines that would, in effect, increase the bit capacity of the system, rather than Vocoders that would have decreased the demand for bit capacity.

▪ Synthetic music. Like synthetic speech, which allows the compression of transmitted bandwidth for voice communication, synthetic music may one day permit comparable bit reduction for music transmission. What the Vocoder is to speech, the Moog (pronounced like rogue) Synthesizer is to music. This device is essentially a keyboard instrument that uses 12 oscillators and a maze of easily connectable filters, delays, reverberators, echo devices, phase manipulators, and resonators to generate musical tones and control their attack, quality, and decay. The synthesizer started making strong inroads in the recording of commercials and jingles where, hidden from public awareness, it could spin its peculiar melodies to sell such products as soap and aspirin. But not until George Harrison, one of the Beatles, made an all-Moog album for Columbia Records called "Switched on Bach" did the Moog take hold in pop music. Moog music, as the synthetic refrains have been dubbed, poses two problems. First, it doesn't seem to have the power associated with high recording levels, consequently the needle on level meters runs off-scale before any semblance of Wagnerian impact has been achieved. Second, since the synthesizer can only produce one note at a time, recording is a painfully slow process that must be done on video tape recorders fitted out with up to 32 tracks, in order to put across even a moderately complicated orchestration. Then, of course, truly synthetic sounds had no names. This led to made-up descriptive names—"pagwipe" (described as inside-out bagpipe) and a "ploboe" (an oboe sound with a "plah" attack), for example. Based on the current trends in pop music, there's no question that the Moog Synthesizer will remain on the musical scene for quite some time. And, undoubtedly Moog music will grow in popularity with time and refinement. Even Hugo Montenegro has made a recording using the synthesizer.

Clearly, speech and music synthesizers, remote paging units, quadrophonic tuners, amplifiers and phonograph cartridges, hard-copy broadcast receivers, and direct-broadcast satellites, and roof-mounted antennas will all be part of a proliferation of black boxes in coming decades.

Airliner In Trouble May Parachute Down

Are drag 'chutes and large parachutes practical as a method of saving airliners in distress? Yes, according to two safety researchers.

They point out the concept has already been tested with helicopters, and they emphasize that no serious attention has been given to midair emergency evacuation in civil air transportation. They argue that today's military technology could and should be adapted for the general population.

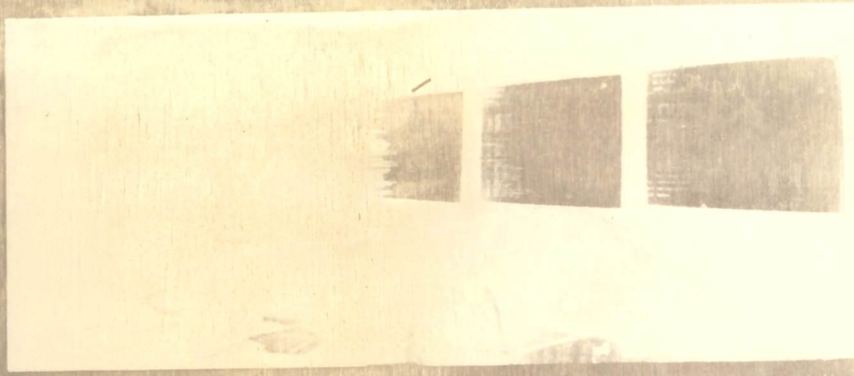
Here is the system as seen by Dr. Richard G. Snyder, University of Michigan, and Air Force medical doctor Col. John P. Stapp:

- When an airliner develops trouble, the pilot pushes a button before he loses control.
- The fuselage lets go of engines, wings, and tails, and a drag 'chute is deployed.
- After the craft is slowed, main parachutes go out and the airliner floats down gently and safely.

The need is both obvious and urgent, according to the safety experts. Projections are that 2,000 passengers will die in crashes each year in the mid-1970s, at least 15,000 persons in the '80s, and as many as 60,000 per year within three decades.

Much work needs to be done, the researchers admit. For one thing, physiological effects on passengers exposed to extreme environments are influenced by many factors. Yet little is known about "the range of tolerances for infirm, infant, or elderly individuals in a hostile environment. Existing data are for physically fit, healthy young males, mostly from military air crews, who have experienced the high-altitude environment in the past."

Advances in techniques for emergency in-flight evacuation have been confined largely to military and aerospace requirements. There is no civilian version of the rocket-powered ejection seat or the protective capsule which separates the pilot from the disabled aircraft. The techniques, say Snyder and Stapp, might be applicable to commercial-airliner flights.



Long-distance conferences between representatives of the two companies are being held via voice-communications and wall-screen hookups.

Voice-Picture Hookups Connect Two Companies

Aerospace experts at Boeing and Lockheed are now linked by a powerful communications network. The two companies are working together on shuttle-spacecraft design.

Called Teleconference, the network permits representatives of the two firms to meet electronically for detailed, probing discussions. Large screens are used to display information simultaneously in many locations.

Free and rapid exchange of information between the companies has proved vital since they teamed up to seek a NASA contract to design the space-shuttle system. Boeing has operated Teleconference since 1967, using the system to cut costs for the Apollo program and reduce difficulties of bringing together engineers around the country.

Now, as part of the teaming arrangement, Seattle-based Boeing has brought Lockheed headquarters in the San Francisco Bay Area into the network, which also includes Houston, Huntsville, Ala., Cape Kennedy, and Washington, D.C. The network uses existing phone lines connecting the locations through a switchboard at Huntsville.

Three rear-projection screens at each site display written or printed matter just as it is shown at all other sites. The visual aids are transmitted at high speed by Long Distance Xerography, before or during a conference.

How To Reclaim Ferrous Scrap Metal?

Research aimed at resurrecting millions of tons of ferrous scrap metal now being hauled to urban dumps is under way at the University of Wisconsin. Engineers will attempt to determine how America's huge ferrous urban waste can be put back into metallurgical furnaces to produce new metal shapes for new products.

Nationwide accumulation of all types of ferrous scrap is becoming a serious waste problem. One possible solution: use of ferrous waste as part of the charge to furnaces.

At present, 8 to 10 million tons or more of iron scrap could be consumed annually by the foundry industry, but most of this is a more select type of material, such as structural steel, plate, railroad steel, and other identifiable and segregated low carbon material. Ferrous scrap from municipal waste might become a very useful lower-cost charge material if problems common to the use of all scrap material in the casting industry could be properly identified and resolved.

The principal difficulty in utilizing ferrous urban waste lies in the presence of small amounts of certain contaminating elements which are believed to be deleterious to the production of quality metal products. The UW engineers say that the specific effect of many of these residual elements is in doubt, and no assessment has been made of the degree of impairment of structure or properties permissible within the limits of engineering alloy specifications.

ADMINISTRATIVELY CONFIDENTIAL

COMMUNICATIONS FOR SOCIAL NEEDS: TECHNOLOGICAL OPPORTUNITIES

A STUDY FOR THE PRESIDENT'S DOMESTIC COUNCIL

INTERIM REPORT

AUGUST 17, 1971

ADMINISTRATIVELY CONFIDENTIAL

OPTIONAL FORM NO. 10
MAY 1962 EDITION
GSA FPMR (41 CFR) 101-11.6

UNITED STATES GOVERNMENT

Memorandum

TO : Walter R. Hinchman
Office of Telecommunications Policy

DATE: August 23, 1971

FROM : Leonard Jaffe, Chairman, Communications Capability Group
Donald Haag, Chairman, Government and Commercial Services Group

SUBJECT: Interim Report, "Communications for Social Needs: Technological Opportunities"

The enclosed copies (numbers 1-25) of the Interim Report on "Communications for Social Needs: Technological Opportunities" are forwarded in accordance with the requirement indicated in your letter of August 4, 1971.

The Reports of Working Groups on the Government and Commercial Services and on Communications Capability have been combined. This was done to assure the consideration of interrelation of the user problems and services with the appropriate technological capabilities.

It is noted that some of the requirements of the task given to the Working Groups could have involved the non-Federal or industrial committee, but because of the administratively confidential nature of the study no commercial source was solicited for information.

The appendices contain all of the information from which the summary and conclusions were drawn. The appendices were compiled and arranged to assist the process of technical and costs assessment.

This report is the result of considerable interaction between the technical, costs, and user teams. It should be noted that this interaction was beneficial not only in producing the required report, but in the longer term benefits that will accrue as a result of the real understanding created between technical and non-technical committees regarding the potential applications of advanced telecommunications.

The report will be valuable as a source document for future developmental and user planning, and we would recommend that the final report be made available for such purposes.

Leonard Jaffe

D. G. Haag

Enclosures (25)

INTERIM REPORT
August 17, 1971

CONTENTS

SECTION I

INTRODUCTION AND SUMMARY

This report provides the results of a study performed under the aegis of the Office of Science and Technology, Executive Office of the President, in response to a request of the President's Domestic Council. The request was to identify national problems whose solutions presented new technological opportunities in the civilian sector and to suggest national initiatives that might accelerate changes of national priorities. In this study, the technological opportunities were to be provided by telecommunications.

This study was conducted on a multi-agency basis recognizing the operating agency as the ultimate user of a service. Problems of national importance have been identified by detailed discussions with users in education, health care, public broadcasting, law enforcement, postal services and disaster warning. These problems are summarized in Section II. In the delineation of problems and possible solutions, the user agencies have helped to identify applications of telecommunications which are necessary to implement their solutions.* The communications services required for such applications have been defined.

Existing telecommunications resources available in the nation today and the planned expansion of those resources have been examined. The telecommunications capability available without a Federal initiative for further expansion is inadequate to provide the required new services.

The Federal initiative suggested by this study has the intent of providing solutions to a number of nationally recognized social and cultural problems involving applications of communications technology. The need to augment the present national telecommunications capability to include wired services for our cities and satellite service at least to rural areas by 1980 is apparent. Included in the initiative is the concurrent development of the programmatic techniques and materials necessary to the solution of social problems. Near-term visibility can be provided by bringing into being new

* The information contained in the OE Educational/Cultural Report was made available for use by the technological opportunities activity at the close of business on 16 August 1971.

experimental facilities to permit development of the services enumerated and to demonstrate their effectiveness.

A series of experiments has been described in which the suitability of specific applications to solve the national problems identified by the users will be evaluated. These experiments will also be directed toward making visible the social benefits and economic viability of the services they demonstrate. Visibility will be achieved initially by experiments already underway. Continuing visibility will be achieved during subsequent years by additional experiments which the initiative will support.

A possible program responsive to the recommended Federal initiative is described in Section IV. Assumptions are that all the telecommunications services determined to be necessary for the successful solutions of national problems identified by the users are implemented; that the experiments are successful in delineating the nature of the operation resources necessary to their implementation; and that the operating agency will embark upon parallel programs leading to the solution of the identified national problems.

The social and economic benefits accruing from such a program are summarized in Section II, as are the political, social, and economic impacts and problems to be anticipated from their implementation. An additional benefit of implementing the Federal initiative which includes these programs may be to redirect the technological resources developed by the nation over the last decade to the solution of significant national problems of a social and cultural nature.

SECTION II

CONCLUSIONS

A. URGENT NATIONAL PROBLEMS

The major conclusion of this study is that there are urgent national problems broadly recognized by the public, whose solutions require improved telecommunication services.

1. EDUCATION

In education five problems have been identified:

a. The present formal education system does not provide adequate and equal availability of education to all segments of the population.

b. The present formal educational system does not provide adequately for education outside of the normal school years. Opportunities for pre-school preparation and post-school education are needed. Better opportunities for completion of high school must be provided. The overloading of universities must be alleviated.

c. Training for a beginning or changed career is inadequate.

d. Opportunity for the educational professional to confer with other professionals is limited.

e. Training aids to assist the teacher in the educational process are inadequate.

2. HEALTH SERVICES

In health services two major problems have been identified:

a. Professional health services are not adequately accessible to the public. Contributing to this problem are limited facilities for consultation among medical personnel, the difficulty of access by professionals to patients medical records and to other medical information and limited means of distributing health information to the public.

b. Cost of medical care has risen disproportionately.

3. PUBLIC BROADCASTING

Public noncommercial services reach less than 75 percent of the population of the 50 states. Access to educational and cultural television programs or noncommercial channels is needed for 100 percent of the population.

4. LAW ENFORCEMENT

In law enforcement three major problems emerge:

a. The protection of the lives and property of our citizens is inadequate.

b. There are delays in the apprehension of criminals.

c. There are delays in the administration of justice.

5. POSTAL SERVICE

There is public awareness of the problems within the postal system:

a. Material handling costs, and therefore rates, are increasing due in part to increasing mail volume.

b. The existing postal system cannot provide the improved postal services that the public demands.

c. Current mailing practices prevent an economically selfsufficient postal service.

6. DISASTER WARNING

Unnecessary losses occur from natural disasters because of limited ability to warn the public.

7. URBAN PLANNING

In urban planning two problems have been identified:

a. The public feels a remoteness from the government. Contributing to this feeling is the inadequacy of communications within the urban community due to a lack of planning. Adequate information about community actions is not provided to the public. There are limited means for communicating the consensus of individual opinion to government agencies.

Means for the individual to request services from government agencies are inadequate.

b. There is no effective guidance to the public on the use of urban facilities and services.

Solutions to the problems enumerated above have been defined by the users. The user requirements have been analyzed to determine the specific communications services required to implement and support the solutions. The study has determined that:

(1) The communication services required cannot be met with existing or planned expansion of national communication resources.

(2) The costs to provide the total communications system are estimated to be within the economic capability of the nation.

(3) Economies of scale evolve from combining individual user requirements into a single service system.

B. PUBLIC IMPACTS

If the initiatives recommended in this report are implemented, they will produce the following impacts (which are described in more detail in Appendix I).

1. EDUCATION

a. By FY 1975 the number of people who will achieve an education of high school equivalence will be increased by 1 million and by 1976 by 3 million.

b. By FY 1974 the day-care model program will have trained 5000 adults in early childhood education; by 1976 an additional 20,000 will have been trained.

