<u>SOFTWARE DESIGN DEVELOPMENT AND IMPLEMENTATION OF A HIGH-RELIABILITY</u>

<u>NETWORK-WIDE ELECTRONIC MAIL SYSTEM</u>

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NOTE:

This entry is being submitted for the competition resulting in the awarding of a scholarship cosponsored by the Thomas Edison/Max McGraw Foundations. I certify that I have met the requirements outlined in the NSSA Newsletter Vol. XVI, No. I. Supportive addenda is contained herein since it is an integral part of the explanation of the project. A letter of recommendation from my high school chemistry teacher has been included.

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    Date   Signature

SOFTWARE DESIGN DEVELOPMENT AND IMPLEMENTATION OF A HIGH-RELIABILITY

NETWORK-WIDE ELECTRONIC MAIL SYSTEM

The purpose of this project was to create a highly-reliable, network wide electronic mail system for the transmission and retrieval of mail and to assess the feasibility of such a system in an academic research environment. Researchers at the College of Medicine and Dentistry of New Jersey (CMDNJ), where I have de-signed and implemented this system, use computers in their daily work. Many of these researchers also have their terminals and/or computer equipment in their labs. It was evident that some rapid means of communication, in an official memo style format, with colleagues whom they frequently confer would prove to be quite practical. This mail system, known as EMAIL (Electronic MAIL system), permits messages to be created, edited, sent, tagged with the names of sender and receiver, postmarked, and retrieved. EMAIL also makes extensive use of data base management tools, is implemented in modular form, and has numerous "fail-soft" capabilities. An effort has also been made to provide a "friendly" and understandable user inter-face for those unsophisticated in computer lore.

To exemplify the use of this system, consider the following situation. A busy executive is hardpressed for time and needs to send an important document to his business associate in Japan. Instead of using conventional means to send his mail, he instructs his secretary to compose the document on their personal video terminal which is connected to a computer network. The document is then transmitted to his associate several thousands of miles away. His associate, in turn, is then capable of receiving a hard copy of the document, on a similar terminal, in a matter of minutes.

The above scenario does not take place at some time in the future; infact, it illustrates a somewhat daily experience encountered by many researchers, secretaries, and administrators at CMDNJ. The original goal in developing EMAIL was to have communication among the various departments and groups; however, this system has proven to be quite dynamic in that throughout its two and a half years of development, including school days, weekends, and summers, it has grown to the point where it now services some several hundred users. Its built-in networking capabilities, by which mail may be transmitted to users who are geographically distributed, has also enabled its linking to the Rutgers Medical School (RMS) in Piscataway, New Jersey some thirty miles away. This capability may be easily expanded to many nodes (computer sites). The computer network to which EMAIL is currently linked, is illustrated in Appendix I.

In developing this package, factors such as reliability, security, efficiency and effectiveness, versatility, and expandability of the system were considered. Primary importance was given to reliability. The notion of software and hardware reliability, especially in the era of the 80's in which computers shall be used to a great extent, will become a paramount issue. The consideration given in EMAIL's development are reflected in many of its features. Since a great volume of mail is constantly transmitted, the system was developed to insure that no mail is lost or destroyed under almost any circumstance, whether human or mechanical. This was achieved through a series of intricate updating features. The details of these fail-soft techniques are shown in Appendix II. Thus, a user is assured that a memo that he/she sends will reach the designated addressee(s). Security was insured by allowing no user to tamper with or corrupt the "mailbox" of another user without knowledge of the user's mailbox number. This "number" is actually a string of eight characters which may contain printing as well as nonprinting (control) characters.

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The versatility of EMAIL is reflected in the various modes that a user may send and receive mail. Appendix III shows the various modes that a user may issue. The scan option, for example, allows a user or "busy executive" to read priority or preferential mail on a certain subject or from certain individual(s). Another salient feature is that a user may send carbon copies and broadcast mail. This ability to transmit a memo to more than one receiver by merely entering the body once and then listing all the addressees is very convenient and reveals the enormous potential of EMAIL. A feature that the user is transparent of is that his mail is edited through a word processor. The aforementioned features reveal a few of the many options that EMAIL offers.

