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Potentials of Interactive Cable Television

The Promise of Interactive Television

New forms and imaginative uses of telecommunications can make contributions of fundamental importance to meeting and solving nearly every major problem of urban society and urban life. The report recently issued by the Committee on Telecommunications of the National Academy of Engineering, whose membership is widely representative of government, industry, and national civic groups, states:

> Our cities have many problems in urgent need of solutions. City governments have a requirement for closer communications with their citizens and readier response to citizen needs. City schools are less than satisfactory in providing quality education to the nation's youth. Medical care is inadequate for the cities' poorer and older citizens. Individualized transportation is clogging the streets and polluting the air. Public transportation is often inefficient and unattractive to its users. Law enforcement agencies have difficulty in coping with a growing crime rate.

> The Committee believes that modern communications technology, thoughtfully applied, can help in relieving many of these problems and in upgrading the level of city life. This conviction has been further confirmed as a result of the Committee's in-depth study of city operations, and a continuing exchange of ideas with officials in a cross-section of U.S. cities.[1]

Interest in telecommunications as an increasingly powerful tool for dealing with urban problems is now worldwide. A telecommunications study made by

the Canadian Department of Communications says: "Multiservice telecommunications systems can provide not only means of developing new life patterns for city dwellers, but also solutions to many of the ills of urban living. Through the planned use of such systems, urban dwellers will be able to enjoy ordered, well-defined, and harmonious surroundings. They will have the opportunity of participating in society in a manner never before possible."[2]

In these and other studies, interactive television, delivered via cable systems, is a coming communications medium that could have particularly high social value. Urban planners, social scientists and historians are increasingly concerned that one-way television communications may be adding to, rather than ameliorating, basic problems of our society.

A second source of increasing interest in interactive television stems from its potential for performing functions and delivering services that cannot be provided by one-way communications and that offer great promise for ameliorating problems caused by growing urbanization. These services might enable better access to education, wider and better dissemination of health care, direct access to a wide range of information through computer hook-ups, delivery of specialized visual material to the home when the subscriber wishes to see it, facsimile printing of material in the home, and greater participation of urban population in civic life through polling and direct interaction with political leaders.

Interactive television, built on the existing, highly refined television technology in which American citizens have already invested over $20 billion, has been developed to the point of public demonstration.[3] By coupling home television sets on cable systems to computers, interactive television is ready for studies, experiments and demonstrations leading to the fulfillment of its potential. By early 1975, the MITRE Corporation will install the first full-scale experimental implementation of interactive television in an American city.

Sackman and Boehm[4] point out the great promise of interactive television, especially when combined with video cassettes, computer information systems, and communications satellites, which they call the total "information utility." They see as a leading potential for this nationwide information its capability to reduce the unit cost of education and to increase productivity in the knowledge industry. Not only would the capacity of the individual instructor be enhanced, but educational institutions would be aided to meet the important challenges of equality of access to educational opportunity and open enrollment in universities, life-long learning, the need for periodic (or continuous) retraining accommodated to the individual on a flexible schedule in the home or office, and diversity of curriculum content to meet demands for relevance and variety.

Interactive television can supplement classroom or televised lectures through delivery of computer-assisted instruction (CAI) into a home environment, thus allowing for more efficient use of educational facilities and teacher time, as well as allowing the student to access the CAI material at the time most appropriate for him.

Education is a leading use, but by no means the only use of interactive television delivered to the home. Municipal services, polling and voting, tele-shopping, entertainment, news, person-to-person communication and banking services are but a few of the ultimate services which interactive television will deliver into the home. Many of the potential noncommercial uses have been demonstrated over the past two years in Reston, Virginia and I will illustrate some of these below.