2. HEALTH

a. By FY 1976 the man-power training program will have trained 10,000 specialized health personnel.

b. The health program is expected to provide from 20,000 to 40,000 new jobs distributed throughout the neighborhoods of the nation. An additional 14,000 people skilled in health education or in computer-assisted educational techniques will be needed. An estimated total of 90,000 new jobs will have been created by FY 1975.

3. PUBLIC BROADCASTING

a. By FY 1974 the Open University of the Air Program will have at least one model operating with an accreditation system. The program will demonstrate cooperation among the Department of Health, Education, and Welfare, the Corporation for Public Broadcasting, and the National Science Foundation.

b. In FY 73 a demonstration using ATS-F will demonstrate instructional and cultural television distribution to the Rocky Mountain states, Alaska, and Appalachia.

c. In FY 75 the opening of a new segment of the electronic spectrum at 12-GHz and multichannel coverage of selected geographic areas with non-commercial television will be demonstrated.

4. POSTAL SERVICE

The Postal Service will achieve a point-to-point transcontinental demonstration of Electronic Mail Handling (EMH) in the late summer of 1972. By 1975 a basic EMH service will be operational.

5. NATIONAL EMPLOYMENT OPPORTUNITIES

A result of this initiative will be the creation of new jobs: 4700 by 1972; 13,400 by 1973; 15,700 by 1974; and 35,000 by 1975.

C. BENEFITS AND COST COMPARISONS

In the course of the study, the benefits of implementing the recommended initiatives have been assessed. The costs of implementing the programs described in IV have been determined and then effects on employment have been estimated.

The benefits start when the experimentation is complete and phases of the programs begin. The dollar values of the total economic benefits as a function of time for three programs are shown in Figure II-1. The three programs selected are those having quantifiable benefits in terms of the cost of supplying the service by present methods compared with the costs of supplying the services by modern telecommunication; the costs of undertaking these programs are shown also in Figure II-1. No attempt was made at this time to quantify other benefits from these three or any benefits from the rest of the program.

But increased effectiveness in delivery of health care could help to reduce health care costs and eliminate time lost to illness of present delivery inefficiencies. Expansions of public broadcasting will markedly improve availability of cultural and educational opportunities to the general public. Delivery of modern instructional material and techniques to remote regions could provide greater opportunities to the inhabitants than now exist for formal education. These important social and cultural benefits were not quantifiable in this study, but should be during the course of the recommended initiatives.

During the study, a comparison was made between the costs of implementing the required telecommunications system improvements by terrestrial means and by a combined terrestrial and satellite system. The terrestrial system calls for an investment of 2.9 billion dollars and an annual operating cost of approximately 400 millions. The combined terrestrial-satellite system requires an investment of approximately 600 million dollars and an annual operating cost of approximately 200 million dollars.

Further comparison of two of the largest users (Public Broadcasting and Postal Services) indicates a similar result. Their combined total annual communications cost by terrestrial systems is approximately 235 million dollars while the corresponding cost by combined terrestrial and satellite systems is less than 32 million dollars. Therefore, it is concluded that for the services studied a combined terrestrial-satellite communications system is more cost effective than a terrestrial system.

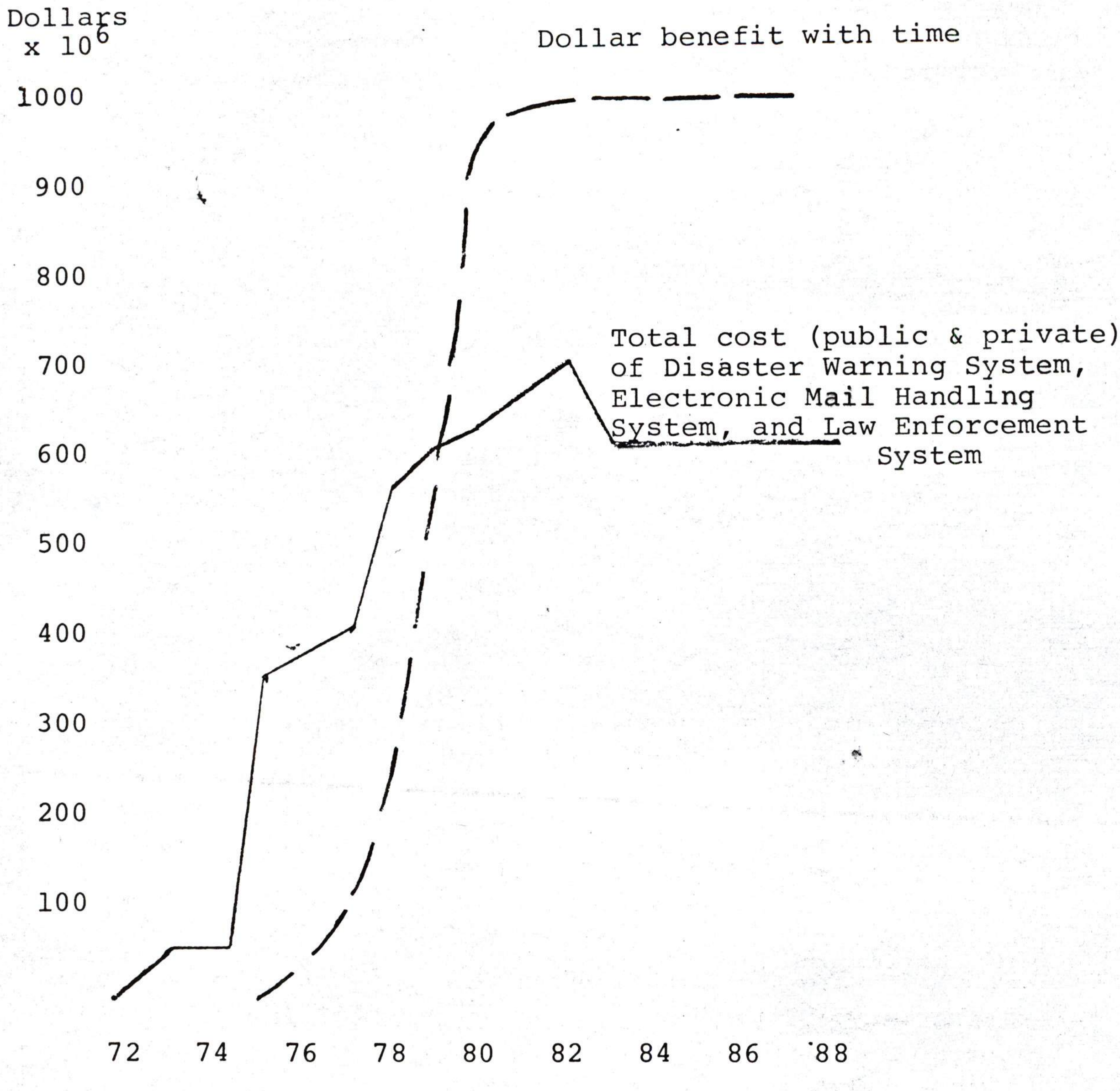


Figure II-1
Estimated Program Costs and Benefits

D. BUDGET IMPACTS

The estimated cost of the recommended program as it affects the Federal budget is shown in Table II-1, displaying the contribution of each user component. The portions of these budget items allocated to experimental and operational phases of the programs are shown by fiscal year in Table II-1. Since the experimental program is to lead to an operational system one can anticipate an increasing investment in the operational phase as time progresses. By FY 1975 the annual cost of the experimental phase has decreased by 23%. This decline can be expected to continue as the experimental results contribute to operational system growth.

The largest costs associated with the operational phase are in the education and health programs. These costs are also the most difficult to estimate accurately. Additional effort will be required to refine them.

TABLE II-1

FEDERAL BUDGET BY PROGRAM

($ in millions)

FY	72	73	74	75	76	Totals
Education	2	24	29	12	14	81
Health Services		15	12	8		35
CPB/PBS		29	42	54	46	171
Law Enforcement		1	2	2	2	7
Disaster Warning			29	55	54	138
HUD	2	3	5	5		15
Satellite Systems		38	44	82	129	293
Totals	4	110	163	218	245	740

FY	72	73	74	75	76	Totals
Experiment Costs	4	70	116	122	101	413
Operational Phases Costs		40	47	96	144	327
Total Program Costs	4	110	163	218	245	740

TABLE II-2

FEDERAL BUDGET ALLOCATIONS
BY PROGRAM PHASE
($ in Millions)

E. POLICY

Two basic types of policy considerations arise from the recommended initiatives.

1. POLICY CONCERNED WITH IMPLEMENTATION OF THE EXPERIMENTAL PROGRAM

Such policies as are required should be established at the outset of the program and used by the implementing organizations as guidance. These include approaches to funding (government versus private), encouragement of industry and commitments to stimulate it, organizational assignments, standards, and frequencies to be used. Establishment of such policies is generally the function of the Office of Telecommunication Policy, and that office should execute this responsibility.

2. POLICY CONCERNED WITH USES TO WHICH FACILITIES MAY BE PUT

Under this head, questions of the legal and ethical aspects of a proposed use might be considered. Examples might be the use of facilities to convey governmental information (from the executive agencies or legislative or judicial bodies), the use of facilities for political campaigning, or the delivery of educational material by national institutions to local interests. These considerations involve the Federal Communications Commission and Department of Justice, as well as a number of other concerned agencies. Questions of these types can arise at any time during the course of the program as new uses of facilities and services are conceived and these uses are requested. To deal with these types of problems, it would appear desirable to form a Committee for Policy on Information, which would involve the concerned agencies and interests as necessary. Questions could be put to this committee by OTP or any of the agencies concerned.

Specific areas of risk and policy are implicit in providing the various services recommended in the report. Some of these are outlined below.

1. PUBLIC BROADCASTING

In public broadcasting the extent of ability to control program content should be evaluated in view of existing law and regulatory authority at Federal, state, and local levels.

A jurisdictional determination should be made concerning certification of educational achievement through public television.

2. LAW ENFORCEMENT

In law enforcement the question of legal rules of evidence as applied to video tape depositions and confrontations of witnesses through television must be addressed.

3. POSTAL SERVICE

In electronic mail handling the issue of common carrier status for the Postal Service must be determined. The impact of electronic mail on the existing common carriers of message services must be more adequately determined. The authority to police and maintain privacy of the mails when electronic means of transmission are employed must be determined.

4. DISASTER WARNING

In disaster warning there is a possible impact on non-English speaking members of our society in that they may not be able to comprehend instructions given in English over the system.

There is jurisdictional question of authority and responsibility for disaster warning and recovery between NOAA, Interior, OCD, Earth Resources, and state and local authorities.

5. HOUSING AND URBAN DEVELOPMENT

In the Model Cities the impact on local regulatory agencies with regard to control of services provided over a Federally planned and implemented system must be determined.

F. ORGANIZATION AND MANAGEMENT

For the initiatives recommended in the report, two types of management roles are required: that for implementation of the experimental programs and that for implementation of the operating systems.

The recommended initiative should be implemented by existing agencies insofar as possible. Where an operating agency has dominant responsibility, it should have the assignment; for example, HEW/CPB for all educational and cultural programming and Health Service experiments, HUD for the determination of a wired communities design and test, Postal Service for electronic mail experiments, and Department of Justice for law enforcement experiments.

For some functions no single responsibility exists. This condition is more applicable to the operational phases than it is to the early experimental phases, where ad hoc responsibilities can be assigned without prejudice to the final organization. This situation permits time for ultimate decisions to be based on some actual experience in operations, just as the experimental program provides experience on which to base technical systems, user methodology, and assessment of benefits. Therefore focus of attention on the organization of the initial experimental phases is recommended.

In the case of the Disaster Warning System, although several agencies are concerned (DoC, OEP, DoD, and others), DoC has taken the lead, and it is recommended that they carry out the experimental program.

Where purely commercial experiments are suggested by private enterprise, OTP should coordinate their participation.

Regarding the implementation of the required systems, where existing or already planned facilities can be employed, they should be, and the already assigned authorities should be asked to participate with the use of their capabilities ; e.g., commercial facilities or planned experimental satellites. Based on the past performance of the agency, where overall systems management is needed, NASA would appear to be the logical choice.

Organizational responsibilities for operational phases of combined services should be determined after some time for accumulation of experimental experience on which assignments can be based. This problem cannot be adequately considered without such experience, and time is needed to develop appropriate policies.

SECTION III

RECOMMENDATIONS

It is recommended that a Federal initiative be established to:

A. Bring improved social, educational and cultural services to every individual in our Country.

B. Establish a modern, rapid, electronic mail service.

C. Increase the quality and availability of health care.

D. Improve our ability to enforce the law and administer justice.

E. Establish adequate means for warning the public of natural disasters.

F. Make significant improvement in urban planning.

Having concluded that modern telecommunications techniques can contribute materially to these needs, it is further recommended that the nation proceed with the introduction of the required services over the next decade.

It is recommended that this initiative be implemented in several progressive steps that will minimize risk taking at each phase of the program and demonstrate decisively to both the decision makers and the public at large the benefits and desirability of continuing.

The recommended steps include:

A. Funding and authority to proceed with the experimental portions of the users' program to provide solutions to their indicated problems and the development of techniques for the beneficial applications of advanced telecommunications.

B. Involvement of those elements of existing and already planned developmental telecommunications capabilities in the users' experiments.

C. Funding and authority to proceed with development or expansion of existing communications capabilities required to support the completion of the users' experiments.

D. Direct a study to be performed to:

   1. Determine the actual national communications capabilities required to sustain the users' operational objectives as a result of demonstrated benefits, and

   2. Develop a detailed plan for the most cost effective, and least costly to the Federal Government, means of establishing these capabilities in time to meet the needs.

SECTION IV

PROGRAM DESCRIPTION

A. EDUCATION

Experiments are proposed during the period from 1972 through 1976 in: increasing the number of people with high-school equivalency training, training personnel in early-childhood education for the staffing of day-care centers, training of health-care personnel, making university training broadly available through television and providing television instruction in mathematics to school children. In each of these experiments, the effort focuses on the development and application of program material for use with television and on the delivery of that material via telecommunications. The program materials would be developed during 1972 and 1973; sites and target populations for the experiment chosen during 1973; and tests run and evaluated during 1974-1976.