To implement EMAIL it was necessary to use HP/1000 running under the HP/RTE-IV B operating system. It was programmed using Fortran IV and other system available utilities. These included the DS/1000 Network Communications Manager, the IMAGE/1000 Data Base Manager, HP/1000 Editor, and Word Processor.

Various techniques were used in the development of EMAIL. The most significant characteristic is that it is constructed in modular form. The user interface, for example, is uncoupled from the actual task of mail set-up and transmission since a separate program called 'SENDR' actually processes, edits, and transmits mail. Thus, a user, is free to issue other commands while his mail is being processed; he may even compose another memo. Appendix IV shows the process what occurs when mail is sent. It also reveals the complex program-to-program communication that exists between the user interface and 'SENDR.' The importance of this modular form in developing EMAIL cannot be but over emphasized; it, in fact, has greatly contributed to its versatility. Improvements and new features, for example, may be easily implemented without upsetting the program logic or coding. This modular form is also apparent in the various message transmitting and retrieving components that exist in the user interface. These components are shown in Appendix V.

It is evident that though the concept of electronic mail may be trivial in nature, the actual design and implementation of such a system is highly complexed. The reason for its complexity is that numerous factors had to be considered in the design and implementation of the system. These considerations have, in turn, resulted in a practical and extremely viable mailing system.

When Thomas Alva Edison invented the light bulb, he never perceived that his invention would have such world-wide acceptance and acclaim; however, it has. The light bulb is an integral part of our daily living. One day, electronic mail, like Edison's bulb, may also permeate and pervade our daily lives. Its practical applications are unlimited. Not only is mail sent electronically, as many telexes and teletypes are capable of doing, but it offers a computational service that automates a secretary's or file clerk's work of writing a memorandum, document or letter, editing, filing, and retrieving. If electronic mail systems become a reality, they will surely create different patterns of communication, attitudes, and styles. Volumes of written work, for example, shall become obsolete.

