Requirements for a shared data processing system for hospitals

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INTRODUCTION

The Service to Minnesota Hospitals program is one in which Minnesota Blue Cross, together with participating hospitals, have joined in making available the best possible EDP services to hospitals in this area.

Consideration of this program began in 1963 when a feasibility study commenced in which Blue Cross and four hospitals in Minneapolis participated with approvals from the Twin City Hospital Association and the Minnesota Hospital Association. This study was concluded in mid-1964 and the results were incorporated in the publication entitled "Cooperative EDP for Minnesota Hospitals" released to all hospitals in the State in September, 1964. The conclusions reached by the Study Committee were that a cooperative EDP system for Minnesota hospitals in which centralized computer facilities would be installed at Minnesota Blue Cross is definitely feasible and would result in significant benefits to the hospitals served. It was further recommended that the cooperative program should result in the eventual installation of an integrated system of EDP services for all feasible applications in hospitals but that the initial applications to be developed should be referred to as "Stage I" and should consist of:

- Patient Accounting.
- Payroll and Personnel Record Accounting. (Employee Information System)
- Inventory Control and Purchasing.
- Accounts Payable Accounting.
- Property Ledger Accounting.
- Preventive Maintenance Scheduling.
- General Ledger Accounting.

The principal advantages and disadvantages of a cooperative as compared to individual hospital EDP effort were concluded to be the following.

Advantages

The cooperative approach to EDP provides greater potential benefits to hospital operation for less cost. Some of the individual factors which justify this observation are as follows:

1. The combination of equipment and staff under a cooperative system can perform greater services due to *Greater Capability of Equipment*—a cooperative system can afford the computing and peripheral equipment to most effectively perform all hospital functions that should benefit from EDP. Technological obsolescence can be more effectively coped with as new and better equipment becomes available since there is a broad base over which to share any replacement costs.
   Skilled Systems, programming and operating staff can be retained. The highest degree of data processing skills can be brought to bear in the development and operation of a cooperative system. Desirable specialization of functions can be achieved. Retention of key individuals in small individual systems can become extremely difficult due to the competition that exists.
   A broad base of analysis is made available through the cumulative hospital experience of numerous hospitals.
   Contributions in Consultation as well as direct effort from outside sources can be very significant particularly in a cooperative approach. These outside contacts include equipment manufacturers, consultants, other hospital and hospital-related institutions, etc. These contributions will be particularly valuable in the development and realization of long-range systems planning.
   More Operating Systems for each hospital will result in a shorter period of time due to the ability

of a relatively large staff to simultaneously plan for and implement several areas of EDP services.

2. *Initial Investment*—Under the cooperative approach, the initial investment is substantially reduced since all costs are recovered through monthly service charges that commence only when a system becomes operational for that hospital.
   Elements of this initial investment expense consist of such items as:
   Salaries for systems analysis, programming, proect director, training of operating staff, etc.
   Equipment Rental for any period of time during which the computer is on rent and not yet productive (or fully productive).
   Construction Costs for a data processing room including necessary temperature and humidity control, special electrical power, etc.
   Supplies—particularly magnetic storage (tapes or other type) which are a costly item of initial expense.
3. *Supporting Staff*—The installation and operation of an EDP system requires the efforts of a skilled and well-managed staff. In an individual as well as in a cooperative system, all these skills must be procured and retained. The personnel expense for this staff is significant. In a cooperative approach, however, the cost per hospital through the monthly service charges is drastically reduced.
4. *Equipment Rental*—It is fundamental that potential processing cost per unit is cheaper as the size of the computer is increased. Therefore, substantial ultimate benefit to participating hospitals due to the fact that larger, less expensive per unit of processing equipment is utilized.

Disadvantages

The cooperative approach inherently requires willingness to compromise individual hospital interests where necessary to achieve the benefits that can be realized. Some elements of this compromise are:

1. *Systems Design*—The precise design of operating systems can be made flexible to include numerous options which will accommodate the desires of one or more hospitals. This, however, is not always economically practical.
2. *Planning*—Planning for future systems must be done cooperatively.
3. *Priorities*—Decisions as to the sequence of applications to be installed as operating systems will have to be worked out on a basis of the aggregate benefit to all participating hospitals. The same would be true with respect to selection of future applications for further research and implementation.

Hospital data processing council

To coordinate the activities of the EDP program, a Hospital Data Processing Council has been established. This Council consists of administrative representation from each hospital participating in the program. The purposes of this Council are to receive recommendations from the Blue Cross staff and to make all final decisions regarding the characteristics of the systems that are to be offered.