In order to obtain a complete sampling of the various target groups which, it is hoped, would benefit from the educational programs, it is necessary to have communication facilities that can reach into rural and remote locations as well as urban communities. The opportunity to use NASA experimental satellites to reach these isolated populations provides an attractive and cost effective method of conducting the needed sampling of different target populations during the process of developing program material. Critical questions about the appropriate size of audience that can be served by a single variation of a program affects the per capita cost and must be answered early in the development program. In addition, several different arrangements of the communications facilities will have to be provided in order that different approaches to a total delivery system, which includes support services, can be evaluated.

At a very early date in the development of each of the educational programs, certain technical communication facilities will be required to test and evaluate the material being produced with a wide range of target populations. It is anticipated that one-way transmissions of experimental television program material can be begun almost immediately utilizing the network and over-the-air broadcast facilities of the Public Broadcast System and the facilities of a number of cooperating cable TV systems. The availability of the NASA experimental satellite ATS-F in mid- 1973 affords the first opportunity to test material with certain remote populations. It also can provide two-way communication capability to both test interactive program material and to enable field test teams to communicate evaluation data to the production center. Similar two-way capability will be available on selected cable systems in late 1972 and early 1973.

Target populations are found in different parts of the country and will have to be reached in a variety of different viewing environments. Conventional broadcast and cablecast facilities will be sufficient to reach an adequate sample of the urban target populations. The specific structure of the required urban communication capability will be discussed in the following section. The various rural and isolated populations can be most effectively reached by satellite. The sort of geographic coverage that would adequately sample the target populations mentioned above during the time period 1973-1974 includes the Rocky Mountain Region, Alaska, and Appalachia. The communication service into these regions can be on a time shared basis and would consist of a single TV program distribution channel with limited audio and data feedback channels.

An estimated 500 receiver terminals throughout the areas mentioned, feeding broadcast facilities, cable front ends, and individual institution closed circuit systems, would permit a valid experimental sample to be gathered. A pictorial description of the coverage is provided in appendix IV-C-1.

In densely populated urban areas broadband cable systems offer the best prospect of an early experimental capability. Many questions involving the involvement of various intermediaries in the educational process cannot be resolved without some opportunity to experiment with different system configurations.

A part of the experimental program would designate a number of cities (perhaps a representative cross section of from 10 to 20 drawn from those already selected for increased Federal assistance) as test sites for a comprehensive cable communications experiment designed to permit a wide range of commercial and public communications services to be developed.

The specific locations should be selected on the basis of a combination of factors including: composition and specialized needs of their populations, the interest and resources that the community itself is willing to devote to the project, the cooperation of private cable operators, and the prospect of a sufficiently advanced cable system with adequate penetration to permit a wide range of experimentation.

Frequency halving speeds phone transmission of texts

A new facsimile transmission system uses a frequency halving technique called "bandwidth compression" to send text and drawings over phone lines at more than twice the speed of existing equipment. The availability of low-cost, solid-state digital circuitry able to perform the necessary binary conversion in a compact space makes this commercial product practical.

The Bandcom-1000, designed and developed by Graphic Transmission Systems (GTS), Inc., Hanover, N.J., can send and receive 8½ x 11-in. facsimile copy in less than three minutes between direct-dial telephone locations. The system consists of two compact typewriter-size units, a sender, and a receiver. The receiver, which can also be used as a computer terminal, produces dry electrostatic copies.

Sending documents. To send a document, the first step is to call the receiving station on the telephone and insert the document into the sender for transmission.

When the document enters the sender, it interrupts a light and photocell combination that initiates both transmission and reception (diagram). Fluorescent lamps illuminate the lines or characters on the front face of the original copy. A slotted strip selects successive lines of copy as the drive rollers draw in the paper.

The reflected image of the copy viewed through the slot is reduced optically and reflected down onto a slotted helical drum. The rotating drum acts as a horizontal scanner as it admits successive increments of the line image to the optical system within the helical drum.

As the drum makes one revolution, it scans the complete 8½-in. width of the document. Successive trains of alternating darkness and light fall on a photomultiplier tube that produces a pulsating direct current output. This output is the electrical analog of the scanned light and dark sequence.

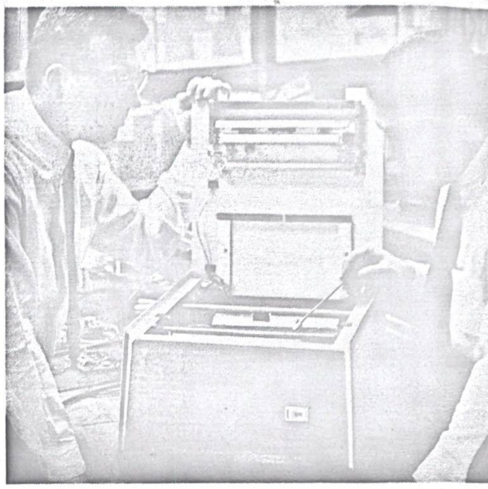
Drum scanner and photomultiplier are able to resolve marks on the document as small as 10 mils high and 7 mils wide. About 10 horizontal scans are necessary to transmit a standard typewritten line of copy.

Two-level format. The analog output of the photomultiplier is in a so-called two-level format; that is, zero voltage represents white, and the peaks represent black. This analog signal could be sent over the telephone lines and is comparable to the signal used in facsimile systems.

Engineers at GTS, the designer of the compression circuitry, say that by processing the analog signal, the Bandcom-1000 sender not only speeds up transmission but makes more effective use of the available telephone-line band-width.

"Most facsimile transmitters send the raw signal that we obtain from the photomultiplier directly over the phone line," says the spokesman, "but we amplify this signal and clip it to uniform amplitude to produce a true binary signal with steep leading and trailing edges. Then we convert this two-level binary signal to a three-level binary code.

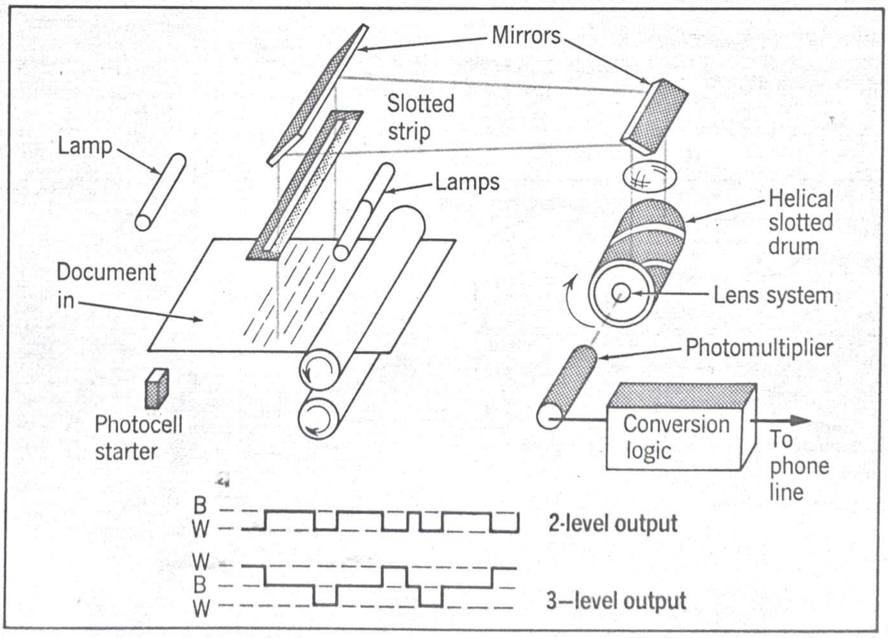
"By setting the black level equal to 3.5 v, we designed the circuits so the white level can then be either 0 v or 7 v. As the two-level signal alternates back and forth from white to black, the sender electronic circuitry converts it to a three-level signal. A two-level change from black to white is converted alternately from the 3.5-v level to either 7 v or 0 v. This alternation turns out to be a frequency halving of the original analog signal and, therefore, leads to bandwidth compression.



Paper transport for receiver is checked by engineers Al Libbey and Ted Richardson.

The engineer added that, after frequency halving, the signal is conditioned to improve its transmission properties before it is sent over the telephone lines. The conditioning minimizes signal degradation.

Double duty. Receiver electronics convert the three-level code back to a two-level binary signal and then to a voltage that is applied to moving styli. The styli, mounted on a carriage, are scanned in the X-direction over moving plastic-coated paper in the receiver. The electrostatic charge induced on the paper is an analog of the original black-to-white tone scale. Probe charge will swing to about

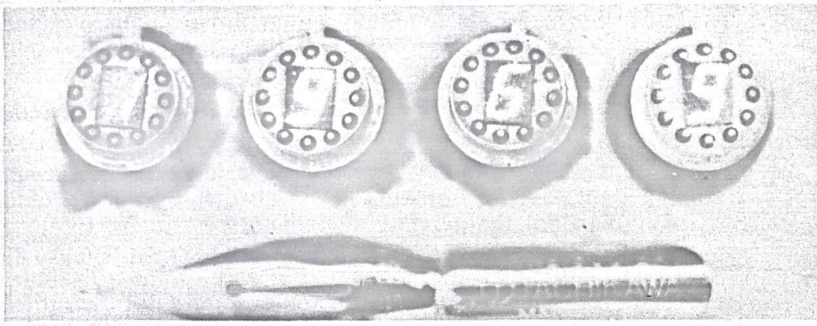


Mirrors transfer image of document, line by line, to rotating scanner drum. Helical slot on drum scans horizontally, and electro-optics form 3-level transmit code.

Copy of revised index code (heavy type numbers) for filing information is available for 50¢ from Reader Service Department.

Developments to watch

A new high-brightness photodiode for use in alphanumeric character displays and readouts has been developed by Hitachi of Japan. Like other solid-state devices of this type (*PE*—Jan. 13 '69, p 56), the light it emits is red, but it differs from most solid-state diodes now available in that it employs large crystals of gallium-arsenic-phosphate, has a new type of monolithic integrated structure, and can be used for segmented

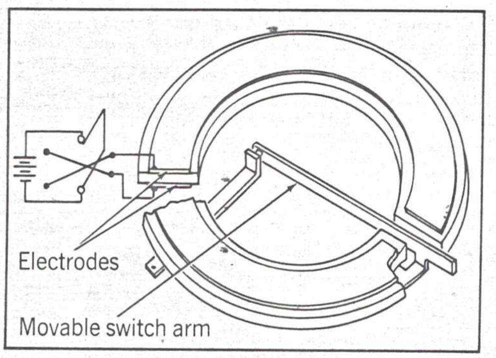


displays like those shown in the photo. (The pen-point is included for size comparisons.) Also, low voltage requirements permit operation on dry-cell batteries, so the diodes can be used in portable units. **(4.444)**

Temperature-compensated dielectric substrates for integrated circuits are being custom-tailored at Raytheon by mixing titanium dioxide and several compounds that have positive dielectric constant-temperature coefficients.

A. E. Paladino of Raytheon says, in a report prepared for the American Ceramic Society's New England Section, that a series of sintered mixtures has been prepared for microwave use. Dielectric constants range from 22 to 36, and X-band loss tangents are less than 6×10^{-4}. **(4.8)**

A new piezoelectric switch has been designed by E. Gikow of the Army Electronics Command. The switch, especially suitable for remote control, has a piezoelectric ceramic element in place of the conventional coil.



A good many different arrangements are possible. The basic design requires only that at least one switch contact arm will move in response to flexural or radial deformation of an arc- or disk-shaped piezoelectric or electrostrictive transducer member as a result of exposure of that transducer member to an electric field.

In the system diagramed, the transducer is in the form of a split ring provided with electrodes to which a unidirectional control voltage (battery at left) may be applied. Flexural movement of the split ring causes the ends of the ring to move relative to one another so the switch arm, mounted on one of the split faces of the ring, will move with the face.

Advantages of the design: small size, very low power requirements, and insensitivity to external fields. **(4.411)**

An electrically-driven garden tractor is being readied by General Electric for introduction this spring. At the Electric Vehicle Council's International Symposium last fall, GE showed an experimental electric passenger car. But the company sees the tractor as an introduction to electrically-driven vehicles for the public. The tractor will also serve as a portable power source for attachments (mowers, snowblowers, saws, etc.). It will, the company hopes, put GE and the electric industry in the farm and garden equipment business. **(4.11)**—*Annesta R. Gardner*

For more Developments to Watch, see pp 17, 86, 88.

600 v, while the special plastic-coated paper is maintained at ground potential.

The charged paper passes through a toner bath containing black or colored toner powder. Upon heating and pressing, the toner forms a permanent reproduction of the original copy. It will roll out of the receiver as a continuous print, or it can be cut to 8½ x 11 in.

Graphic Transmission engineers point out that, in addition to being the first facsimile reproducer to produce dry electrostatic copies, it can double as a direct readout unit for a digital computer, with design modification. **(4.9; 4.42)**

Ceramic device switches home circuits from afar

A new solid-state ceramic transducer may soon be remotely controlling home appliances, heating systems, lamps, or even office equipment and industrial tools.

The electrical properties of the ceramic can be adjusted electronically to turn on, turn off, or smoothly vary the electron flow in circuits, according to its developers, RCA Laboratories, Princeton, N.J.

Two pushbuttons will operate the device—one turns on a lamp or control circuit gradually, and the other turns it off gradually. If circuit and pushbutton are near each other, they could be wired together, but if widely separated or if mobility is desired, the pushbutton output could be transmitted to the control circuit by radio or ultrasonic signals.

Source of control. The device is made up of two ceramic wafers bonded by epoxy. Each wafer exhibits ferroelectric and piezoelectric characteristics.

When a radio or ultrasonic signal is applied to one wafer, it vibrates because of its piezoelectric properties. These vibrations are transmitted through the epoxy to the second wafer, which converts them back to an electric output signal.

The amplitude of the piezoelectric output signal can be raised or lowered by subjecting either wafer to an electronic control pulse, thus changing the amount of ferroelectric polarization in the wafer. The output signal is stable and changes only when the polarization is changed. **(4.43; 4.8)**

U.D.C.551.576:621.396.6:621.397.12

An Automatic Picture Transmission Cloud Cover Receiving Station

By

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Presented at the Second New Zealand Electronics Conference (NELCON II) organized by the New Zealand Section of the I.E.R.E. and the New Zealand Electronics Institute and held in Auckland in August 1968.