Acknowledgments

COMPUTER NETWORK OF E MAIL

Appendix I

RWJ - PISCATAWAY, NEW JERSEY

GSDNJ - NEWARK, NEW JERSEY
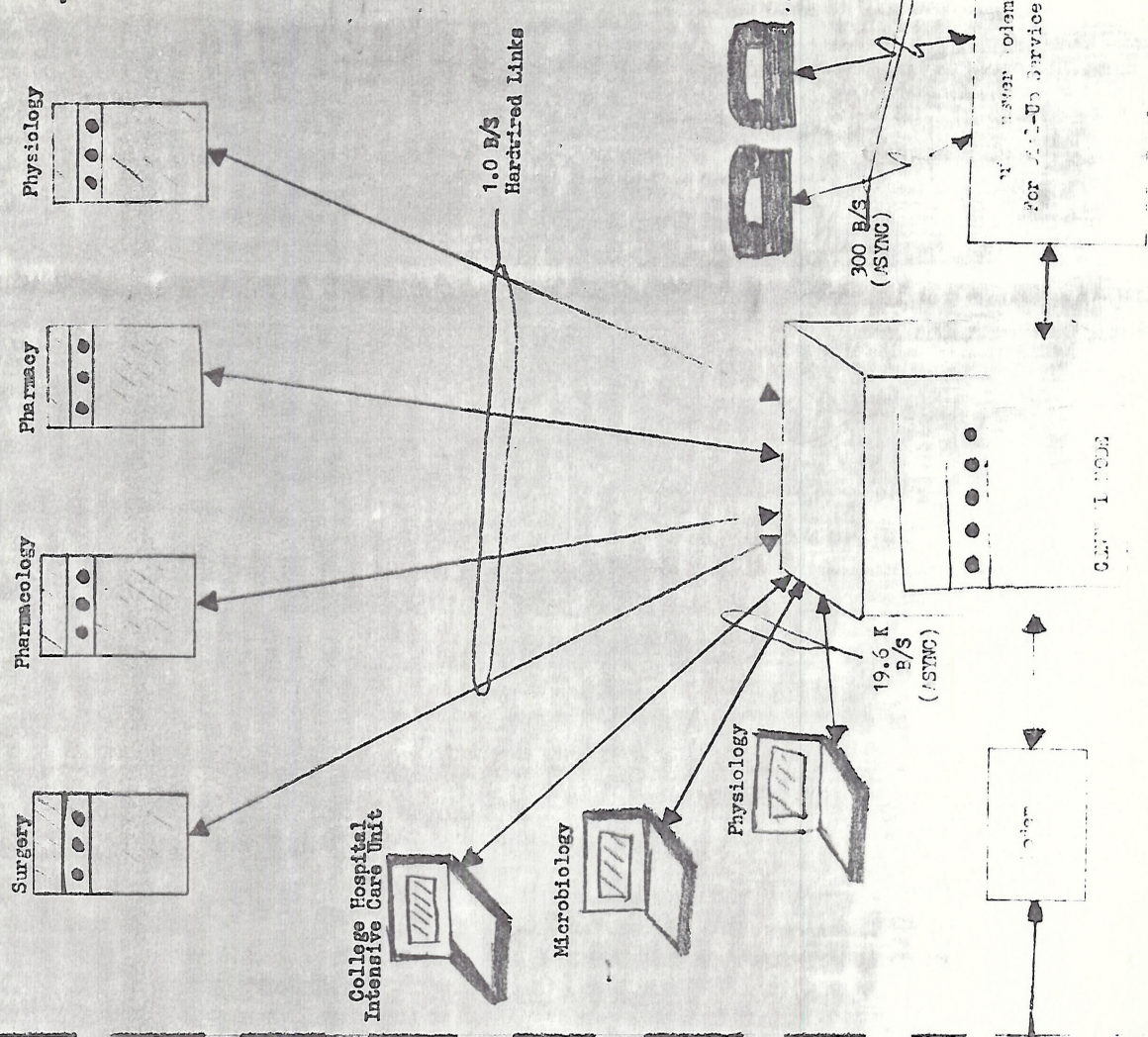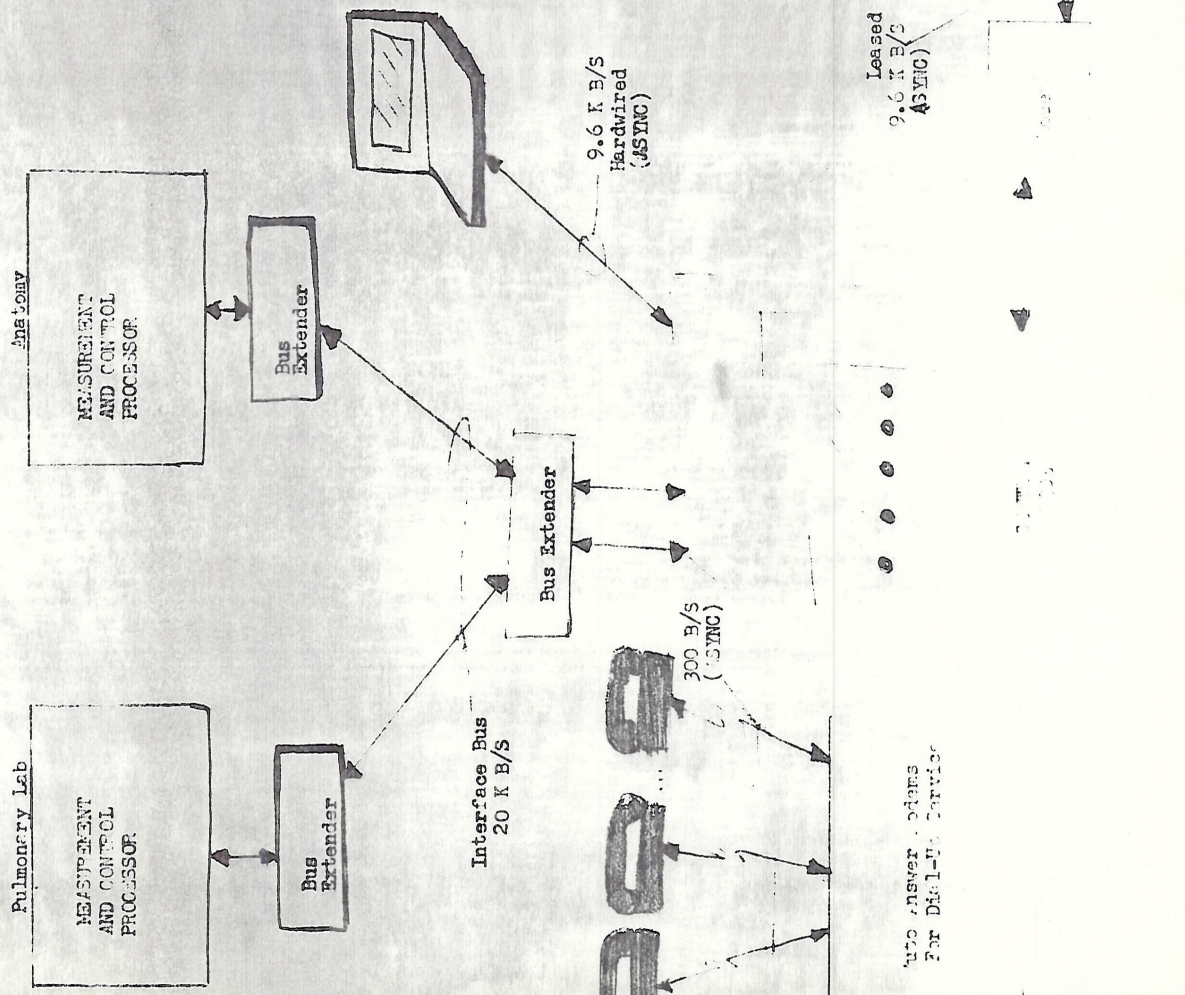
The following diagram illustrates the updating feature that occurs as each individual(if there are more than one receiver of a memo) is being transmitted a copy of the memo.