The Problem of Interactive Television

Discussions of the future of cable television often present glowing pictures of potential two-way communications services on cable. Extensive lists of potential services have been compiled. Commercial services, such as security alarm monitoring, remote shopping, and computer-to-computer data transmission are often cited as important to the economic success of cable television in cities. It is also recognized that noncommercial services, such as interactive educational television in the home and direct citizen feedback on local political issues, would be of great public benefit. Impressed with these possibilities, the FCC has recently ruled that all new cable systems installed in the 100 largest U.S. television markets must have a two-way transmission capability, although such capability need not be immediately activated.

As is often the case with emerging technologies, the promise of two-way services on cable has, at times, been oversold. Although most proposed new services are technically feasible, many may not be economically feasible. Others can probably best be accommodated on the telephone network or by other means. Some may not be desirable at all. I would like to stress that the value to society of, and the commercial demand for various new cable services is unknown at the present time.

Actually, the near-future capital investment per subscriber to provide the delivered technology system for providing this vast potential array of services is smaller than that currently invested in the U.S. telephone system (investment is approximately $1,000 per telephone, although incremental costs to the system are in the $1,200 per telephone range). Thus, a most tempting set of commercial opportunities exists on the horizon. Most people knowledgeable in communications, academia, government, and commerce see mass utilization of two-way CATV as an eventual certainty.

Because of the present lack of any market tests of these services, not only is the investment community reluctant to support expansion in this area, but governmental planners—from municipal to federal, from educational specialists to telecommunication regulators—are also reluctant to initiate programs without information on citizen response to this new media. It seems probable that such uses as credit card validation and point-of-sale terminals (leading toward the

cashless society) in the next three years will develop information on the market for commercial services. Some, including the MITRE Corporation, believe the same should be done for the noncommercial services, to investigate options such as interactive educational television for the home.

Overview of MITRE's Program in Interactive Television

Since 1968, MITRE has been actively developing a computer system called TICCIT (Time-shared, Interactive, Computer-Controlled Information Television). Through the coupling of commercial television and advanced computer technology, MITRE has attempted to open new areas for cost-effective utilization, with emphasis on computer-assisted instruction.

A milestone was reached in July, 1971 when the country's first interactive television system was demonstrated in a Reston, Virginia home by MITRE. This system connected standard television receivers in a few homes and schools in Reston to MITRE's computer system via the Reston cable television system. A demonstration of a great variety of potential interactive services has been demonstrated to government and industry leaders during the following years.

In December, 1971 the National Science Foundation awarded a grant to MITRE to study the technical and economic considerations attendant on the home delivery of formal instruction and other educational services via interactive cable television. The emphasis was on the problems associated with the development of an interactive television system serving several thousand subscribers.

During the two years since the original grant award, the cable television industry has undergone significant evolution. Briefly, CATV has developed from a relay system for over-the-air television stations into a system capable of delivering a wide variety of services into the home.

New technology has opened up the opportunity to deliver thirty channels or more of television pictures. Two-way cable experiments are developing new commercial and noncommercial uses for CATV. Federal regulations have allowed the expansion of cable television into the United States' largest cities, where other services than over-the-air television delivery are needed in order to achieve high subscriber penetration. Among the services being experimented with in the cities are premium or "pay" television, local program origination, commercial services and interactive television. What services will increase CATV subscribership remains to be seen, but there is little doubt that the next few years will see a considerable diversification of services delivered by cable television.

MITRE's Interactive System

The MITRE Interactive System consists of two minicomputers, plus other peripheral equipment, connected to the headend of a two-way cable television system. The computer is capable of receiving commands from as many as 100

separate users simultaneously and of delivering individualized television pictures of written material in seven colors, full-color pictures and videotapes. Only a twelve- or sixteen-button keyboard is required in the home, although a standard CATV converter must also be used on most systems to receive the full complement of channels. Those persons using certain CAI material, which requires responses in more than sixteen characters, will have a full typewriter keyboard. If a system is installed to serve several thousand persons in a major urban environment, limitations in cable channel availability will require frame grabber devices in the home as well. Such devices will "grab" and hold a single picture at the home television set as long as desired, freeing the cable to transmit fifty-nine other pictures or frames of information each second to fifty-nine other homes.