Summary: The automatic picture transmission (APT) sub-system carried on weather satellites transmits, at facsimile rate, cloud cover photographs of the Earth below. Frequency modulation of a carrier in the 137 MHz band transmitted at a level of 5 watts is used to give pictures representing an area approximately 2400 km (1500 miles) square with an average resolution of 3 km (2 miles).

Major factors governing the design of a ground station which has been operational since early 1967 are presented. Signal/noise considerations show that a desirable combination is a tracking antenna having a gain of 10 dB followed by a receiving system having a noise figure not greater than 4 dB. Except for a doubling of line frequency a standard wire facsimile is used for final picture print-out.

Many additions to, and refinements of, the basic station are possible. A few of these are outlined and assessed in terms of operational convenience.

1. Introduction

In weather prediction, meteorologists have been, and still are, hampered by a lack of information on the current state of the atmosphere which they need to forecast the complex movements that determine the weather. Satellites are an obvious surveillance platform provided they can sense the atmospheric parameters from a distance. To date, the only useful link between our atmosphere and a satellite has been electromagnetic—either at the visible or infra-red wavelengths. Despite this limitation much valuable atmospheric information can be conveyed by cloud cover photographs.

Out-of-date information is of no use to the meteorologist except for research purposes. The Earth's atmosphere is a dynamic system with the situation changing hour by hour. Hence a means of automatic picture transmission (APT) direct from satellite to local ground stations was devised. An additional incentive for the development of such a system was the overloading of available data channels which would follow if the pictures were collected at a few central stations and distributed from there to the local forecaster.

This paper outlines the design of an APT station. Foremost objectives throughout the project were reliability and ease of operation by the meteorologist. Other major factors influencing the design decisions were economics, ease of manufacture and maintenance and non-critical alignment—both electrical and mechanical.

2. Satellite Characteristics

To satisfy the meteorological requirement of complete Earth coverage at least once per day, weather satellites are injected into a near-polar orbit. Simultaneous consideration of camera characteristics, picture overlap, resolution and aspect-ratio limit the mean orbital height to between 900 and 1500 km, giving an orbital period between 104 and 116 minutes. Picture interpretation and latitude/longitude gridding problems are eased if the orbit is circular and the satellite is Earth-stabilized.

The satellite sub-system which is of concern for this paper is presented in Fig. 1. A picture sequence begins with 300 Hz modulation of the 2·4 kHz sub-carrier for 3 s as an alert signal, followed by 5 s of white level tone interrupted at line scan rate by a 12·5 ms black pulse for phasing purposes. In accordance with standard facsimile technique, no further synchronizing pulses are transmitted.

Concurrent with the above procedure the vidicon is exposed for 40 ms and the picture, typically representing an area 2400 km (1500 miles) square, is 'charge stored.' During the 200 seconds following the completion of the phasing sequence the picture is read from the vidicon at 4 lines per second and the video information is amplitude modulated on the 2·4 kHz

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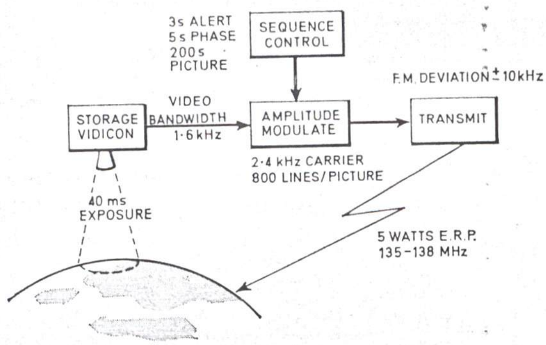

Fig. 1. Satellite sub-system.

sub-carrier; maximum carrier indicates white level and the video bandwidth is 1·5 kHz. The sub-carrier is frequency modulated on a 137 MHz r.f. carrier at a deviation of 10 kHz. Effective radiated power is 5 W.

Daytime cloud cover pictures may be supplemented by night-time infra-red transmissions for which the line scan rate is 48 lines per minute. Other differences occur in the picture format and an absence of phasing pulses in the infra-red system. However, since the main features determining ground station design are unaltered, this system will not be considered separately.

Further details on meteorological satellites are well presented in References 1–6.

3. Ground Station System: General Considerations

3.1 *Antenna*

A preliminary estimate of the station complexity may be obtained by calculation of the received signal/noise ratio. At an orbital height of 1500 km the path length of an horizon signal is 4000 km from which the signal received on a unity gain antenna is −140·2 dBW, increasing to −131·7 dBW when the satellite is overhead. (See Appendix).

At 137 MHz, antenna noise temperature due to natural sources[7] is typically 1000° K to which an additional 1000° K is added to account for man-made noise. Assuming a system noise-figure of 4 dB, which may be readily obtained by careful application of standard techniques, the total equivalent noise temperature is 2450° K. Further, by use of the simplified formula,[8]

$$\text{r.f. bandwidth} = 2(f_m + \Delta f)$$

where f_m = maximum modulating frequency

Δf = frequency deviation,

the minimum pre-detection bandwidth may be calculated as 28 kHz. Allowing for receiver drifts and tuning inaccuracy the i.f. bandwidth, B, is taken to be 40 kHz. A noise temperature of 2450° K then corresponds to a received noise power of −148·7 dBW. Siting to eliminate man-made noise reduces this figure to approximately −151 dBW.

An estimate of the base-band signal/noise ratio necessary for satisfactory picture quality must now be made. The dynamic range of the video signal handled by facsimile machines is typically 32 dB. If some 'spotting' in the black is tolerable a minimum base-band white signal/noise ratio of 38 dB would be permissible. By application of the formula[9]

$$(S/N)_b = 1{\cdot}5\,(S/N)_p\,(\Delta f/f_m)^2\,(B/f_m)$$

where $(S/N)_b$ is the base-band signal/noise ratio and

$(S/N)_p$ is the pre-detection signal/noise ratio

it is found that a pre-detection S/N ratio of 18·3 dB is necessary. In the calculations above, the received signal and noise powers were −140·2 dBW and −148·7 dBW respectively, giving a $(S/N)_p$ ratio of 8·5 dB. Hence an antenna gain of 9·8 dB is required.

Since the antenna to be used in this service must be circularly-polarized (the incoming signal may have any polarization) either the helix or 'crossed' Yagi array is suitable. Table 1 summarizes the performance of these for a gain of 10 dB.

Table 1.
Comparison of helix and Yagi antennas

Parameter	Helix	Yagi
General form	length 1·5λ 6 turn, 76 cm diameter	length 1·5λ 7 elements/plane
Polarization	naturally circular	λ/4 phasing section required
Axial ratio	closely unity	may vary widely
Beamwidth	45°	variable, but typically 40°
Side-lobes	less than −12 dB	variable; generally higher than helix
Bandwidth	50%	same order as received band; tuning critical
Feed	coaxial	balanced
Impedance	110Ω	variable, typically 40–100Ω (folded)
Size	lengths comparable, wind-load 30% higher on helix	
Construction	helix simpler, particularly in weather sealing	
Cost	comparable	

For both antennas the beamwidth is such that the ability to track during an orbit is required. If an 'elevation-on-azimuth' mount (el/az) is used a tracking speed of 6 degrees per second on both axes is sufficient for all orbits above 650 km and with maximum elevation angles less than 84 degrees.[10] Orbits passing through greater elevations may be considered as either overhead or at 84° for tracking purposes, since any reasonable pointing error is adequately offset by the lower signal path loss.

Other mounting arrangements may be used to advantage. For example, the X–Y mount avoids the infinite azimuth velocity required of the el/az mount for overhead passes. However, difficulties in mechanical arrangement, together with the ready availability of tables for the conversion of latitude, longitude and height data to azimuth and elevation co-ordinates, make the use of the el/az mount almost compulsory.

A few calculations comparing acceleration and wind-load forces[11] soon show the latter to be the more significant. Furthermore, it becomes obvious that to withstand winds over 100 km/h (60 miles/h) the pedestal and antenna structure must be large and robust with an all-up weight approaching 750 kg (¾ ton). This, combined with a turning radius of 3·6 m (12 ft), introduces some minor siting problems when it is remembered that read-out at existing meteorological offices is required. At best it can be expected that a distance greater than 50 m and up to 240 m between the antenna and the operator's console must be allowed. Because of cable loss and consequential deterioration in signal/noise ratio, a pre-amplifier will be needed at the pedestal.

3.2 *Tracking System*

With the beamwidths listed in Table 1 it is apparent that an overall tracking accuracy within ± 10° should be sufficient. However, to allow for other operational errors it would seem appropriate to design to closer limits. A ± 1% accuracy (say ± 4° in 360°) would seem a reasonable first specification which could be tightened or relaxed later when balanced against the cost of methods of system implementation.

Since accurate and up-to-date satellite orbital data are supplied regularly by N.A.S.A. there is no need for a completely automatic, self-locking tracking system. This leaves the possibility of various systems which basically fall into the categories of open- or closed-loop and which may be further subdivided into continuous or discrete types. The decision between open- or closed-loop system hinges mainly on operator convenience. Will more than one operator be required if the system is open-loop? Is there substantially less chance of error if a closed-loop system is used? Experience has shown that for general use an open-loop system is satisfactory, but for an experimental station, where the operator may be fully occupied with other equipment, the closed-loop system may have an advantage.

In general, with a moderate beamwidth antenna, it is likely that step-by-step or discontinuous tracking would be less expensive than continuous tracking provided that the stepping frequency required is not too great. A continuous system must of course be a variable-speed type.

3.3 *Signal Path*

Typical losses in 9·5 mm (⅜ in) diameter coaxial cable at 137 MHz are 10 dB per 100 m. Any such loss arising prior to amplification must be added to the system noise figure which has been assumed to be 4 dB. Hence the need for a pre-amplifier.

To avoid the need for low-noise design in the receiver a pre-amplifier gain at least 10 dB in excess of cable losses should be provided. A noise figure of 4 dB without cable loss would then become 4·6 dB if the receiver noise figure were 6 dB.

The f.m. receiver design is governed by the standard considerations of spurious response, image response, and bandwidth, with the additional demand for facsimile signals of linear phase shift in the pass-band. Since the range of signal level to be handled is small, no a.g.c. is required, but the 2·4 kHz output level must be constant to within 0·2 dB. Discriminator linearity of ± 1% is an advantage for infra-red transmissions. A pulse-averaging discriminator seems most suited to this and limits the maximum usable intermediate frequency.

Because of the 'one-shot' nature of the transmitted signal the display device must be readily operated with a minimum of skill. Furthermore, there is the meteorological requirement to have the picture available within a few minutes of reception. Both the above, without further consideration of the associated technical problems, eliminate an oscilloscope display.

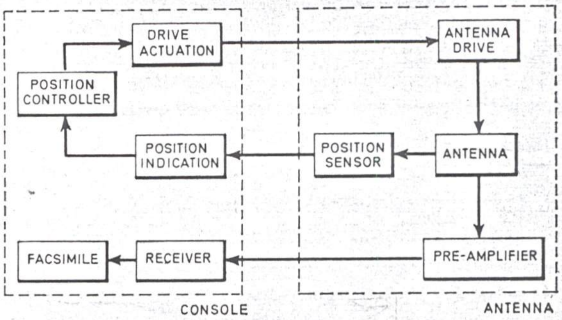

Fig. 2. System functional diagram.

A facsimile machine using either photographic or electro-sensitive paper seems to be the most reliable available picture display device. The photographic machine gives the better resolution and grey tone range but is more expensive and difficult to operate than the electro-sensitive type. The latter has the advantage that the picture may be viewed as it is formed.

The above considerations lead to a system for which the functional block diagram is as shown in Fig. 2.

4.6 *Position Control System*

Velocity calculations[10] show that if step-wise tracking is used with 10° increments the average stepping rate is a little greater than 1 per minute, with a maximum rate (for an orbit with a maximum elevation angle of 84°) of four in any one minute. This rate is well within the capability of small three-phase induction motors, which are more robust, reliable and less expensive than the more usual d.c. motors. Other methods of drive, notably hydraulic, were rejected as unsatisfactory at an early stage.

By fitting the motors with a brake, a very simple closed-loop control system was devised. This is pictured diagrammatically, together with the switching characteristic of each direction, in Fig. 4. The combined switching characteristic is shown in Fig. 5, where the guardband must encompass brake operating time and overrun during braking. Insufficient guardband will lead to hunting oscillations of the control system.

Most of the control system block diagram is self-explanatory except perhaps, the first-order interpolation unit. This enables satellite positions at one minute intervals to be programmed but the desired position fed to the error-detecting network to be a linear time interpolation between these positions.

Potentiometer feedback, as compared to synchro, was used because the signal indicating the desired position was more simply derived electrically. Furthermore, in view of the likely cable lengths of 240 m, a d.c. system was judged to be preferable. Errors were well within bounds at $\pm 0{\cdot}4°$ for potentiometer linearity and $\pm 0{\cdot}9°$ for worst case potentiometer loading. These figures are quoted for azimuth and must be halved for the elevation axis.

Not represented in Fig. 4 but incorporated in the final design are three possible modes of operation. The input from the interpolation unit may be replaced by a single desired position with the backlash in the switching characteristic reduced accordingly. Further, there is facility for open-loop manual control both at the console and at the pedestal, with appropriate interlocks where necessary.

5. Refinements

The requirements of a basic APT station capable of successful operation by a non-technical operator with the minimum of training are presented above. However, there are a few refinements which would increase the versatility of the station.

5.1 *Tape Recorder*

All the detail within a picture may not be obvious in a single mean level exposure. It may be that expansion of the white or black contrast will highlight additional features. Tape recording of the transmitted pictures allows these additional exposures to be taken. Further, it supplies 'back-up' in the case of facsimile equipment malfunction or operator error.