```
        ┌─────────┐            Record
  (A)──▶│ Access  │}   ┌1─────────────────────────────11┐
        │ Record  │    │        Receiver's Name          │
        └─────────┘    └─────────────────────────────────┘
```
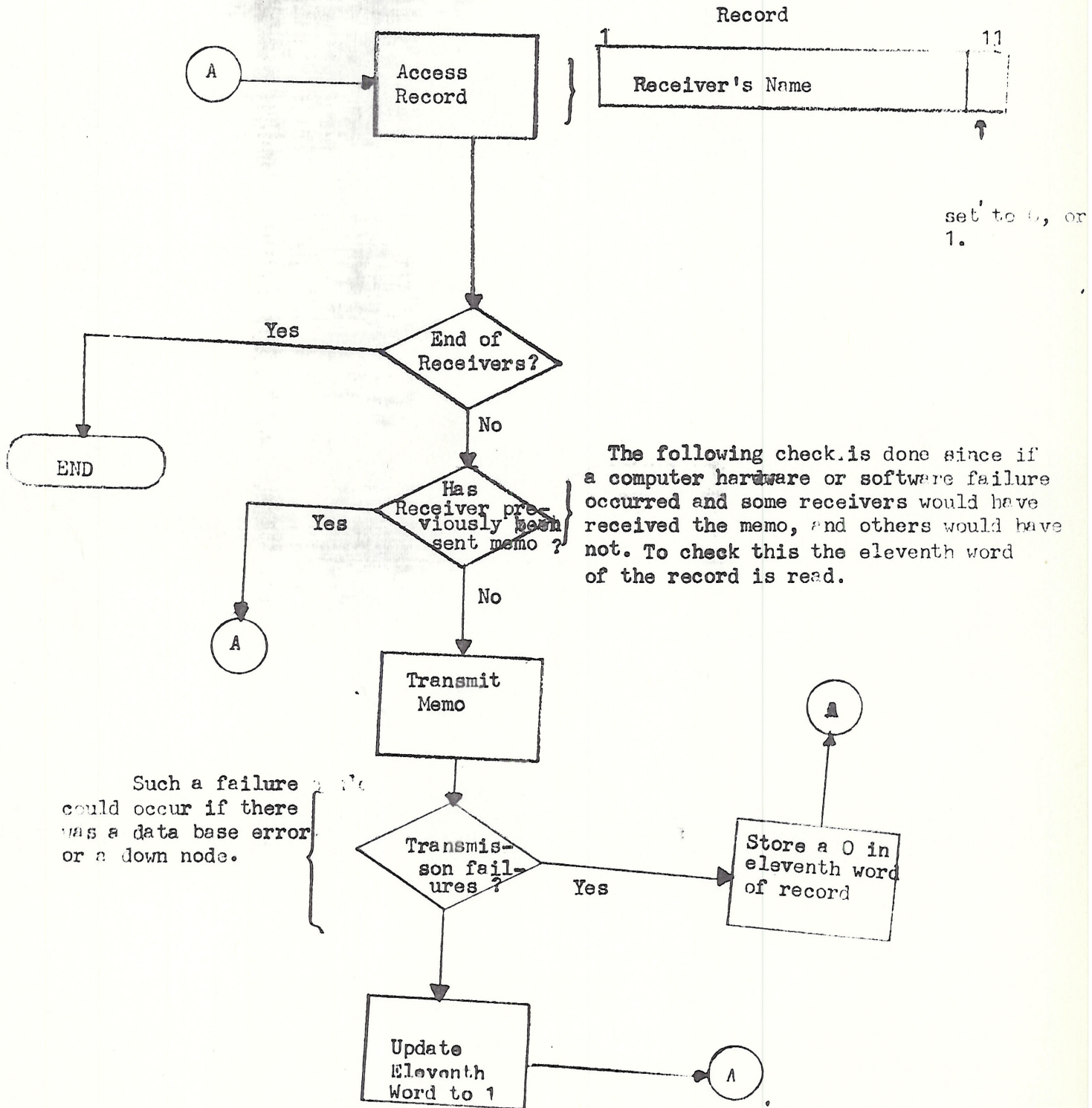
set to , or 1.

