The Place of the Minicomputer in Clinical Medicine

Chi-ning Liu, John L. Fanton, Thomas C. Horth
Medical Electronics Division, Hewlett-Packard Co.
Waltham, Massachusetts

ABSTRACT

Computers of all sizes have been widely used in biomedical research for many years. We are now on the threshold of extensive computer usage in clinical medicine. There has been a great deal of debate between advocates of large central computers serving many areas of the hospital versus those who favor many small local computers.

In some situations, such as monitoring, mini-computers answer the need. In others, such as the hospital data bank, large machines make better economic sense. In some diagnostic situations, either might be used, and we discuss the trade-offs involved, and review the important features of a small computer system from the point of view of a hospital considering such a purchase. Important points include initial cost, on-going costs, software availability, compatible medical equipment, reliability, service, programming assistance and turn-key type systems.

COMPUTER SYSTEM DESIGN CONSIDERATIONS

Computers of all sizes have been widely used for years in biomedical research. Large computers are now well established in the hospital business office, but we are just on the threshold of extensive computer usage in clinical medicine. As computers have become less costly and more flexible, we have begun to visualize applications in nearly every area of the hospital.

One of the decisions faced by medical institutions wishing to implement extensive computer assisted medicine in a rational way is the choice of type of computer system. A very large central computer system is one such possibility. A collection of independent departmental mini computers is another. In between there are mixed systems; a group of interconnected computer systems of various sizes. In our view, the latter is the practical choice, and we will attempt to show why and how such a system can be developed without serious compatibility problems.

There are two fundamental limits in a computer--time and memory. Some functions such as Data Acquisition and Data Compression are quite time consuming, but use relatively little memory. A data bank, on the other hand, will use extremely large amounts of memory, but little computer time. This bears on the question of computer size since bulk memory is more economical in large units, but a bigger computer isn't necessarily much faster.

Let's now look in more detail at some considerations in selecting computer systems.

Data Rate, especially peak data rate, and access time usually dictate the computer speed requirements in clinical situations. Designing systems which can handle high peak rates and guarantee short access times could lead to inefficient average computer usage. Multi-programming systems help overcome the problem, and are available these days on small as well as large computers.

Data Quantity, even after compression, is very large in most any hospital situation. This is especially true if an information handling system is to be made available and worthwhile.

Reliability is a central concern, especially in any application having to do directly with patient care. Modern computers are highly reliable. MTBF's on the order of magnitude of a year or more are available in commercial machines. Nevertheless, if a computer is serving a large segment of a hospital, and the staff has become dependent on it, a certain amount of chaos and degraded patient care will inevitably follow from any extended computer down time unless counter measures are specifically planned. Backup systems and duplicate hardware are the answer, but they may add to system cost. Two small computer systems, which may cost no more than one large one, can back up each other and perhaps offer a speed advantage as well.

Physical distance between a computer and the hospital areas it serves can cause problems. Some peripheral devices easily lend themselves to long distance transmission and others do not. Adding special long distance communications hardware adds significantly to a system's cost and compromises reliability.

Cost is obviously a most important consideration in choosing a computer system. Both initial and on-going costs must be considered. On the hardware, a trade-off can be made by leasing. However, the largest cost may easily be software. Considerable can be saved here in development costs if suitable applications software and operating systems are already available for the machine.

Administrative responsibility is an often overlooked but very knotty problem. Where administration of the computer systems is centralized, the success of the systems from the

point of view of a particular department within the hospital may depend heavily on the personalities of the administrators and the demands of other departments. On the other hand, there are strong economic arguments, both in terms of hardware and personnel, for centralization.

Flexibility and expansion capabilities are obviously important in a world where computers and medicine are both changing rapidly.

PLANNING THE SYSTEM

Let's now look at a typical hospital situation and see how these considerations can be integrated into an overall system. We shall discuss a system for a fairly large hospital. Obviously functions will be combined in smaller institutions.

Suppose that the long-term goal is an extensively automated patient data management and inventory system aimed primarily at making clinical services more efficient. There will also be a number of specialized functions such as process control in the chemistry lab, diagnostic calculations and monitoring.

The total data rate for the entire hospital will undoubtedly be very high. Much of it must have short access time, i. e., be essentially real-time operations. Since we want the system to be used, it will have to be convenient, and that means short access time many places where it isn't strictly medically necessary. The total speed required is well beyond even the fastest presently available computers. The only way to achieve the goal is to have a number of central processors.

We suggest a system laid out in this way. First, there must be a machine to serve the hospital communication network. It must communicate with the data bank, other central processors, and stand alone terminals. Because the hospital will eventually become very dependent on this system, it should be backed up with a second machine of the same type, which can normally be used for less time-critical functions such as inventory and program development.

Next look at each department. If it is large enough to eventually justify at least two multiprogramming mini-computers and is geographically reasonably compact, then it can be considered a separate unit. Otherwise, it may be necessary to judiciously combine departments. Each of the two processors should have a direct link to the communications central. The advantages of such a system are considerable.

1. A great deal of computer speed can be brought to bear, irrespective of what else may be going on in the hospital.

2. Reliability is assured by having two local systems. In normal operation, one machine can handle the uncritical functions and program development.

3. Cabling is fairly short and simple. The critical link to the data bank is simple and duplicated.

4. The computers can be acquired at different times, matching the work load and available funds.

5. The computers for different departments can be from different vendors. This is very important, since different vendors may offer good software support to various hospital functions. For example, we at the Hewlett-Packard Co. are currently developing mini-computer based systems, including complete software packages, to serve in three different functional areas: the catheterization lab, ECG diagnosis, and intensive care monitoring.

6. If a common intercommunication scheme is adopted, such as serial ASCII, and most programming is done in a high level but widely available language such as Fortran, no serious problems in compatibility should be caused.

7. Administrative control of those functions of the system peculiar to one department lies with that department. This does not, however, exclude a central programming group.