SIMULATION REQUIREMENTS FOR HEALTH HOSPITAL SERVICES

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Abstract

Computer requirements for Health/Hospital Services have grown in the past five years to a point where standard data processing is no longer the only function of these systems. Simulation has now become a viable tool for research and development in this area.

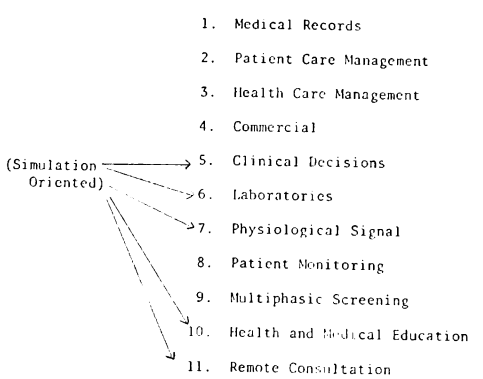
Computer requirements in terms of hardware utilized, software packages available, languages for standard and specialized functions, etc. have been surveyed. Results of this survey with conclusions concerning administrative data processing, educational and research efforts, and simulation are given.

Introduction

Simulation application in the medical field has been described as "one big stride toward alleviating the medical doctor shortage" through more efficient education methods, and increased research capabilities that in the past slowed the development of medical specialists.

The computer is being utilized in most phases of medicine on a rapidly increasing basis providing an impetus for medical personnel to be familiarized with what type of software and hardware is being utilized. The computer software application areas found to be most prevalent are: (1) Medical histories, (2) Patient care management, (3) Health-unit care management, (4) Commercial, (5) Clinical decisions, (6) Laboratory, (7) Physiological signal analysis, (8) patient monitoring, (9) Multiphasic screening, (10) Health and medical education, and (11) Remote consultation. Table 1 shows the 11 application area. In the last 5 years, categories (5), (6), (7), (10), and (11) are heavily simulation oriented.

TABLE 1
Application Areas



Over 3,000 medical facilities in the United States utilize one or more of the 11 computerized application areas described previously. Two hundred of these facilities were surveyed in order to establish some guidelines on what type of computers were being utilized, languages, size of memory, etc. for future computer-medicine application development.

Language Usage

In surveying the computer language applications of the 200 facilities, over 339 language applications were found. There were some language duplication and some multiple language usage. Table 2 provides the percentage usage by language.

There were a host of small in-house developed languages such as FOPS (File-Oriented Programming System - a multiprogramming, list processing, virtual memory, interpretive system similar to MUMPS) (1,2) and PILOT (Programming Inquiry, Learning or Teaching - a simple programming language developed by the University of California at San Francisco for CAI, testing, and interview simulation) (3), that were utilized, but provided only a small percentage of the total usage. FORTRAN provided 39% of the language applications, COBOL, 18%, followed by PL/1 with 8%, Course-writer providing 7%, GPSS providing 6%, MUMPS (Massachusetts General Hospital Utility Multi-Programming System - an interpretive text processing language developed by Massachusetts General Hospital for medical applications) (4,5,6) with 4% and Assembler language with 5%. These statistics imply that the commonly used languages available such as FORTRAN, COBOL, PL/1, etc. are utilized on a larger percentage basis than the special purpose languages such as MUMPS, FOPS, PILOT, GPSS, etc. These statistics also provide an implication of the type of hardware needed to utilize this software. It means that a FORTRAN, COBOL, and PL/1 compiler should be available with the hardware in order to utilize these existing programs. In addition, the general purpose languages dictate a specific memory size (approximately 16K to 32K for the FORTRAN and COBOL compilers). The programming languages cited call letters such as REACH (Real time Electronic Access Communications for Hospitals - an on-line CRT-driven information and communication system developed by National Data Communications, Inc.) (7,8), CAMP (Computer Assisted Menu Planning - a dietary program) (9,10), and MEDLARS (Medical Literature Analysis and Retrival System of the National Library of Medicine) (11), which in themselves may be written in one of the common programming languages such as FORTRAN, PL/1, MUMPS, etc.

TABLE 2
Language and Percentage

	Language	Percentage
	ASSY	5
	FOPS	2
	MUMPS	4
	FORTRAN	39
	PL/1	8
	COBOL	18
CAI Languages	TUTOR	4
	COURSE WRITER	7
	PILOT	3
	RPG	4
	GPSS	6
		100%

Language Memory Sizes

In order to assess the type or size of main memory needed for each of these languages, statistics were gathered from the survey concerning the size of memory for each language utilized. See Table 3 for memory size percentage utilization while Table 4 shows the language to memory utilization. FORTRAN, which was the most commonly used language found in the survey, used all types of memory. COBOL, as well as GPSS, utilized the large memories for a large percentage of their applications. It appears that like MUMPS are utilized with the larger machines of 64K to 256K, PL/1 with machines of 16K to 256K, while languages such as Assembly language and FOPS are utilized on the smaller machines of 8K. These findings indicate that

FORTRAN is not only one of the most widely used languages found, but is also the most adaptable for the wide spectrum of memory sizes. In other words, different memory sizes have dictated a smaller or larger version of the FORTRAN compiler while special purpose languages such as MUMPS, GPSS and FOPS are developed either for the smaller machines or the larger machines and have not been refined or redeveloped to fit the intermediate memory sized machines.

Machine Main Memory Sizes

The main memory sizes ranged from a small of 4K which is 4,000 bytes of main memory to a large of 3M which is 3 million bytes of main memory as seen in Table 3. 53.5% of all the machines found utilized a main memory size of 256K which can be considered a large computing system. 53.25% of the machines used a 32K main memory size or smaller which leaves approximately 46.75% of machines utilizing 64K to 3M memory sizes. This again indicates that almost half of all the computing machinery surveyed were of a large main memory size.