End of Receivers? — Yes ──▶ **END**

No ──▶

The following check is done since if a computer hardware or software failure occurred and some receivers would have received the memo, and others would have not. To check this the eleventh word of the record is read.

Has Receiver previously been sent memo ? — Yes ──▶ (A)

No ──▶

Transmit Memo

Such a failure could occur if there was a data base error or a down node.

Transmission failures ? — Yes ──▶ **Store a 0 in eleventh word of record** ──▶ (A)

No ──▶ **Update Eleventh Word to 1** ──▶ (A)

Command	Meaning	Purpose
??	Display Command Menu	To list all the commands a user may issue from this part of the user interface
SC	Scan Mail	Allows user to print only the top part of his memo, containing the receiver's name, date, and subject. After reading the header, he has the option of continuing with the body of the memo.
GM	Get Mail	Retrieves all existing mail in user's mail box and user may either delete or save his mail as he reads.
ST	STop	To exit from the user interface.
SM	Send Mail	To put user in Send Mail Mode.

The following commands are those that the user may issue in the Send Mail Mode:

Command	Meaning	Purpose
??	Display Send Mail Menu	To list all commands that the user may issue from the Send Mail part of the user interface.
DN	Display Names of listed users	To display names of those receivers who have their names on the listed directory.
DG	Display Group(or department) Names(ie. Pharmacy, Surgery,etc.)	To display currently existing names of a department or group.
WM	Write Memo	To write a personalized memo to an individual with or without Carbon Copies to several other individuals.
BM	Broadcast a Memo	To send personalized memos to more than one individual.
MG	Memo to Group	To send a memo to each and every member of the designated group or department under that group's or department's title. This may also be sent with or without Carbon Copies to several other individuals who are not part of the group.