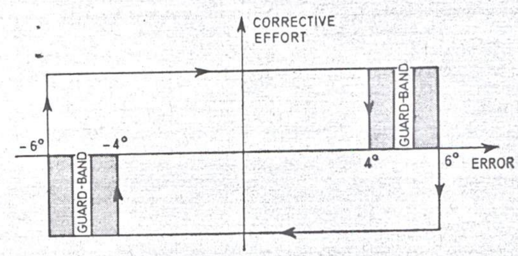

Fig. 5. Control system switching characteristic.

Most good-quality domestic tape recorders have satisfactory speed stability and bandwidth. However, since the signal to be recorded is amplitude modulated, 'drop-out' caused by head misalignment or low-quality tape contributes marked picture degradation. To overcome this the picture may be frequency-modulated on the tape, or alternatively, a high-quality tape must be chosen.

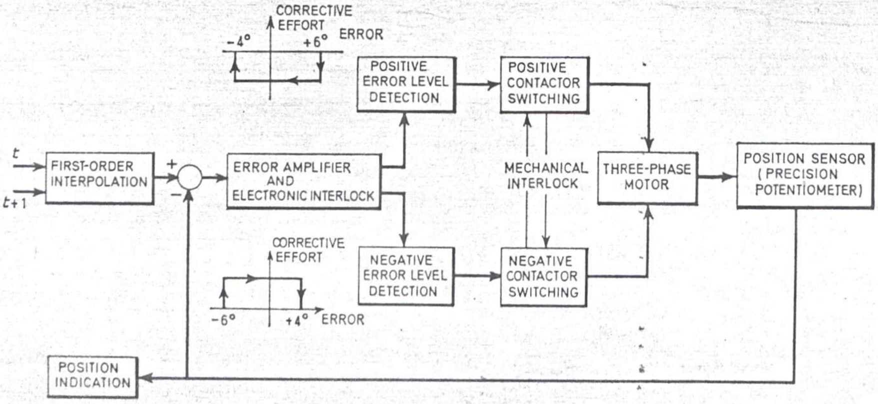

Fig. 4. Control system block diagram (Duplicate for second axis).

5.2 *Video Remodulator*

In Section 5.1 mention was made of contrast adjustment by photographic exposure level. However, electronic methods of implementing this are more convenient, repeatable and add considerably to the evrsatility of the station. Although adjustment may be made on the directly received picture it is more usual to use the remodulator in conjunction with the tape recorder.

As its name suggests this apparatus remodulates the incoming signal to alter overall contrast or to expand the contrast at either end of the grey scale, or to carry out both operations.

5.3 *Control System*

The control system outlined in Section 4.6 allows for a wide range of desired position input devices. If considered desirable it would be possible, without alteration of the present system, to control the antenna positioning from a punched paper tape. This would allow up to one month's orbits to be pre-computed and to be clocked to the control system at the appropriate time.

5.4 *Interference*

It is unfortunate that most meteorological offices are stationed at airports. This is one of the worst environments imaginable for the reception of low-level signals, particularly when these signals border on the aircraft communication band. Further, the level of man-made noise at airports is often high.

The most obvious solution to this problem is to site the antenna at a remote location but maintain control and read-out at the meteorological office. Such remote control would be readily incorporated in the station described above. The alternative is a rather stringent design of the receiving system; the most difficult requirement is the rejection of a 50 mV signal (satellite horizon signal is 2 μV) at a frequency as close as 1 MHz to the 3 MHz wide satellite band.

A preliminary investigation has shown that blocking and intermodulation may be avoided by utilizing 3-pole Chebyshev filters as interstage and output coupling in the pre-amplifier. To maintain interstage losses within acceptable bounds helical resonator filters must be used.

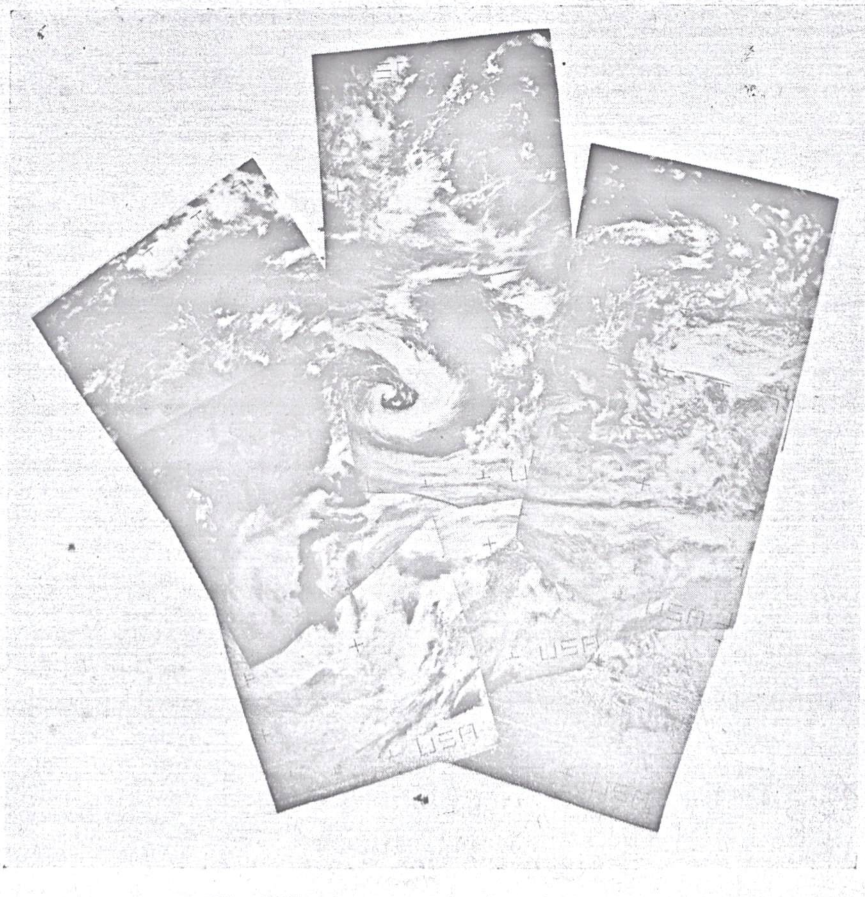

Fig. 6. Cloud montage of a single day's orbits.

6. Conclusions

An outline of the factors influencing the design of a meteorological satellite receiving station has been given. Throughout the design the overriding consideration has been the satisfaction of the meteorological objectives.

Over a period of operation of 16 months, during which at least 6000 orbits have been tracked, the total down-time has been 11½ hours involving the loss of five orbits. The loss of three of these orbits could be directly attributed to prototype faults, i.e. design features or manufacturing imperfections which were already noted as requiring correction in the production model.

The antenna structure has, without ill effect, withstood a measured 200 km/h (125 miles/h) gale. Azimuth backlash has settled down at a rather large $\pm 1{\cdot}8^\circ$ but methods of eliminating this in future models have been devised.

Antenna beamwidth was measured as 43° with the maximum side-lobe level 14 dB down. With the pre-amplifier noise figure and gain measured at 3·3 dB and 30 dB respectively, combined with the receiver noise figure of 4·5 dB, a total cable loss of 21·3 dB could be tolerated before the system noise figure deteriorated to 4 dB. An average overall noise temperature was measured on site as 2600° K with fluctuations rising to 300° K above this in directions of industrial activity. Thus the detected signal/noise ratio, although not measured directly, should have been within 1 dB of the preliminary design estimates. Received pictures indicate that this was so. A typical set of pictures received from a satellite in one day has been assembled as shown in Fig. 6.

The meteorologist has found cloud cover photography an invaluable aid to weather prediction. However, before accurate forecasts are possible the meteorologist must have access to the measurement of atmospheric parameters at a large number of sample points. It would seem that satellites are destined to fill a major role in this instrumentation, both for operational and research purposes.

7. Acknowledgments

The building of this station was made possible by a grant from the New Zealand Meteorological Service. For this and subsequent advice and co-operation the authors are grateful.

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The generosity of various organizations in the U.S.A. in making the data from weather satellites freely available to all interested nations is acknowledged.

8. References

1. Stampfl, R. A. and Stroud, W. G., 'The Automatic Picture Transmission (APT) TV Camera System for Meteorological Satellites', NASA X-650-63-77, 1963.
2. Tepper, M. and Johnson, D. S., 'Toward operational weather satellite systems', *Astronautics and Aeronautics*, p. 16, June 1965.
3. Vaeth, J. G., 'Progress in satellite meteorology', *Spaceflight*, 7, p. 190, November 1965.
4. Hubert, L. F. and Lehr, P. E., 'Weather Satellites' (Blaisdell, Waltham, Mass., 1967).
5. Goldshlak, L., '*Nimbus III* Real Time Transmission Systems (DRID and DRIR)', Technical Report No. 5, Contract No. NAS 5-10343, March, 1968.
6. Albert, E. G., 'The Improved *Tiros* Operational Satellite', ESSA Memorandum, NESCTM 7, August 1968.
7. Ko, H. C., 'The distribution of cosmic radio background radiation', *Proc. Inst. Radio Engrs*, **46**, pp. 208–215, January 1958.
8. Krassner, G. N. and Michaels, J. V., 'Introduction to Space Communication Systems' (McGraw-Hill, New York, 1964).
9. Schwartz, M., 'Information Transmission, Modulation, and Noise' (McGraw-Hill, New York, 1959).
10. Rolinski, A. J., Carlson, D. J. and Coates, R. J., 'Satellite Tracking Characteristics of the X – Y Mount for Data Acquisition Antennas', NASA TN D-1697, 1964.
11. Brown, J. S. and McKee, K. E., 'Wind loads on antenna systems', *Microwave J.*, **7**, p. 41, September 1964.
12. Kraus, J. D., 'Helical beam antenna design techniques', *Communications*, **29**, pp. 6–9, 34–5, September 1949.
13. Ghausi, M. S., 'Principles and Design of Linear Active Circuits' (McGraw-Hill, New York, 1965).

9. Appendix

9.1 *Received Signal Strength*

Signal attenuation or path loss, L, between isotropic antennas separated a distance, D in free space may be expressed as[8]

$$L = \left(\frac{4\pi D}{\lambda}\right)^2$$

or more conveniently as

$$L\,(\mathrm{dB}) = 32{\cdot}5 + 20 \log f + 20 \log D$$

if distance is expressed in km and frequency in MHz.

For $f = 137$ MHz

D (horizon range) = 4000 km.

L may be calculated as 147·2 dB.

Transmitted signal power is 5 W or 7 dBW. Hence the received power (assuming unity gain antennas) is $-140{\cdot}2$ dBW, which increases by $20 \log \left(\frac{4000}{1500}\right)$ or 8·5 dB when the satellite is overhead.

9.2 *Noise Power*

In general the received noise power may be expressed as

4. Design Solutions

A more detailed indication of the design solutions incorporated in the station under discussion will now be given.

4.1 *Antenna*

Since the overall size of the antenna and pedestal structure is dependent solely on wind-loading, an early decision on allowable wind conditions had to be made. A maximum operating wind-speed of 130 km/h (80 miles/h) and a survival speed of 200 km/h (120 miles/h) were finally chosen as suitable for local conditions.

On the basis of the factors outlined in Table 1, with emphasis being placed on the absence of critical alignment and the comparative ease of manufacture, the helix was chosen. To obtain a little extra gain[12] it was designed for a centre frequency of 125 MHz which with 6 turns gives a calculated gain of 10·5 dB and an expected beamwidth of 43°. Although the design formula of Kraus[12] applies to an axially-terminated helix, it was found that performance was not noticeably impaired with circumferential termination.

Difficulty was experienced in obtaining a reliable measure of antenna gain but the beamwidth was within ± 1° of that calculated. Since less than 20% of the system noise power is introduced by the amplifier any small deviation of antenna gain from optimum will have a second-order effect on system signal/noise ratio. Thus it was deemed unnecessary to make extensive gain measurements.

To reduce the necessary driving torque the antenna was counterbalanced against both weight and wind.

4.2 *Pre-amplifier*

Since the helix impedance is 110 Ω it was decided to mount the pre-amplifier directly behind the ground plane to use it for impedance matching to the 50 Ω cable.

A two-stage amplifier mounted on printed circuit board and enclosed in a cylindrical housing was designed following the mismatch techniques outlined by Ghausi.[13] Active components used were Fairchild SE5020 transistors. Interstage coupling and input and output matching utilized single-tuned circuits. A stability factor of 11 was obtained for an alignability of 0·3, and a typical gain of 28 dB over a bandwidth of 3 MHz. The noise figure, measured by the noise doubling technique, was 3·3 dB.

Some difficulty due to condensation of water within the pre-amplifier has been experienced.

4.3 *Receiver*

In outline, the receiver is double superheterodyne using intermediate frequencies of 10·7 MHz and 1·5 MHz. It would be more usual in a receiver of this type to choose a higher first i.f. but initially it was envisaged that a standard 10·7 MHz crystal or block filter might be used in the 1st i.f. Five switchable crystal frequencies are provided. The measured receiver noise figure is 4·5 dB.

The single 10·7 MHz stage is followed by three stages of amplification at 1·5 MHz using integrated circuit i.f. amplifiers chosen for their excellent limiting action. This completely eliminates the need for a.g.c. All the bandwidth determination of 40 kHz is done using double-tuned interstage coupling within the 1·5 MHz amplifier. Both Foster-Seeley and pulse-averaging type of discriminators are provided; the output from the latter is too low to drive the tuning indicator without introducing drift problems. Signal strength indication is derived from the first stage in the 1·5 MHz chain.

4.4 *Facsimile*

A commercial unit is used. It should be noted that the line-scan frequency is double the maximum usually provided in facsimile machines.

4.5 *Pedestal Structure*

Mechanical details of the pedestal will not be elaborated in this paper. Figure 3 shows the general structural form.