The user's commands are transmitted to the computer from the keyboard via the cable system's return channel. Alternatively in communities without a two-way cable installation, touchtone telephones can provide the return link, in which case no additional equipment need be installed in the home.

Although only 100 persons can use the MITRE computer system simultaneously, many times this number may access the data base over a period of one day. If each user stays on the system for one-half hour per day, 2,000 such users may interact with the computer over a ten-hour day. The ultimate number to be given access is completely speculative until we are able to measure usage patterns.

Demonstration Services

The demonstration which MITRE gave to Reston, Virginia for more than two years illustrated some of the services which interactive television will deliver into a community. Figures 1 and 2 illustrate the general categories of noncommercial information available. The demonstration data base is keyed to Reston, but in urban use, material will be written by and for the community. The material will also be expanded many times over and will be continuously updated.

Instruction

Each of the nine instructional subject menus calls up one or more sets of instruction and/or information of greater or lesser extent and complexity. Samples have been implemented to represent a broad range of practicable possibilities. The gamut of capabilities decisively demonstrates the system's versatility and adaptability.

As a communication medium, interactive television is substantially independent of instructional strategy and approach. The instructional functions include:

```
         RESTON  INDEX

   PRESS          FOR

     1#           INSTRUCTION

     2#           COMMUNITY SERVICES

     3#           HEALTH SERVICES

     4#           AUTHORING AND EDITING

     5#           USER DIRECTIONS
```

Fig. 1. Master Index.

1. information retrieval
2. data retrieval
3. calculation
4. temporary and permanent data storage
5. straight information presentation
6. question-and-answer didactic frames
7. multivariate simulation
    a. single-student
    b. multiple-student
8. testing
9. response evaluation
10. performance recording and reporting
11. remedial sequencing
12. motivational feedback
13. administrative directions
14. controllable timing and pacing

The media mix includes:

1. alphanumeric and graphic visual frames
2. linear audio
3. video and audio
4. simultaneous and sequential mix of 1-3

MASTER RESTON INDEX

1# INSTRUCTION

```
              INSTRUCTION

     1#    STUDIES FOR GED EXAM
     2#    MATH
     3#    FOREIGN LANGUAGES
     4#    READING
     5#    ENGLISH
     6#    SCIENCE
     7#    CAREER STUDIES
     8#    CONSUMER EDUCATION
     9#    INFORMATION
```

2# COMMUNITY SERVICES

```
        COMMUNITY SERVICES

  1#   EMERGENCY NOTICES
  2#   RESTON ORGANIZATIONS
  3#   COMMUNITY OMBUDSMAN
  4#   RECREATION AND GAMES
  5#   SUBSCRIBER-AUTHORED MATERIAL
  6#   HOME CALCULATOR
  7#   VIDEOTAPE LIBRARY
  8#   COMMUNITY BULLETIN BOARD
```

3# HEALTH SERVICES

```
        HEALTH SERVICES

  1#   FIRST AID EMERGENCY CARE GUIDE
  2#   HEALTH TIPS
  3#   SEASONAL ILLNESS AIDS
  4#   DOCTOR'S DIRECTORY
  5#   COUNTY/LOCAL HEALTH AGENCIES/
           CLINICS/HOSPITALS
  6#   HEALTH EDUCATION PROGRAMS
  7#   INTERACTIVE MEDICAL OUTPATIENT
  8#   PARAMEDICAL SYSTEMS REVIEW
```

4# AUTHORING AND EDITING

```
       AUTHORING AND EDITING

  1#   REVIEW AN  EXISTING PAGE

  2#   CREATE A NEW PAGE FILE

  3#   EDIT/UPDATE AN EXISTING PAGE FILE

  4#   REVIEW AN EXISTING ACTION FILE

  5#   CREATE/EDIT AN ACTION FILE
```

5# USER DIRECTIONS

```
         USER INSTRUCTIONS

  (DIRECTIONS FOR "PAGING" BACK
  AND FORTH, FOR CANCELLING
  ERRONEOUS ENTRIES, FOR
  EXITING, AND TELEPHONE
  NUMBER TO CALL IN CASE OF
  TROUBLE.)
```

Fig. 2. Services Indexes Reached from Master (Reston) Index.