TABLE 3
Memory Size of Machine

SIZE	%	ACCL %
4K	1.25	1.25
8K	16.75	18.00
16K	19.75	37.75
24K	1.25	39.00
32K	14.25	53.25
64K	14.25	67.50
128K	3.75	71.25
256K	22.50	93.75
512K	3.75	97.50
3M	2.50	100.00

TABLE 4
Language vs Memory

Language	8K	16K	24K	32K	64K	128K	256K	512K
ASSY	✓						✓	
FOPS	✓							
MUMPS					✓		✓	
FORTRAN	✓	✓	✓	✓	✓	✓	✓	✓
PL/1		✓					✓	
PILOT							✓	
RPG				✓				
COBOL		✓			✓		✓	
GPSS						✓	✓	
COURSE WRITER	✓	✓						
TUTOR		✓	✓					

Machines By Vendor

Because the selection of software is directly dependent on the type of hardware being utilized, we felt it necessary to investigate all the different types of hardware utilized in the 200 facilities surveyed. Tables 5a and 5b provide machines by vendor and model. IBM with its 360, 370 and 1100, 1400 and 1800 series dominated usage with 48.75%. This can be espected, of course, because IBM is the giant in computer vending and will normally maintain an upper hand in percentages in any area of application. The DEC vendor with its PDP-8 through PDP-15 provided 20% of the computing machinery found in the survey. This is not surprising because DEC equipment has been always widely known as a small computing system with varied capabilities. DEC systems provide analog to digital (A-D) and digital to analog (D-A) converter capabilities which is a necessity in medical applications, especially some forms of simulation. Honeywell provided 6% of the vending equipment found utilized by hospitals and medical institutions. Followed with a smattering of Hewlett-Packard, Univac, Link-8's and CDC equipment. It is obvious that the DEC equipment outclasses all the computing vendors in terms of percentage usage, simply because it is not the second leading vendor of computing equipment in the United States, yet it provides the second largest percentage in the medically oriented programs.

TABLE 5a
Machines by Vendor and Model

Vendor IBM Model	#	PDP Model	#	CDC Model	#	Raythan Model	#	H-P Model	#	Honey-well Model	#	XDS Model	#
360/20	1	8	5	3200	1	2700	1	2114	1	516	2	Sigma	1
360/30	4	9	1	6000	2			2116B	1	200	1	930	1
360/40	5	10	1					Exper	1	2200	1		
360/50	9	11	1							1695	1		
360/65	1	12	7										
360/67	1	15	1										
1800	11												
Other	9												
TOTAL	41		17		3		1		3		5		2
%	48.75		20.0		3.5		1.0		3.5		6.0		2.25

TABLE 5b
Machines by Vendor and Model (Cont.)

General Electric Model	#	TOSBAS Model	#	Model	#	MED Model	#	UNIVAC Model	#	DATA GENERAL Model	#	NCR Model	#
435	2	5400	1	8	2	116	3	1108	3	Nova 1200	1	339	1
TOTAL	2		1		2		3		3		1		1
%	2.5		1.0		2.5		3.5		3.5		1.0		1.0

Application Area By Language

It is common knowledge that some languages are more adaptable than others for programming certain types of tasks. It was felt that gathering statistics concerning what language is most commonly utilized for each of the 11 application areas would be important for future application development. Table 6 provides percentage of language application for each of the 11 areas. Since FORTRAN provided the largest number of programs available, it would be expected to be of greatest utilization and it is. The laboratory and physiological signal analysis would be expected to be in FORTRAN because of the scientific nature of the data, however FORTRAN was heavily prevalent in medical records and commercial applications. These areas are inherently I/O bound type applications and are normally programmed in COBOL, RPG, PL/1. MUMPS was prevalent in the education and remote consultation areas as expected because of its evolvement. FORTRAN was also prevalent in simulation. GPSS (General Purpose System Simulation) language was the second most commonly used simulation language found.

TABLE 6

Application Area By Language

1. Medical Records
   FORTRAN - 67%
   PILOT - 33%

2. Patient Care Management
   FORTRAN - 80%
   PL/1 - 20%

3. Health Care Management
   COBOL - 33%
   RPG - 33%
   FOPS - 34%

4. Commercial
   FORTRAN - 58%
   COBOL - 14%
   ASSY - 14%
   PL/1 - 14%

5. Clinical Decisions
   FORTRAN -100%

6. Laboratories
   A. Research
      GPSS - 33%
      FORTRAN - 33%
      PL/1 - 33%
   B. Test
      FORTRAN - 60%
      COBOL - 40%

7. Physiological Signal
   FORTRAN - 75%
   ASSY - 25%

8. Patient Monitoring
   FORTRAN -100%

9. Multiphasic Screening
   FORTRAN -100%

10. Health and Medical Education
    MUMPS -8.5%
    FORTRAN-16.75%
    Tutor -17.5%
    Course Writer - 57.25%

11. Remote Consultation
    A. Consultative
       Mumps - 50%
       FOPS - 50%
    B. Radiology
       FORTRAN - 100%

Conclusions

It is hoped that this survey illuminates the types of hardware, software languages, etc. that the computer medicine researcher will have to contend with in the real world. This information should provide basic guidelines for developing computer medicine education curriculums, and for hardware-software selection for simulation application. Emphasis should be placed upon the type of application areas being considered for adoption before hardware specification is designed. This survey provides a basis for vendor evaluation in terms of percent utilization as well as a measure for programming language demands. Since software is normally more espensive than the hardware in a medical environment, historical software applications that are available at low licensing costs or provided through vendor user's groups should be a major consideration.

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