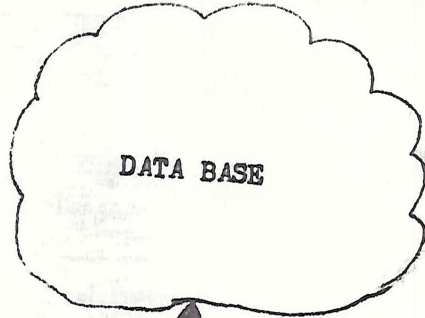| Command	Meaning	Purpose
EM	Edit Memo	To allow the user to edit the file containing the body of his memo. (The system editor is scheduled from the interface)
DN@ (nonprinting)	Display Names of users on the unlisted directory	To allow a user who has a high capability level(a number is designated to each user to designate the commands which he may or may not issue. As of now DN@ is the only such command) to display the names of those on the unlisted directory.
RT	Return To the first part of the user interface	To allow the user to return to the other part of the user interface.
ST	STop	To exit from user interface.

Flowchart for Sending of Mail

WORDPROCESSOR

User Interface

User composes
memo

Transmit
Memos to
All Receivers

Go Dormant

Stored in
ASCII File.

Filename A
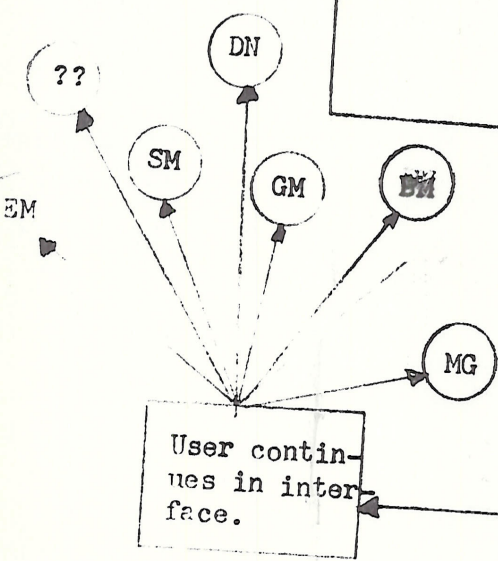
The SENDR is scheduled period-
ically from the system and in-
complete requests that are in the
data base are processed.

Access File
A and edit
through W.P.

Store other
pertinent(ie,
Day,Year,# of
receivers,sen-
der, names of
all receivers,
the nodes at
which they are,
etc.
Filename B

DATA BASE

Request issued
by sender
stays in data
base.

In this pro-
cess mail
shall be edit-
ed, and pro-
cessed

DN

??

SM

GM

BM

EM

Write File-
name A, File-
name B into
a DataBase
record.

At the same
time schedule
SENDR to process
mail. Pass record#
of record written into
Data Base.

SENDR
Dormant ?

Yes

No

MG

SENDR

User contin-
ues in inter-
face.
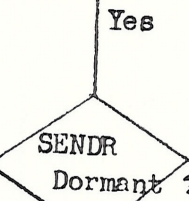
Appendix V

Message Transmitting and Retrieving Components

```
                        ┌──────────────┐
                        │   Command    │
                        │  Processor   │
                        └──────┬───────┘
         ┌────────────┬────────┴────────┬────────────┐
   ┌─────┴─────┐ ┌────┴─────┐    ┌───────┴────┐ ┌─────┴────┐
   │  Getting  │ │ Scanning │    │Transmitting│ │ Exiting  │
   │   Mail    │ │          │    │            │ │          │
   └───────────┘ └──────────┘    └─────┬──────┘ └──────────┘
```

Command Processor

Getting Mail

Scanning

Transmitting

Exiting

Sending Memo to Group

Sending Memo to One Individual

Displaying Directory

Carbon Copies

Displaying of Command Menu

Broadcasting

Editing Memo File.