Potential curricular and administrative contents are, for practical purposes, unlimited. The array of subjects is only suggestive, including coverage of pre-school through adult achievement levels in mathematics, language arts, consumer education, sciences, and career studies.

These curricular materials are often accessible from the community and health services menus, which, in turn, contain still other instructional programs which can be reached directly from within the instructional index. Whenever pertinent, branching is enabled from one curricular sequence to a different but related set of information, services or instruction.

The General Educational Development preparation both informs the student of the local requirements for obtaining a high school equivalency diploma and gives drill and practice of the type of question that can be expected on the examination. MITRE's demonstration program in spelling prevents the student from moving on to the next set of problems until he answers all questions correctly in the previous set.

Similarly, in elementary school math the computer will give the student the correct response after two wrong answers. If the student fails to give the right answer the third time, the sequence stops and a message is flashed on the screen requiring the student to get human help (see figure 3a). Other illustrated mathematical services utilize the computer's calculating ability (see figures 3b-e).

Foreign language instruction is accomplished with a mix of visual and auditory presentation. Paired English words and phonetic transliterations of their foreign equivalent appear on the screen (see figure 4a). An FM channel is automatically selected and assigned, with instructions to the learner for tuning (see figure 4b). Once started, the student coordinates the rate of frame change with the touchtone keyboard, and can stop and start the linear audio accompaniment to match his own pace. Complementary foreign-language videotapes also have been indexed and can be accessed on demand. Specimen materials have been assembled to demonstrate various kinds of instruction in five languages (see figure 4c).

Other demonstrated instructional uses include speed reading, where the lines disappear at timed intervals according to reading speed (see figure 5); various types of videotaped and interactive scientific material; career and consumer education and guidance; and information regarding local college courses of instruction, adult and open university courses.

Community and Health Services

TICCIT was designed as a delivery system for computer-assisted instruction. Interactive television, an extended application of the TICCIT concept, is a full-scale information utility. It is clear from the demonstration that interactive television is capable of supplying individualized instruction and administration not only in schools, but in cabled homes as well.

An extraordinary feature of the system as a communications medium is that it opens the way beyond institutional barriers to interaction on demand with a dispersed and immensely broadened population of learners. The same

```
                    WHAT IS THE SUM OF 73+98

       156
           TRY AGAIN.
       139
           SORRY, YOUR ANSWER IS INCORRECT.
           THE CORRECT ANSWER IS 171.
           NOW ENTER THE CORRECT ANSWER.
       111
           PLEASE SEE YOUR TEACHER FOR HELP.

       TEACHER: WHEN YOU FEEL YOUR STUDENT'S
       READY, ENTER THE CODE TO BEGIN AGAIN
```

A

```
TABLE OF LAND MEASURE TRIVIA
TO IMPRESS YOUR FRIENDS WITH

  .92 INCHES    =     1 LINK
 100 LINKS      =     1 CHAIN
  80 CHAINS     =     1 MILE
   1 FURLONG    =   220 YARDS
   8 FURLONGS   =     1 MILE
 5.5 YARDS      =     1 ROD
30.25 SQ. YDS   =     1 SQ. ROD
 160 SQ. RODS   =     1 ACRE
 640 ACRES      =     1 SQ. MILE
   3 MILES      =     1 LEAGUE
   6 SQ. MILES  =     1 TOWNSHIP
```

B

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                   METRIC EQUIVALENTS

   PRESS      FOR      ENTER       ANSWER
                       NUMBER
    1#       INCHES    #____       ___MTRS
    2#       FEET                  ___MTRS
    3#       YARDS                 ___MTRS
    4#       MILES                 ___KMTRS