Participating hospitals

Data processing service by Blue Cross to Minnesota hospitals commenced in 1955 when the first hospital, St. Barnabas of Minneapolis, transferred its Payroll processing to Blue Cross. Since that time, this Payroll service has consistently increased until currently there are over 30 hospitals in Minnesota whose payroll is being processed by Blue Cross. This system has undergone many changes since 1955 and is now a completely computerized operation. This service handles the payroll for approximately 22,500 hospital employees. A second service that was added was Discharged Accounts Receivable processing in 1963.

The above services of Payroll and Discharged Accounts Receivable were not planned on a formally-organized basis with hospitals and will be eventually merged into the cooperative program otherwise described. Those hospitals which have to date elected to participate in the cooperative EDP program and whose activities are governed by the Hospital Data Processing Council are as follows.

Minneapolis
Abbott Hospital
Lutheran Deaconess Hospital
Eitel Hospital
Mount Sinai Hospital
Northwestern Hospital
St. Barnabas Hospital
The Swedish Hospital
The University of Minnesota Hospitals

St. Paul
St. John's Hospital

St. Cloud
St. Cloud Hospital

By July, 1967, the Patient Accounting System will be installed in all participating hospitals. All other Stage I Systems will either be installed, or available for installation, by the end of 1967.

Financial policies

Charges by Blue Cross for hospitals serviced under the cooperative EDP program are based on actual costs of operation, including amortization of necessary development expenses. Cost accounting methods are used to assure that hospitals are not charged for the services beyond the actual costs of operation, nor will the operation be subsidized by income from Blue Cross subscriber payments.

Computer center equipment

The computer center at Blue Cross currently consists of two Honeywell Series 200 computers. One computer, an H-200, is primarily a communication processor and is connected by communication lines to each hospital.

As of May, 1967, the configuration of this system was as follows:

H-200 Central Processor—28K (characters) memory.
1—Tape Control Unit.
2—20kc Magnetic Tape Drives.
2—High Speed Random Access Drums (2.6 million characters of storage-each drum).
1—High-speed Printer.
1—Console Printer.

This system is the interface between the hospitals and the accounting systems that are run on another computer.

All input for the various accounting systems is prepared in the hospital and transmitted via communication lines to this system. Batch total reports, error reports, census reports, and other low volume reports are transmitted back to the hospital via this computer.

There is also a once a day update of the random access drum, where summary bills for in-hospital patients are stored. Summary bills and other patient data are printed in the hospital on demand.

In addition to handling traffic to and from the hospitals, the system also drives a high-speed printer utilizing print image tapes from other processors.

At the present time, all devices connected to this system operate at their maximum speed, simultaneously. We do not anticipate a noticeable slowdown of individual peripheral devices until after thirty (30) communication lines have been connected to the system. This slowdown would then only occur in a worst-case condition.

The other computer used for these accounting systems is a Honeywell 1200 equipped as follows:

2—Tape Control Units.
4—44kc Magnetic Tape Drives.
4—67kc Magnetic Tape Drives.
1—High-speed printer.
1—High-speed card reader.
1—Console Printer.

All processing for the accounting systems is accomplished on this system. Quite frequently this system operates in the foreground/background mode. In other words, card-to-tape, and tape-to-printer operations occur simultaneously with, but independent of, other processing.

As additional hospitals and/or services are added to the cooperative program beyond the capacities of the installed units, the Series 200, as well as equipment offered by other manufacturers, offers built-in growth potential so that all types of services desired by participating hospitals can actually be performed by the computer center.

Mechanisms for adding capacity for the present Series 200 systems consist of the following:

- Additional Series 200 computers.
- Successively higher speed central processors which offer growth without program translation thru higher speed execution of instructions, and increased capability in the area of multi-programming.
- Additional internal memory. Maximum memory size of a single Series 200 processor is over one (1) million characters.
- Random access storage. Several types of random access devices are available.

Communications and terminal units

All accounting systems are on-line systems requiring data communications lines and terminal keying and printing units to be located in the hospital. Specific information relative to these devices is as follows.

ACS-35

This is a combination keying, printing and paper tape reading/punching device provided by the Northwestern Bell Telephone Co. and manufactured by the Teletype Corporation. It is directly connected to the H-200 communication computer via communication lines.

Basically, this device is an ASR-35. It has been modified to include a second paper tape reader and a stepping circuit. The purpose of this modification was to provide format control when keying data for the accounting systems. This device operates at a speed of ten (10) characters per second.