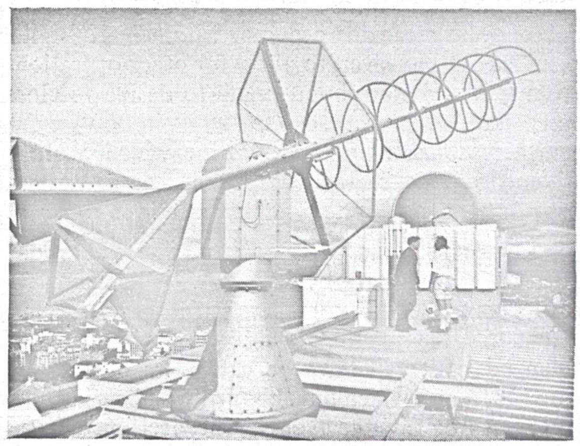

Fig. 3. Pedestal structure.

The antenna is mounted directly on the output shaft of the main elevation gearbox, which is driven from a subsidiary gearbox and ½ hp 3-phase induction motor housed in the upper structure. This unit is rotated in azimuth by similar gearboxes and motor housed in the lower cone.

Signal, power and control cables limit the azimuth rotation to 370°, but the elevation may travel ± 92° from vertical to allow continuous tracking for all possible orbits.

$P_n = KTB$ where the symbols have the following meaning:

K Boltzmann's constant, $1{\cdot}38 \times 10^{-23}$ joule/deg K

T equivalent input noise temperature, °K

B pre-detection bandwidth, Hz.

Hence, if $T = 2450°$ K and $B = 40$ kHz then $P_n = 1{\cdot}35 \times 10^{-15}$ W or $-148{\cdot}7$ dBW.

9.3 *Signal/Noise Ratio*

Above threshold the narrow-band noise model relates pre-detection and base-band signal/noise ratios by the following formula.[9]

$$(S/N)_b = 1{\cdot}5\,(S/N)_p\,(\Delta f/f_m)^2\,(B/f_m)$$

where $(S/N)_b = 38$ dB $= 6300$

$\Delta f = 10$ kHz

$f_m = 4$ kHz

$B = 40$ kHz

Hence $(S/N)_p$ may be calculated as 67·3 or 18·3 dB.

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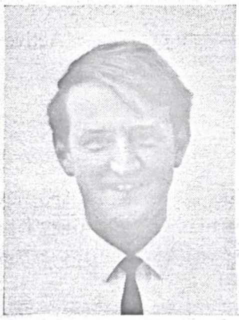
Contributors to this Issue



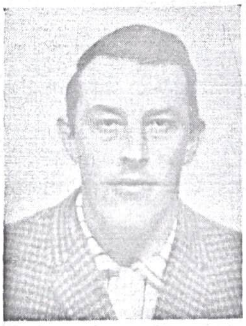
Dr J. K. Bargh is currently a senior lecturer in electrical engineering at the University of Canterbury. After completing his M.E. degree at that University in 1956 he accepted a short service commission in the New Zealand Defence Scientific Corps. During this period he spent 3 years working in the Control Group of the Cambridge University Engineering Laboratories and two years at the Naval Research Laboratory in Auckland, New Zealand. After leaving the Defence Scientific Corps, Dr Bargh spent some time as a systems engineer with Elliott Automation before returning to academic life. His main research interests are system identification and modelling.

W. K. Kennedy joined the staff of the University of Canterbury after graduating with a B.E. degree in 1963. His teaching interests include circuit theory and service courses. At present his research is centred on machine recognition of photographic features, with particular reference to cloud cover photography.

L. Leng graduated from Manchester University with a B.Sc. Tech. degree in electrical engineering. He received his technical training at S.T.C.'s North Woolwich factory and also at B.T.H., Rugby.

His engineering experience was acquired on electrical drive and control gear while working with the consulting engineers, McLellan and Partners. He then joined the U.K. Atomic Energy Authority where he was concerned with nuclear plant instrumentation and control.

At present, Mr. Leng is the head of Electrical Department of W. & T. Avery's weighing division and is responsible for the design and application of electrical and electronic equipment to weighing machines.



Peter D. H. Cobham (M. 1968, G. 1963) was at the National Physical Laboratory for eight years, latterly as an assistant experimental officer in the Acoustics Section. In 1964 he became an assistant lecturer at Letchworth College of Technology and in 1968 was appointed lecturer in the Engineering Department at Twickenham College of Technology.

COMMUNICATIONS FOR SOCIAL NEEDS

Overall review of the six major areas:

- Education
- Health Services
- Cultural Opportunities and Public Broadcasting
- Law Enforcement
- Postal Service
- Urban Planning: The Wired Community

All the presentations are rational but it takes more than rationality to make such new programs accepted and successful.

EDUCATION

Any improvement in the methods of education is worth studying and pioneering. While the use of satellite to broadcast education programs is one of the available methods, alternative solutions as video-cassettes should be also investigated because of their timing flexibility and possible savings.

The advantages of TV direct broadcasting are in the implied possibility of two way exchange but one must consider that this interactive feature is very difficult to achieve with a large audience, which is the case of satellite distribution and broadcasting. Also, the two way computer program education with one terminal per student is to be strongly considered on a broad scale. It involves also communications but probably limited to the computer location.

The proposal for education should include the full study of these important applications some of which have been already successfully tested.

HEALTH SERVICES

If used efficiently these services should be quite beneficial.

CULTURAL OPPORTUNITIES AND PUBLIC BROADCASTING

Is an increase of 20 times in capacity - 20 channels instead of one - realistic? Will the value of the programs be such that the interest will be maintained and increased over many years. Of course formal educational programs might be sustained regularly for ever.

LAW ENFORCEMENT.

This application seems to satisfy a very specific requirement.

POSTAL SERVICE.

I report separately on this application

URBAN PLANNING:

There seems to be some duplication with Public Service Broadcasting.

The acceptance and use of such systems on a broad scale is difficult to ~~foresee~~ evaluate.

There is no question that wideband wire service will be provided in many homes. The practical uses of such a facility by society will depend on many factors. The distribution must address large groups first, as the wideband on a home by home basis is not going to be technically economical for some time.

In the group use, the interactive service is quite limited as well as the personal interrogation and video answer. The personal video answer requires one coaxial line per receiver with switching. The answering organization if used on a successful large scale, will be important and costly. Interactive systems if efficiently used

These views do not aim at being critical or pessimistic, but as realistic as possible, to orient, if possible, the first applications in the right direction.

GENERAL COMMENTS

Who will own the satellites, and the networks?

Who will finance the education networks?

How will the Health Services be financed?

How will the investments costs be absorbed and recuperated? These problems must be studied in some details.

The financing and operation of the Postal Service is obviously clearer.

POSTAL SERVICE:

The electronic mail system described is certainly realistic but also clearly addressed to the future.

On the technology used, I only recommend that the most expert advice be obtained in the establishment of the specifications for the first tests particularly in coding, storage and proper multiplexing of the total signals to minimize the number of repeats necessary because of simultaneous transmissions to centers.

The organization of the signals is particularly important in such a large simultaneous and common transmission system. This is feasible but ~~I think~~ it has never been achieved before. Therefore, detail analysis must be made.

The planning of the successive phases of the undertaking is well done.

There is one aspect on which I wish to call the attention particularly. It is the marketing of the services. It must be established as accurately as possible what categories of mail will fit and will use the system and what total ~~quantity~~ volume they will represent.

~~To establish this~~ the prospective users will want to know exactly what results they will obtain and ~~the dispostions for~~ all the practical aspects of the connecting with the system at the input, and of the distribution ~~to them~~ at the output. ~~part~~ The cost of the service will have to be very correctly estimated.

It is indispensable to correctly ass~~ist~~ess. the market to be served as the system has its limitations.

It is also possible to influence a certain categor~~y~~ies of mail to make ~~it~~ them fit perfectly the system if there are advantages to the users but obviously the birthday cards, ~~and~~ the checks and many other items will not fit.

A correct marketing evaluation which will establish what mail and what volume will be ~~transmitted~~ ~~will~~ handle should be the ~~determining~~ major factor to reach ~~for~~ the decision to proceed.

H. BUSIGNIES

When considering the application of communications technology towards the social needs of this country, it is important to take into account today's living pattern, where the vast majority of the country's population lives on a minuscule percentage of our land in over-populated urban and suburban areas. The resultant problems, involving crime, pollution, traffic, education, social, etc. we are all aware of, but perhaps we do not realize that we are rapidly approaching such critical conditions that the survival of the nation may very well be at stake.

I have requested the National Academy of Engineering and HUD to allow me to carry out a parallel study of applying communications technology to urban problems. The result of the parallel study has been published together with the main report.

It is my conviction that the activities of my panel were of equal importance in both of these areas. As a matter of fact, the parallel study, which I called "The Cities of the Future", is intended to be funded for its next phase by HUD, and it is this approach which for its success will require large-scale new applications of communications technology.

In "The Cities of the Future" our thesis has been that those reasons which caused originally today's cities to come into being, exist no longer and that today's needs for cities cannot be satisfied with our cities as we know them at present.

Our study showed that today's pattern of life, the major problems and also some of the benefits resulted from science and technology growing at an ever increasing rate as a result of the first and greatest invention in communications, namely the printing press. What happened since, was not planned, hence in many ways we are living in an era dominated by urban conditions. The paradox of communications today is that the closer together people now live, the more difficult they find it to communicate, which is typical of our over-populated urban and suburban complexes where people live under stresses and strains to which our species has not been able to adapt itself, nor will it for tens of thousands of years. Today we represent an angry race, and our studies have shown that crime and pollution, for instance, increase non-linearly with city size. Where the density of population is high, crime and pollution also increase.

We have examined the reasons why people migrate from our vast rural areas to the already crowded urban and suburban centers, and why people from these are not induced to live in an attractive country environment. The major ingredients seem to be the lack of choice, of job opportunities in the rural sections; the lack of cultural, educational, entertainment opportunities, inadequate health services, etc. It has been our belief that imaginative application of known principles and existing inventions to new systems of communcations could solve these problems and make it possible for instance for business not to expand into suburbs, but into distant and attractive rural towns, and at the same time, we have pinpointed communications techniques whereby education, cultural, entertainment, health services etc. and other essential factors for a high quality of life can be created in any part of the U.S.

We do not propose that new towns be built. This requires a large amount of capital and time. We have studied the distribution and the existence of towns between 5,000 and 100,000 inhabitants and found that 100 million Americans between now and the end of the century could easily be attracted to these existing towns which would act as nuclei for enlarged centers, but growing in population not above 200,000.

Analyses have shown that the additional land use based on such a pattern, is insignificant, something on the order of 4 %, thereby leaving intact the great majority of our land resources.

The proposed plan simultaneously changes the role of the large cities and would tend to solve their problems. The transformation of the large city, its new role, it social and economic life under such a plan should be the subject of another discussion. At this time, I am anxious to point out that all the technologies and their pattern of application, as outlined in the current reports of this presidential study, tend to assume that the current mode of population distribution and mode of life will not change. For that reason I wonder whether attention should not be drawn to other uses and forms of distribution as well as new combinations of currently known or proposed terrestrial, satellite, cable or cassette TV systems. Such telecommunication systems must be capable of getting us under way in solving what generally is considered the nation's paramount problem.

EDC

October 15, 1971

MEMORANDUM

TO: Dr. Peter C. Goldmark

FROM: Mr. Edwin D. Campbell, President
Education Development Center
Newton, Massachusetts

SUBJECT: Comments on "Communications for Social Needs: Technological Opportunities"

You have asked me to comment on the educational portion of the President's Domestic Council Study on "Communications for Social Needs: Technological Opportunities." Before discussing the educational section, I would like to make several comments about the overall study itself.

In my judgment, there will be a need for a comprehensive communications system similar to that described in the study. Furthermore, it is heartening to see the degree of cooperation, commitment, and competence demonstrated by the many government agency personnel involved in this study. In a relatively short time, they completed a study which provides a comprehensive starting point for developing the type of communications system this country will require in the years ahead.

Many of my specific comments which follow can be interpreted as negative. Therefore, I wanted to state first my belief in the need for a comprehensive communications system for some types of national problems, and my admiration for the study's efforts. I would appreciate your reflecting on my following observations within the context of the foregoing statements.

My reaction on reading the report as a whole was that "a solution is looking for problems." I have seen this occur many times in industry, where the proponents of a program fall into the familiar trap of making a presentation rather than an analysis. By presentation, I mean the marshalling of data, both general and specific, which support the proposed program. By not presenting enough hard data in an analytic fasion, the proponents end up creating many straw men which opponents then begin to knock down. Sometimes the proposed program is destroyed by this process.

For example, there is a wide difference between the application of the proposed communications system to problems of the postal service and its application to education. For the postal service, the problems of handling an ever-increasing volume of mail and at the same time improving the efficiency of the mail service might be "solved" by the communications system. In reading the report, I see a direct correlation between some of the needs of the postal service and the services offered by the proposed communications system.

In the areas of education and health services, I do not see a similarly direct relationship between the communications system and pressing problems which the report has identified. Likewise, I did not find a direct relationship in the oral presentations last Saturday. Regardless of how improved a communications system we construct, and regardless of how much it may be needed by these two sectors of our society, it certainly will not "solve" the educational and health problems which were enumerated in the report. I am sure that the individuals involved in the study do not believe that a new communications system will solve these problems. But unfortunately, by presenting the application of the proposed communications system to certain education and health problems in an oversimplified, general way, the authors create straw men which can easily be destroyed.

At this point let me make some specific comments about the proposed impact and benefits of the communications system on the educational problems which are defined in the report.

<u>By 1975, the number of high school graduates or graduate equivalents could be increased by one million</u>.

In my opinion, increasing the <u>number</u> of high school graduates is not one of the high priorities in education. Making education more useful and usable, and making it more meaningful to the existing school populations are much more serious problems. Furthermore, many members of minority groups who currently have a high school diploma cannot get jobs. I would almost argue that turning out more high school graduates who have aspirations toward satisfying employment or higher education and who cannot get either is actually damaging to our society and to them. How communication help

Another point concerns the percentage of high school dropouts. The report cites the fact that 40% of urban students and 25% of all students nationwide do not finish high school. From this I infer that the percentage of dropouts in rural areas must be less than 10%. In a cost effectiveness sense, if a high school equivalency is deemed desirable, then why not concentrate solely on the urban areas? And, I would doubt if a new satellite/wired city communications system would be a <u>prime</u> factor in the urban areas.