    5#       PINTS                 ___LITERS
    6#       QUARTS                ___LITERS
    7#       GALS.                 ___LITERS

    8#       OZ.                   ___GRMS
    9#       LBS.                  ___GRMS
   10#       TONS                  ___KGRMS
```

C

```
        DECIMAL EQUIVALENTS

GIVE FRACTION            ANSWER

   NUMERATOR #___

                    =   _____

   DENOMINATOR #___
```

D

```
                 HOME CALCULATOR

     CONTENT               INSTRUCTIONS
     243.76            CODE   FUNCTION
     1498               *1    ADD
                        *2    SUBTRACT
                        *3    MULTIPLY
                        *4    DIVIDE
     INPUT ABOVE        *5    SQUARE ROOT
     *3                 *6    RAISE TO POWER
     MULTIPLY          *71    ENTER $N.NN MODE
                       *72    LEAVE $ MODE
                        *8    DELETE LAST LINE
                       *90    CLEAR ALL LINES
                        **    IGNORE THIS ENTRY
                       *99    FINISHED
```

E

Fig. 3. Sample Math Instruction Information and Calculation Frames.

computing and communications power, further, make a natural medium for the delivery of interactive community and health services beyond the instructional services described so far.

The range and mix of possible community services and instructional offerings is demonstrated by "Hypothetical Scenario of the use of Interactive

```
MANDARIN CHINESE - PLEASE LISTEN
     AND REPEAT THE FOLLOWING

ONE      YEE
TWO      UR
THREE    SAN
FOUR     SE
FIVE     WOO
SIX      LIOU
SEVEN    CHEE
EIGHT    BA
NINE     JIOU
TEN      SHR

          *9# TO CONTINUE
```

A

```
FOREIGN LANGUAGE INSTRUCTION

SPANISH                    1#
FRENCH                     2#
GERMAN                     3#
MANDARIN CHINESE           4#
RUSSIAN                    5#

IF YOU WANT INSTRUCTION IN ANOTHER
LANGUAGE, WRITE TO:
          THE MITRE CORPORATION
          WESTGATE RESEARCH PARK
          McLEAN, VA.  22101
```

C

```
CONVERSA-PHONE MANDARIN CHINESE

TUNE TO 106.7 ON YOUR FM DIAL&SELECT:

  LESSONS 1-14              1#
  LESSONS 15-20             2#
  NUMBERS, DATES, SEASONS   3#
```

B

Fig. 4. Sample Foreign Language Instruction Frames.