Friden add punch

This is a free-standing paper tape punching device operated by a ten-digit keyboard for use in punching

numeric only data. The device includes a check digit verifier which will automatically detect errors in keying when they occur, and before they are recorded in the punched paper tape. The paper tape created by this device is transmitted to the computer center utilizing the ACS-35.

The above units are the initial units specified for operation with the various accounting systems. Improvements will be made in this area from time to time as the situation warrants it. We expect these changes will be in the following areas:

- High-speed transmission of paper tape.
- Faster character printing capability.
- Line Printers.
- Cathode ray tubes for use as input and temporary display devices.

What systems shall a cooperative group implement first?

In any cooperative venture into Hospital Data Processing, several factors must be taken into consideration before a cooperative group can make a decision as to what area of the hospital is to receive the benefits of data processing first. Some of the factors are:

Objectives of the cooperative group

Long-range and short-range objectives of the cooperative group must be outlined. Following are some questions that should be answered.

- Do we desire to develop or acquire a standard Hospital Information System that would be installed in all hospitals, or, on the other hand, do we merely wish to share a central computer and develop our own systems, designed to an individual hospital's specifications?
- To what extent do we desire standardization of systems and procedures?
- To what extent do we wish to share or compare information concerning patients, employees, supplies, services, etc.?
- What hospitals in the community or the state will these services be offered to, and what will be the method of input—On-line or off-line?

Source and amount of funds available

Are they:

- A Government or private grant?
- Hospital supplied?
- A loan?
- Must they be repaid or merely accounted for?

Data processing staff

- What are their skills and backgrounds?
- What are their abilities and knowledge of the task at hand in the areas of:
  Systems analysis?
  Systems design?
  Computer and related hardware?
  Computer software?
  Hospitals?

Equipment suppliers

- What kind and how much support are the equipment suppliers willing to give?
- What application packages or capabilities, that will assist you in attaining your objectives, do they have or will commit themselves to supplying?

Computer hardware and software

- Is the hardware and software, that will enable you to achieve your systems objectives, available on the market?
- Can it be delivered in time to meet your implementtation plan?
- Can you afford it?

Accounting systems first in Minnesota

After taking all of the above factors, and many others, into consideration, the Study Committee concluded that a cooperative EDP System for Minnesota hospitals utilizing a centralized computer facility was definitely feasible, desirable, and would result in significant benefits to hospitals served. This cooperative system would provide EDP services for substantially less cost than would be incurred for comparable services if hospitals individually installed computers. The services rendered through cooperative data processing would tend to be superior to services which could be rendered by individual hospital computers due to greater computing capacity and the potential for economical growth.

The recruiting and retention of a skilled systems, programming, and operating staff would be easier and more economical on a group basis. Substantial duplication of effort in research (system analysis), systems design, and programming activities would be avoided as compared to several hospitals doing these things separately.

It was determined that there are many types of data processing services which could be provided hospitals by such a cooperative system. Some of the potential functions were currently being performed in certain hospitals, such as patient accounting, inventory control, payroll, etc. There are many other potential applications, however that, for the most part, have not as yet been defined, and developed.

There is great interest today in EDP as an aid to the clinical practice of medicine. This could include, for

example, the handling by electronic means of all or much of the information in the patient's chart. There can be no question that once clinical applications are perfected and adopted by the medical and professional hospital staffs, they will be of substantial benefits to health care.

There is, however, widespread consensus that hospitals must initially install those EDP applications that are practical, proven, easily defined, and understood, and do not add significant cost to patient care. For these reasons, we chose to implement those accounting applications previously referred to as "Stage I Systems."

In retrospect, both the member hospitals and Minnesota Hospital Service Association feel that this was a very sound decision. We feel that the experience gained by the data processing staff and the administration of the hospitals will be invaluable in the development of future systems or extensions and improvement of the initial effort.

Future systems development

During the remainder of 1967, a detailed systems analysis will be made in two areas of the hospital—the Clinical Laboratory and the Pharmacy.

In a recently completed survey, four major problem areas in the Laboratory were identified that have potential EDP solutions. They are:

1. *Test ordering*—Can be made more accurate and much faster. Can be used to prepare lab worksheet and specimen collection schedule. Should include a better, more efficient means of specimen identification. A by-product of test ordering would be automatic preparation of charge data for the Patient Accounting System.

2. *Test Reporting*—Can be faster. Can have a better form a display than "shingles," and can be made available for instant display in areas such as the Doctors' Lounge, lab, or nursing station.