<u>By 1976, 20,000 people could be trained in early childhood education</u>

This is an important new national priority, and substantial funds have already been allocated for the establishment of day care centers. At the same time, the major problem in this area has to do with the overall philosophy (custodial vs. developmental) which early childhood education should espouse. For advocates of the developmental role, there are related issues of what should be taught, who should teach it (peer groups, older children, adults, etc.) and how it should be taught. No doubt, new communications systems can profitably be employed in this area, and imaginative experimental programs certainly should be undertaken. But a communications system is a delivery technology and will not solve the most important issues and problems in the area of early childhood education.

By 1976, 10,000 new health personnel could be trained.

Training new health personnel is another important area of national concern. Again, the study does not really address itself to the major problem. It would be fair to say that educational TV, computer-assisted instruction, and other attempts to utilize technology in education and training have not lived up to expectations. Indeed, some people would argue that these attempts have failed.

I believe the report should address itself to this question, discuss some of the reasons why educators and other professionals believe technology has failed, and identify possible new experimental approaches which might be followed. Our having greater technological capacity to reach people will not train them to be effective health personnel unless we know more about how to utilize that technology most wisely. What constitutes effective training? What portion of this training can best be undertaken via telecommunications technology?

By 1976, an open university and a model for accreditation could be established.

Again, the major factors here certainly do not depend upon a more effective delivery system. While such a delivery system will eventually be needed, first priority must be given to such questions as developing the specific role for such a university, providing it with stature so that it will not be a second-rate "degree mill," working out associated and meaningful tutorial and guidance systems, and so forth. In short, the problem is to develop an entirely new educational concept which will make higher education available to more people at lower cost. As in the area of child care training, I can envision the utilization of a system such as the one described in the study. But a comprehensive communication system, by itself, will not make such a university possible. Unfortunately, the report seems to imply that it will.

By 1974, models for deliverying modern instructional materials to remote regions will be demonstrated.

The comments pertaining to training of health personnel are applicable here. The major problem is to develop effective new models, not merely to deliver the models.

Miscellaneous Points

1. During the presentations and in some of the material, "Sesame Street" is cited as "the successful educational TV model" in such a way that the statement cannot be challenged. Yet, its truth has been challenged. Many educators have questioned or disputed "Sesame Street's" effectiveness and value as an educational experience. The BBC decided not to carry the program, partly because of its concern with the effects upon children of learning via the "Sesame Street" model. I am also told that there is concern about the effect upon children of education without opportunity for human interaction and contact.

2. There was no mention of the possible role of video-cassettes as a means for disseminating knowledge and what this might do for education. or audio cassettes

Conclusion

In conclusion, I suggest that the study should not approach the reader from an "educational problem" perspective (high dropout rates, need for health personnel, etc.) but rather from a pedagogical viewpoint. To be convinced of the importance of this telecommunications system, the reader needs to know (1) what attracts people to telecommunications media, (2) what telecommunications systems (such as educational TV) have accomplished in the past and what newer versions such as two-way TV might accomplish in the future, and (3) what type of educational problems can best be resolved by an improved delivery system which utilizes telecommunications technology. By not addressing itself to some of these essential points, the study fails, I believe, to present its case for this important idea in convincing enough fashion.

The early childhood day care and open university areas may well represent the best places in which to conduct major experimental educational programs aimed at utilizing such a telecommunications system. Both of these areas present the need for new educational concepts, and it should be easier to work out such concepts in areas which are not bound by existing practices. Once demonstrated, however, I am sure they could be a major factor in attaining educational objectives in existing areas. For example, new techniques worked out for an open university should certainly be applicable to reducing costs and improving the teaching efficiency at traditional colleges and universities.

Finally, there is not a doubt that our country needs more effective means of education and training for all its citizens. But, in my opinion, a more comprehensive delivery system is not sufficient. It must be coupled with the human resources, programs, and other incentives which are prerequisites for an educational system that truly educates.

A DEMONSTRATION PROGRAM OF URBAN TELECOMMUNICATIONS

PROGRAM SUMMARY FOR BLUE RIBBON PANEL

PREPARED BY

U.S. DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT

IN COOPERATION WITH

OFFICE OF TELECOMMUNICATIONS POLICY

10-9-71

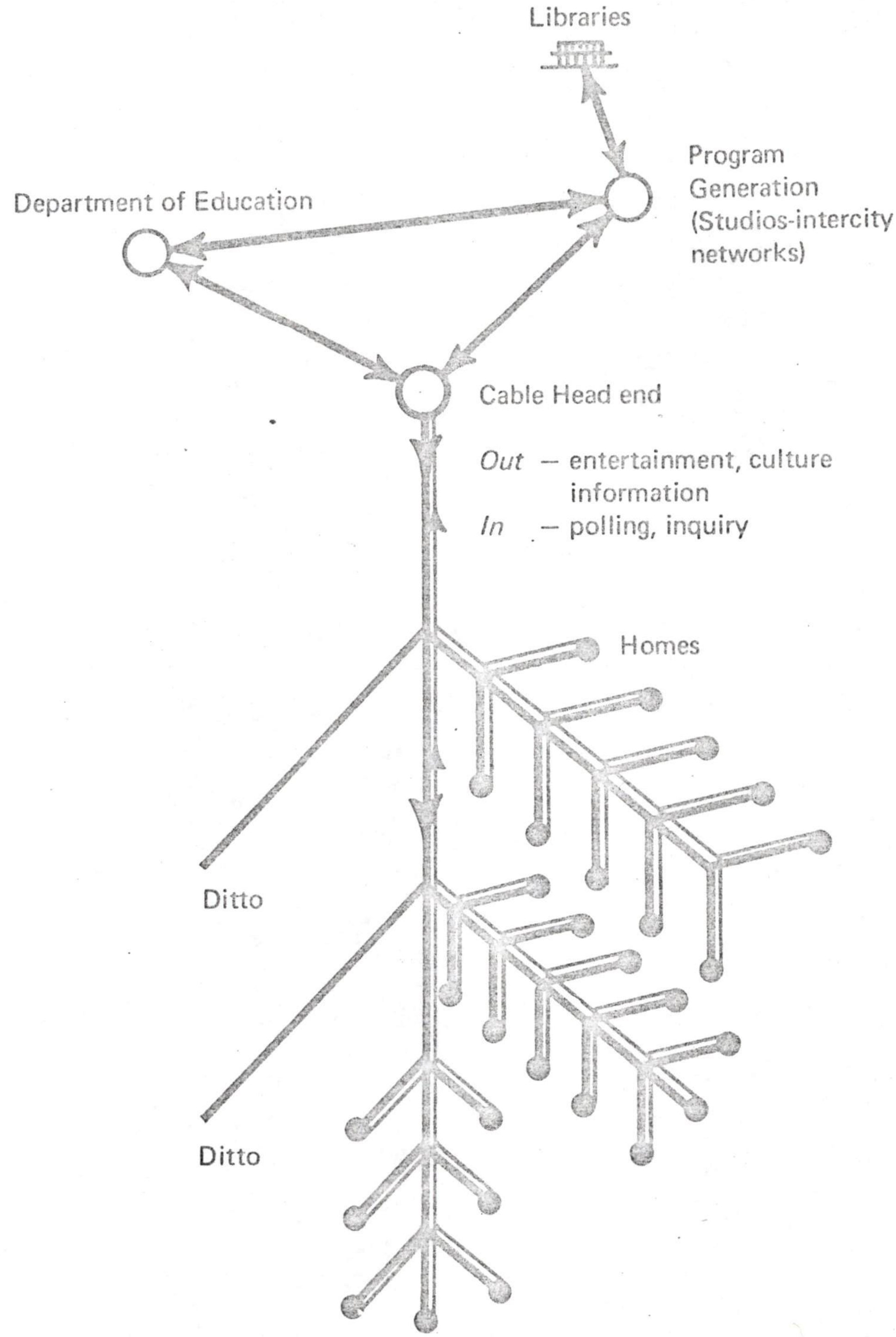
PROBLEM

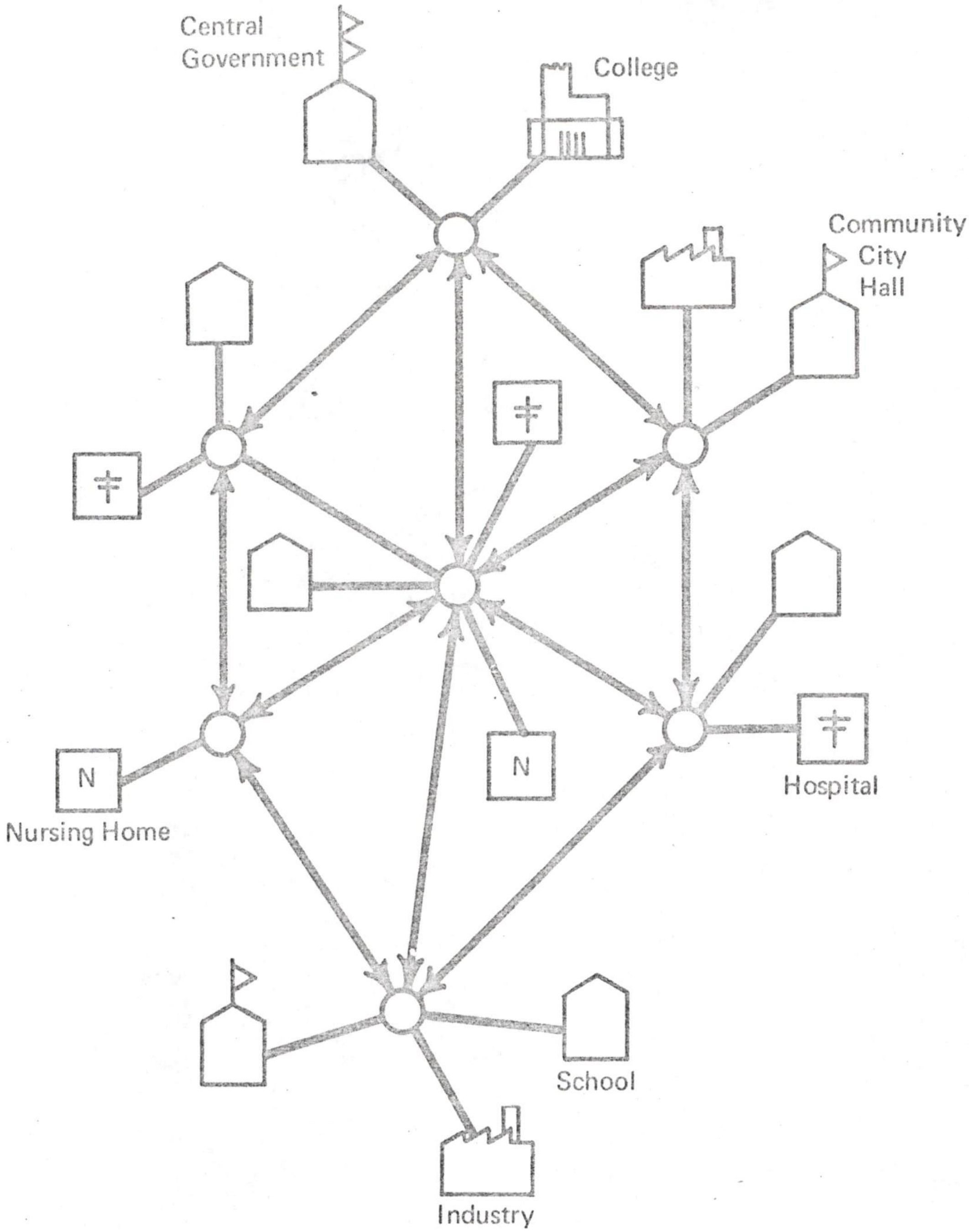
SOCIAL AND POLITICAL ALIENATION OF INDIVIDUALS IN PART CAUSED BY:

- ONE-WAY NATURE OF PRESENT COMMUNICATION BETWEEN THE INDIVIDUAL AND INSTITUTIONS
- LACK OF TIMELY AVAILABILITY OF INFORMATION AND SERVICES TO LARGE SEGMENTS OF SOCIETY
- MISUSE OF RESOURCES BY THE PUBLIC IN OBTAINING NEEDED SERVICES AND IN CONDUCTING DAY-TO-DAY BUSINESS

LARGE PRIVATE INVESTMENT IN CATV IS FORTHCOMING (NO FEDERAL INVOLVEMENT AT PRESENT)

- $10 BILLION FOR BASIC SYSTEM
- $30 BILLION FOR HOME TERMINALS
- FEDERAL RESEARCH AND DEVELOPMENT NEEDED FOR RESULTS TO SUPPORT POLICY DEVELOPMENT


Libraries
Program
Generation
(Studios-intercity
networks)
Department of Education
Cable Head end
Out – entertainment, culture
information
In – polling, inquiry
Homes
Ditto
Ditto


Central
Government
College
Community
City
Hall
N
Hospital
N
Nursing Home
School
Industry

OBJECTIVE

ESTABLISH A MULTI-SITE, MULTI-SERVICE BROADBAND COMMUNICATIONS DEMONSTRATION PROJECT WITH BOTH PUBLIC AND PRIVATE PARTICIPATION

- INSTALL OR AUGMENT TWO-WAY BROADBAND SYSTEMS IN SEVERAL URBAN SETTINGS
- INSTALL SIMILAR SYSTEMS IN NEW TOWNS
- INTERCONNECT PARTICIPATING SYSTEMS, IF POSSIBLE
- INVITE FEDERAL, STATE AND LOCAL AGENCIES TO USE THE PROJECT SYSTEMS FOR DELIVERY OF PUBLIC SERVICES
- INVITE PARTICIPATION BY FIRMS WHO WANT TO TEST THE ECONOMIC VIABILITY OF THE NEW COMMUNICATIONS SYSTEMS AND THE ACCEPTANCE OF THESE SYSTEMS BY THE PUBLIC AND BUSINESS COMMUNITY

ESTABLISH A SERIES OF ONE-STOP COMMUNITY INFORMATION AND SERVICES CENTERS TO SERVE AS A TWO-WAY LINK BETWEEN THE INDIVIDUAL AND CITY HALL.