```
            SPEED READING

   MOST EDUCATED, UNTRAINED READERS
   HAVE LITTLE TROUBLE MOVING
   ALONG AT 200 TO 400 WORDS PER
   MINUTE.  WOMEN, ON THE AVERAGE,
   READ SOMEWHAT FASTER THAN MEN.
   THIS TEXT IS RUNNING AT ABOUT
   250 WORDS PER MINUTE.  TO FIND OUT
   YOUR OWN APPROXIMATE READING
   RATE, PRESS 1# WHEN THE
   TEXT STOPS.  THE RATE WILL
   INCREASE.  KEEP GOING
   UNTIL YOU CAN'T KEEP UP.
```
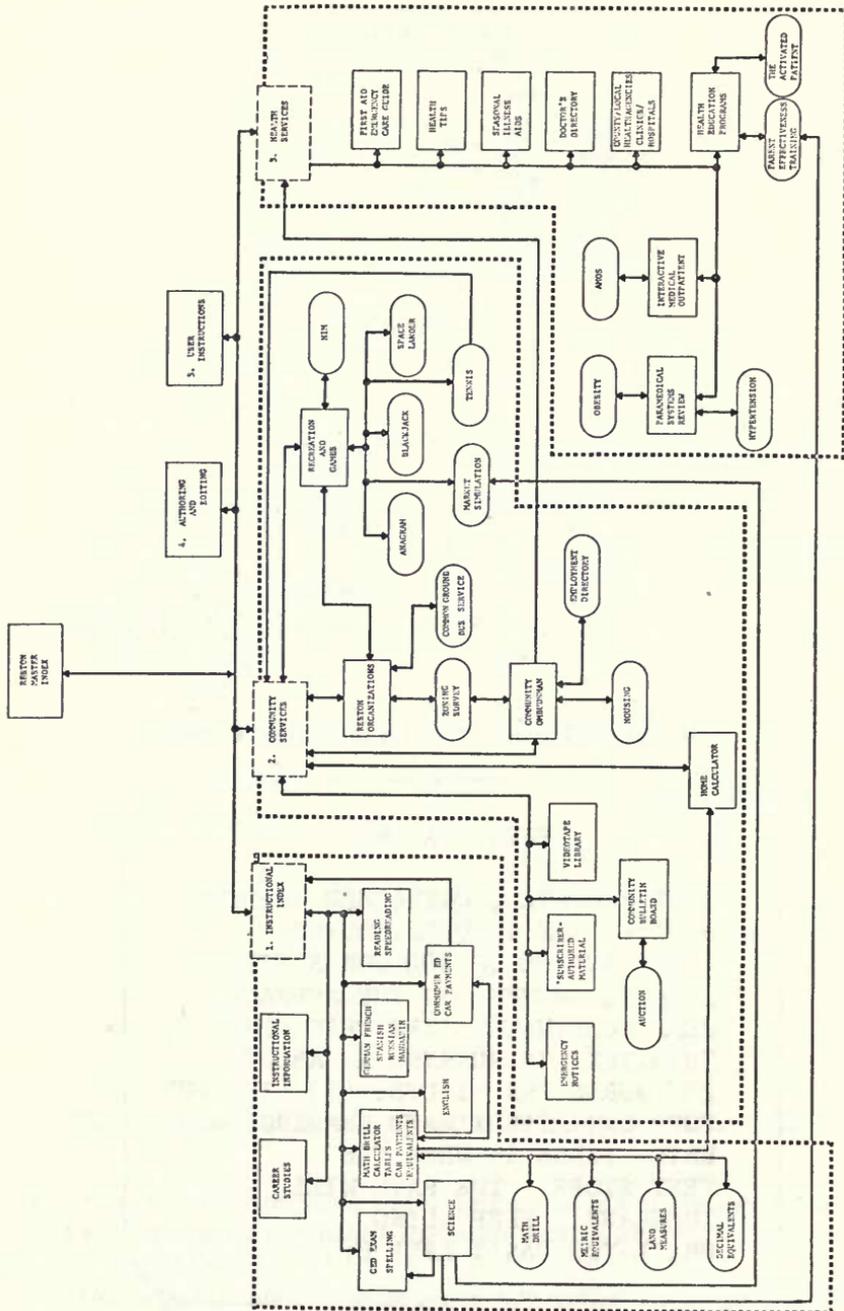
Fig. 5. Speed Reading Frame.

Fig. 6. Interactive Television Demonstration.

Television by One Family" (Appendix A). Working illustrations of many of the services, including actual data and reference to real activities, are part of the interactive demonstration schematized in figure 6. A viewer can, with remarkable ease:

1. learn about Reston community organizations, services and activities;
2. participate in an auction, which features half-tone color photos of items for sale, and computer recording of bids entered;
3. vote in a public zoning opinion survey, and review tabulated results;
4. enter personal requirements, and receive a computer-matched list of employment opportunities or of housing available;
5. select a starting point and destination on the Reston minibus route and receive an instantaneous display of departure and arrival times for buses between the two points;
6. query the computer for available tennis courts, and record a reservation at a specific court and time;
7. play a variety of games with the computer as opponent, including blackjack, NIM, and anagrams;
8. access information about medical services available, and make an appointment to see a physician;
9. go through an interactive, computer-guided diagnostic routine designed for paramedics; and
10. review and study instructional material for laymen, paramedics and medics on first aid, health maintenance, illness prevention, and treatment.

REFERENCES

1. National Academy of Engineering. Committee on Telecommunications. *Communications Technology for Urban Improvement. Report to the Department of Housing and Urban Development.* Washington, D.C., National Academy of Engineering, June 1971, p. 1.

2. Canada. Department of Communications. *Multiservice Cable Telecommunications System: The Wired City.* Ottawa, Department of Communications, 1971, p. 15.

3. "The Reston, Virginia Test of the MITRE Corporation's Interactive Television, MTP-352." MITRE Corp., 1971.

4. Sackman, Harold and Boehm, Barry W. *Planning Community Information Utilities.* Montvale, N.J., AFIPS Press, 1972.

APPENDIX A

HYPOTHETICAL SCENARIO OF THE USE OF INTERACTIVE TELEVISION BY ONE FAMILY

Charlie Lewis is a "do-it-yourselfer." He needs to build a new wing for his house and wants to handle every detail himself. He draws up plans and is about to order material when he realizes that some level of government must approve his plans. Charlie dials into the computer and turns on his television set to the channel assigned him. In the menu he finds a "Housing" category. By pressing appropriate buttons on his touchtone telephone, he successively accesses "Construction" and "Plan Approval."