3. *Quality Control*—Is presently very time-consuming and subject to manual inaccuracies. The personnel interviewed would like improved quality control procedures as part of any new system.

4. *On-Line Monitoring* — Automated equipment, which most of the laboratories have installed or ordered, allows many more tests to be performed. Results must still be monitored and recorded. If these devices were on-line to a computer, monitoring and recording would be automatic.

Characteristics of such a laboratory system would be as follows.

Laboratory requisitions would be entered into the system from the physician's order by the nursing staff, or directly by the physician. As a result of this action, the system would produce the following:

1. Specimen collection schedules.
2. Specimen labels.
3. Laboratory work schedule.
4. A charge to be posted to the patient's account.
5. Updated file of ordered but not completed tests.

When specimens are collected and delivered to the laboratory, they will have the following positive identification:

1. Accession number.
2. Patient number and/or name.
3. Test number and/or name.
4. Date.
5. Time required.

It would be desirable if a portion of the label were in machine-readable format if the test is to be run on automated test equipment.

When a series of tests are set up, either manually or on automatic testing equipment, basically the same procedure is used—the test is calibrated by running a control specimen or a series of controls. Controls may be interspersed to verify continued accuracy of test results. The verification of control results should be performed by the computer, either manual entry of raw results or automatic entry via on-line monitoring.

During a run with an on-line automatic testing machine, results may be adjusted by the computer for drift and specimen interaction as detected by control specimen tests. As tests are completed and filed in the central computer, a report, together with previous tests for the patient, would be made available in the laboratory, the nursing station, and any other location required by the medical staff.

With all test results available on-line, it will be possible to recall a patient profile at any time. Display of the profile can be a permanent hard copy printed by the character printer or temporary display on the cathode ray tube. The profile would display the results of all completed tests and, in addition, tests that have been ordered *but not completed.*

Completed tests will be automatically audited against tests scheduled; an exception reporting system for the laboratory will assure that all ordered collections have been made and that the tests have, in fact, been completed. We feel that the benefits of such a system would be:

1. Reduced clerical effort in the laboratory.
2. Reduced clerical effort in the nursing station.
3. Increased accuracy in test ordering.
4. Better quality control.
5. Improved reporting and display of results.
6. Lost or misplaced test results will be detected and reported.

7. Fewer medical technologists will be able to perform more tests.
8. The ability to perform admission screening and multi-testing economically and rapidly benefits the laboratory, the medical staff, and the patient.

Pharmacy system

Listed below are some of the reasons that we feel that data processing can play a major role in the Pharmacy and medication administration.

- Studies have shown that 30-40% of physicians' orders are for medications.
- Much of the pharmacist's time is spent in clerical work—ordering, stocking, taking inventory, typing prescription labels.
- Medication charges lack accuracy because of clerical work involved.
- Errors due to poor communication and control directly affect patient care.
- A large amount of nursing time is spent on paper work associated with medications.

Our present concepts are that a Pharmacy System would be developed in three stages. These three stages, as well as the benefits to be derived from each, are listed below.

Stage one

Development of a computer-based inventory and formulary catalogue.

Benefits:

- Reduced clerical effort in the pharmacy.
- Improved purchasing including group buying.
- Formulary listing by therapeutic usage makes generic dispensing feasible.
- Drug location index assists inventory and order filling.

Stage two

Integration with Patient Accounting.

Benefits:

- Changes based upon drug cost to both inpatient and outpatient prescriptions.
- Patient drug profiles may be prepared off-line for medical records, probably for medication administration.
- Statistics including drug usage and adverse reactions may be a by-product.

Operating reports may be prepared automatically.

Stage three

On-line, real-time medication administration system.

Benefits:

- On-line drug profiles available in pharmacy, at any other locations.
- On-line medication schedules.
- Automatic stop or hold orders.
- Computer preparation of prescription labels.

Hardware requirements

If it is determined that it is feasible to implement the above concepts in total, we feel that a real-time computer with the following capabilities will be a requirement in the hospital:

1. Communication switching—intrahospital and hospital to the computer center.
2. Analog digital capabilites.
3. Scientific computing capabilites.
4. In-hospital real-time computing capabilites.
5. High-speed random access for storage of programs and small data files.
6. The system must be capable of communicating with a mutiplicity of terminal devices such as cathode ray tubes, teletype printers, and the central computer center.

The system must be capable of being expanded so that other departments in the hospital, such as admitting, dietary, X-ray, may also be served. The computer center hardware must also be upgraded so that patient files are on-line and available at all times.