- LINK COMMUNITY INFORMATION AND SERVICES CENTERS TO EXISTING CITY SERVICES AGENCIES THROUGH TWO-WAY BROADBAND COMMUNICATIONS NETWORKS

EVALUATE PUBLIC ACCEPTANCE AND MARKET POTENTIAL OF BROADBAND COMMUNICATIONS SYSTEMS.

COMMUNITY INFORMATION AND SERVICES CENTERS

GOAL

- PROVIDE EFFECTIVE RESPONSE TO COMMUNITY PROBLEMS AT THE NEIGHBORHOOD LEVEL
- PROVIDE EFFECTIVE DELIVERY OF LOCAL GOVERNMENT SERVICES TO EVERY NEIGHBORHOOD

DESCRIPTION

- ESTABLISH A SERIES OF ONE-STOP COMMUNITY INFORMATION AND SERVICES CENTERS TO SERVE AS A TWO-WAY LINK BETWEEN THE INDIVIDUAL AND CITY HALL
- LINK COMMUNITY INFORMATION AND SERVICES CENTERS TO EXISTING CITY SERVICES AGENCIES THROUGH TWO-WAY BROADBAND COMMUNICATIONS NETWORKS

ACTIONS

- PUBLICIZE THE EXISTENCE OF THE COMMUNITY INFORMATION AND SERVICES CENTERS AND THEIR ACTIVITIES

- INTEGRATE SERVICE DELIVERY ON A NEIGHBORHOOD-BY-NEIGHBORHOOD BASIS

  -- ESTABLISH CENTERS AT EASILY ACCESSIBLE NEIGHBORHOOD FOCAL POINTS

  -- TRAIN NEIGHBORHOOD TEAMS TO WORK IN EACH CENTER

  -- ESTABLISH HOME-BASE COMMUNITY SERVICE CENTER TEAMS AT ESTABLISHED RESOURCES TO PROVIDE NEEDED INTERFACE WITH THE EXISTING COMMUNITY RESOURCES AND THE NEIGHBORHOOD TEAMS

- SERVE AS A FRONT-LINE SOURCE OF MEDICAL INFORMATION

- PROVIDE OPPORTUNITIES FOR CONTINUING EDUCATION AND JOB TRAINING

- PROVIDE JOB PLACEMENT FOR UNEMPLOYED WORKERS

- PROVIDE ASSISTANCE IN OTHER FUNCTIONAL AREAS:

  -- PAYMENT OF BILLS AND TAXES

  -- REQUIRED LICENSE APPLICATION

  -- PUBLIC ASSISTANCE DETERMINATION AND WELFARE

  -- PROBATION AND PAROLE SERVICES

  -- CLIENT ADVOCACY AND LEGAL AID

-- HOUSING

-- CONSUMER SERVICES

-- SOCIAL AND REHABILITATION SERVICES

-- AID TO THE ELDERLY

-- COMPLAINT REFERRAL

TECHNICAL FEASIBILITY

- DEMONSTRATION IS BASED ON THE ASSUMPTION THAT BROADBAND COMMUNICATIONS SYSTEMS WILL BE OPERATING IN THE CITIES

  -- CATV SYSTEMS ARE NOW BEING PLACED IN URBAN AREAS

  -- EXCESS CHANNEL CAPACITY CAN BE USED TO CONNECT NEIGHBORHOOD CENTERS AND CENTRAL AGENCIES

- MORE THAN 2,500 MULTI-SERVICE CENTERS NOW PROVIDE NEIGHBORHOOD ASSISTANCE TO A POPULATION BASE OF OVER 220,000 RESIDENTS

- DEMAND FOR NEIGHBORHOOD SERVICES IS RAPIDLY INCREASING:

  -- MORE THAN 3.5 MILLION PERSONS WERE SERVED IN CHICAGO CENTERS BETWEEN FEBRUARY 1965 AND DECEMBER 1970

  -- REQUESTS FOR SERVICE IN CHICAGO CENTERS INCREASED BY 21 PERCENT BETWEEN 1969 AND 1970

- MODEL SYSTEM FOR COORDINATION OF SOCIAL AND OTHER SERVICES HAS BEEN DEVELOPED FOR HUD AND HEW BY THE INSTITUTE OF INTERDISCIPLINARY STUDIES

PAYOFF

- DECENTRALIZATION OF ROUTINE GOVERNMENT SERVICES:

    -- IMPROVES DELIVERY OF SERVICES TO THE CITIZEN

        * REDUCES DELIVERY COST

        * DECREASES BUREAUCRATIC RED TAPE

    -- REDUCES NUMBER OF DIRECT CONFRONTATIONS BETWEEN CITY HALL AND CITIZENS BY PROVIDING INTERACTION ALTERNATIVES

- IMPROVED COMMUNICATIONS:

    -- BUILDS COMMUNITY PARTICIPATION IN LOCAL GOVERNMENT

    -- REDUCES DUPLICATION OF FACILITIES AND SERVICES

    -- REDUCES CITIZENS' COST OF OBTAINING SERVICES:

        * SAVES TRAVEL MILEAGE AND TIME

        * SAVES PARKING FEES OR BUS FARE

    -- FACILITATES "REAL TIME" RESPONSE BY GOVERNMENT TO LOCAL INQUIRIES AND NEEDS

- EXPANDED OPPORTUNITY FOR EMPLOYMENT AT THE LOCAL LEVEL

SCHEDULED GOAL

ON JULY 4, 1976 6,000 FAMILIES WILL BE USING URBAN COMMUNICATIONS SERVICE OF THE FUTURE

SCOPE OF ACTION

SITE

HARDWARE

SOFTWARE
- PUBLIC
- PRIVATE

OPERATION

EVALUATION

PHASE OUT

DESCRIPTION/ACTIONS

SITE

- LOCATION AND SIZE OF DEMONSTRATION
  - DEMOGRAPHIC COMPOSITION OF COMMUNITY
  - CRITICAL SIZE FOR REALISTIC MARKET DATA
  - COOPERATION OF LOCAL GOVERNMENTS

- HARDWARE
  - EVALUATE AND SELECT TERMINAL EQUIPMENT TO PERFORM NEEDED SERVICES
  - SUBSIDIZE EQUIPMENT IN ORDER TO SIMULATE MASS PRODUCTION COSTS

- SOFTWARE
  - EVALUATE SOFTWARE ALREADY AVAILABLE
  - INVITE OTHER FEDERAL AGENCIES TO PROVIDE SERVICE DELIVERY DEMONSTRATIONS

    HEW
    DOL
    OEO
    USDA
    DOT
    VA
    DOJ

  - INVITE PRIVATE INDUSTRY PARTICIPATION

- OPERATION

  GOVERNMENTAL CONTROL AND OPERATION FOR AT LEAST TWO YEARS

- EVALUATION

- PHASE OUT OF GOVERNMENTAL CONTROL

ORGANIZATION AND MANAGEMENT

PHILOSOPHY

- ANALOGOUS TO HUD'S OPERATION BREAKTHROUGH
  - LOCAL GOVERNMENT CONSTRAINTS
  - MARKET FRAGMENTATION
  - RELIANCE ON PRIVATE ENTERPRISE
  - CONSUMER ACCEPTANCE
  - DEMONSTRATION AS A CATALYST

- HUD WILL PROVIDE A SYSTEM, SOME GOVERNMENTAL AND HOUSING SERVICES DELIVERY
  - WILL ENCOURAGE COOPERATION OF OTHER AGENCIES IN PROVIDING GOVERNMENTAL SERVICE DELIVERY VIA TELE-COMMUNICATIONS
  - WILL ENCOURAGE PRIVATE SECTOR DELIVERY OF ENTREPRENORIAL SERVICE

- HUD MAKES USE OF EXISTING GOVERNMENT EXPERTISE TO CARRY OUT ITS RESEARCH AND TECHNOLOGY PROGRAMS

ORGANIZATION AND MANAGEMENT

. OVERALL COORDINATION AND EVALUATION -- HUD

. POLICY EVALUATION -- OTP

. LOCAL SITE MANAGEMENT -- LOCAL GOVERNMENT/PRIVATE CONTRACTOR

. COORDINATION: INTERAGENCY COMMITTEE ON URBAN TELECOMMUNICATIONS
HUD INTERNAL ADVISORY COMMITTEE

. FEDERAL SUPPORT:
  . FACILITY SUPPORT AND GOVERNMENT SERVICES SOFTWARE -- HUD, NSF
  . TECHNICAL SUPPORT -- DOC, NASA
  . HEALTH -- HEW, VA, USDA, OEO, NSF
  . WELFARE -- HEW, OEO, NSF
  . EDUCATION -- HEW, DOL, OEO, NSF
  . MANPOWER -- HEW, DOL, OEO, NSF
  . LAW ENFORCEMENT -- DOJ, NSF

. NECESSARY REGULATORY CHANGES -- FCC

. PRIVATE OWNERSHIP OF CABLE CAPACITY

PROGRAM/PROJECT COSTS

	FY-72	FY-73	FY-74	FY-75	FY-76	FY-77	FY-78
BASE PROGRAM	1.0	2.5	---	---	---	---	---
ANALYSIS, MANAGEMENT TECHNOLOGY ASSESSMENT AND EVALUATION	---	1.0	2.7	3.3	3.5	3.0	1.5
EQUIPMENT	---	5.0	10.0	15.0	---	---	---
SERVICE DELIVERY	---	1.0	4.0	2.0	2.0	---	---
OPERATIONS	---	---	1.0	2.0	6.0	6.0	---
PHASE OUT	---	---	---	---	---	---	6.0
TOTAL	---	7.0	17.7	22.3	11.5	9.0	7.5

POTENTIAL PROBLEMS

. FEAR OF JOB DISPLACEMENT

. OBJECTIVE SELECTION OF NECESSARY HARDWARE FROM PROPRIETARY EQUIPMENT OFFERED BY COMPETING MANUFACTURERS

. PRIVACY CRITERIA

. VESTED INTEREST GROUPS

DAMON RUNYON MEMORIAL FUND
33 West 56th Street New York, N. Y. 10019

MEMORANDUM TO: DR. PETER GOLDMARK, C.B.S

FROM: T. F. ROGERS, MITRE

SUBJECT: OBSERVATIONS ON THE TELECOMMUNICATIONS "INNOVATIVE PROGRAM"

DATE: OCTOBER 17, 1971

1. The description of the problems, their national importance and the value to the nation of their amelioration as presented to us -- all strike me, in general, as sound and thoughtful. While, in the circumstances, the individual experiments/development-tests designed to address them cannot have been thought out adequately as yet, they are generally of a character as should warrant Federal support at (at least) the fund levels indicated if they can be brought into satisfactory professional focus. And, certainly, the civil areas addressed here cannot but profit from seeing an infusion of new concepts, and of energetic, competent, scientific and engineering activity.

2. To the extent that the aspirations envisioned here are realized, our society will be even more influenced by the character, amount and availability of the nation's telecommunicative capabilities. It is important, therefore, that we obtain a more comprehensive and quantitative understanding than we now have, apparently, of how telecommunications affects the efficiency, i.e., "the productivity", by which goods and services are produced and delivered in both the public and private sectors. I do not have a high degree of confidence in the semi-quantitative estimates given to us of the economic benefits to be expected from the conduct of this program.

3. The conduct of socially- and politically-related experiments/development-tests is a complex and sensitive matter. Today, the amount of true knowledge that we have relative to the social, political, psychological and cultural causal responses to any given major "technological intervention" is small. Also, the number of scientists, engineers and other professionals schooled and experienced in the conduct

and evaluation of such experiments/development-tests is very small. Therefore, we should mount them very selectively and carefully, proceed prudently in their conduct, lead them with extraordinarily sound and sensitive professional groups -- and, expect to confront unexpected difficulties and accept public failures. And, I would not be surprised in the least if they were found to require a great deal more money and time to bring to satisfactory conclusion than is estimated here. And I believe it to be at least as important that, in conjunction with the conduct of any of the more fundamental experiments/development-tests described here, reasonably comprehensive "technology assessment" studies should also be made in order to obtain a better insight into the societal impacts which the eventual widespread adoption of their results could have -- impacts both direct and indirect, desired and undesired.

4. To the extent that the experiments addressed to providing the individual citizen with a great deal more information regarding the workings of his government and the various services which it offers prove to be successful, we can expect an increased demand (perhaps large and rapid) for the general provision of this information and these services. The overall experimental situation should be very carefully designed so as to be prepared to meet these increased demands.

5. Experiments in several areas appear to have some common elements among them. Probably they could profit from being developed and carried out in reasonably close conjunction with one another and, to some extent, sharing any new and expensive telecommunicative facilities. For instance, the envisioned public broadcasting, postal delivery and law enforcement service activities all call for prompt and reliable telecommunicative services being provided among a large number of our cities. Too, many of the educational, health delivery and urban service experiments could be carried out utilizing one (or a few) city cable/telephone/over-the-air

DAMON RUNYON - MEMORIAL FUND
33 West 56th Street New York, N. Y. 10019

broadcast complexes.

6. The capacity x availability "product" envisioned as needed in the public broadcasting area is so large as to appear to be able to accommodate all of the other intercity circuit requirements described with only a very modest incremental increase -- including even the very large postal service requirements. It is important, therefore, that early conclusions be reached regarding the validity of this "requirement": the capacity, the locations to be served, the schedule for circuit introduction and the technical means for circuit provision -- and the financial basis for so doing be identified. For instance, the pace and character of any satellite communications technology development beyond ATS-F and -G could be affected, importantly, by conclusions reached in this regard.

7. Of all of the experiments and development-tests suggested, the one that impresses me the most in terms of its likely technical soundness, positive and large economic impact, and clear public visibility and acceptability, is that of long-haul point-to-point electronic mail delivery. I suggest that this area be given a relatively high priority. And, I further suggest that, in conjunction with the other activities undertaken with respect to ascertaining the true utility of wideband coaxial cable systems, thought be given to expanding the postal service experimental program to include an exploration of electronic mail delivery directly into the industrial plant, the commercial office and, perhaps, the individual residence.