The list tells him that approval is needed both from the county and the Reston Home Owners Association Architectural Board of Review. By pressing the appropriate buttons, he obtains the locations and telephone numbers of the county and Reston agencies as well as the person to call for assistance. Charlie can also view facsimiles of the appropriate forms, with pointers on supplying the needed information. Finally, he retrieves summaries of recent decisions by the Architectural Board of Review so he will know which way the Board has been deciding cases. Confident he knows the proper procedure, he obtains the proper forms and files his application.

His wife, Linda, is looking for a new and unusual recipe for fish. She takes the phone from Charlie, checks the menu on the screen, and discovers "Homemakers' Hints." Rapidly punching buttons for "Food Recipes" and "Fish," Linda obtains a list of original or borrowed recipes which her neighbors have fed into the system through volunteers operating telephone switchboards and terminal keyboards.

Linda suddenly realizes that she and Charlie are invited out for a Bridge game that evening, but have no babysitter for eight-year-old Jeffrey. Nobody has entered a listing in the "Help!" listings, so she types the Lewis' telephone number in the "Help!" section on "Babysitter Wanted—Today" and waits for the phone to ring. Having lined up the sitter, Linda gets a call that their friends are ill and the game is off. She and Charlie are disappointed, but the situation is not hopeless. Through the "Dynamic Bulletin Board" she finds the telephone number of others who need two to fill a foursome. She calls them and discovers a couple on the next block whom they have never met.

Jeffrey then enters the room and announces that he needs the television and telephone for his homework. He is taking English and a math course at Forest Edge Elementary School in Reston using the Computer-Assisted Instruction material prepared by Computer Curriculum Corporation, and he has some homework to do on-line. His identification number will allow his teacher to monitor his progress (the computer grades and records his progress in the assignment.

While dinner is cooking, the Lewis's check the current community news. Charlie checks the "Reston Today" menu and punches up the Reston Community Association (RCA). He learns that a public hearing on the proposed private hospital in Reston is scheduled for the next night. RCA wants his opinion on the hospital, its proposed location, and the projected costs of medical care if a private, rather than a public facility, were constructed in Reston. Charlie consults with his wife who indicates not only that she favors the hospital, but also that she would work on a committee and testify in favor.

The interactive system registers their opinions (the computer compiles the results) and takes Linda's telephone number, noting that she wants to work in favor of the hospital. If, instead, she opposed it, she could register for that committee as well.

During the evening, Jeffrey decides to try a game of NIM. He calls up a friend, and they play the game against each other through the computer. After a while, the friend must leave; so Jeffrey continues playing against the computer.

When his parents get home, they check local organization news, relax and listen to some music selected by touchtone from the interactive FM listings, then call it a day.