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AN ANALYSIS OF SURGICAL REQUEST SCHEDULING BY DIGITAL SIMULATION

by

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An Analysis of Surgical Request Scheduling by Digital Simulation

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ABSTRACT

The system of scheduling surgical requests at the Victoria General Hospital in Winnipeg, Manitoba, is examined analytically. A logically structured model is developed, in which primary system components interact with the incoming daily demand. The construction of a FORTRAN programme to simulate the scheduling (slating) process according to the designed structure is outlined.

Experiments with the simulator, which established the validity of the model and simulated several scheduling policies are discussed in some detail. The experimental results characterize the slating system from the point of view of the patient, the surgeon, and the hospital administration. After an analysis of these results, conclusions are drawn regarding the operation of the actual slating system.

Propositions are presented for the development and use of a "second generation" slating simulator. They are followed by an exposition of the expected role of various hospital sub-system models in large scale computerized information systems.

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CHAPTER ONE

INTRODUCTION

1.1 Purpose of the study

Inherent in the concept of a system are the ideas of structure and interrelationships. Since mathematics is largely the systematic treatment of forms and relations, any well-defined study of a particular system must consist of a mathematical, analytic approach. The purpose of this thesis, therefore, is to present a mathematical model of a specific system and to outline the construction of a digital computer simulator based on the model. The output from various simulation experiments should create a better understanding of the system being analyzed.

1.2 An area of application

Since the cost factor for treatment and cure of disease is currently receiving much attention, the delivery of health care has become a major area for application of "the systems approach " (Churchman,1968). Specifically, much effort is devoted to studying the feasibility of computerized hospital information systems, in order to combine systems concepts with the latest in computer technology. An economic feasibility study of introducing such an automated information system at the Victoria General

Hospital in Winnipeg, was reported by Sprague (1972). In the report, particular concern is given to the system of surgical slating: "At present, surgical slating is performed manually by a single clerk using decision rules which are sometimes arbitrary and not always optimal." Since the slating process involves many components of the hospital system structure, and since the process is almost entirely logical and defineable, the surgical slating sub-system is chosen as the system to be modelled and studied in this thesis.

1.3 Outline of the steps of the study

Following a somewhat detailed description of the actual setting and the activities related to slating at the Victoria General Hospital (VGH), is the exposition of the design of the mathematical model, with the accompanying assumptions. Exogenous events, which affect the modelled slating system but are themselves external to it, and endogenous events, internal to the system, are described. Data bases used for the events' quantitative representation are outlined. Simplifications producing a net effect model are discussed and justified.

Following the design of the model is its construction. A thorough explanation of the FORTRAN coded simulator is presented, outlining the purpose of the main modules, random variable generation and list processing techniques. Features built in for debugging and varying the size and format of the summary report, are described. Evaluative measures for the slating system's performance, obtained as output from the simulator are outlined with reasons for their construction.

The next topic is actual use of the simulation model. After successful validation of the model, an elaboration on the experiments performed is presented. They test the effect on the slating system of alternate time allocation procedures, of varying the number of anesthetists and of altering the surgical bed availability. Results obtained from experimentation are displayed and interpreted, with a brief discussion of their economic implications. Interpretations of experimental results give rise to several conclusions regarding the existing system, which may be of interest to management.

An overall evaluation of the model follows, with highlights of its possible extensions and refinements, both in the design and construction phases. The future role of similar simulators in computerized hospital information systems is discussed.

CHAPTER TWO

DESCRIPTION OF THE SYSTEM

2.1 Slating system components

In order to examine the setting for the model profitably, it is necessary to have, at the outset, an idea of the system and its components. In the case of the slating sub-system, elective surgical requests form the exogenous input. A surgical bed is required for each patient that is to be admitted to the hospital. The request is scheduled according to a block time allocation scheme particular to VGH. Scheduling is performed by the slating clerk, who also handles replaceable and abrupt cancellation. The surgeon, the nursing team, the anesthetist (for general anesthetic surgery) and an appropriate operating theatre form the other requirements for requested surgery to be actually performed. The schedule, or slate, is arranged daily. It generates all surgical activity during the day that is not classified as "emergency".

2.2 Relevant system mechanisms

Surgery is performed by a (fairly) constant number of doctors with operating privileges at the hospital.

Over 150 different types of surgery are performed, varying in time and equipment required, and hence involving restrictions on use of operating rooms.

Hours for regular, elective surgery are 8:00 a.m. to 4:00 p.m. daily except Saturdays, Sundays and holidays.

These hours are subdivided into "blocks" and assigned to the surgeons. Thus, each surgeon knows at what times in the week he can operate. This eliminates too many requests for the morning hours with idleness in the afternoon.

For each regular day, a set of blocks covering all the regular surgery hours, is assigned to an anesthetist. Thus, a surgeon's block time is intended for his elective surgery with a general anesthetic only.

Five anesthetists are in use daily, with each being assigned to a set of surgeons' block times for scheduling purposes.

A request for surgery with a local anesthetic is not scheduled according to the block time allocation scheme.

The blocking system causes surgeons to perform a considerable number of operations in succession.

Elective surgery requests can be classified according to their "admission property".

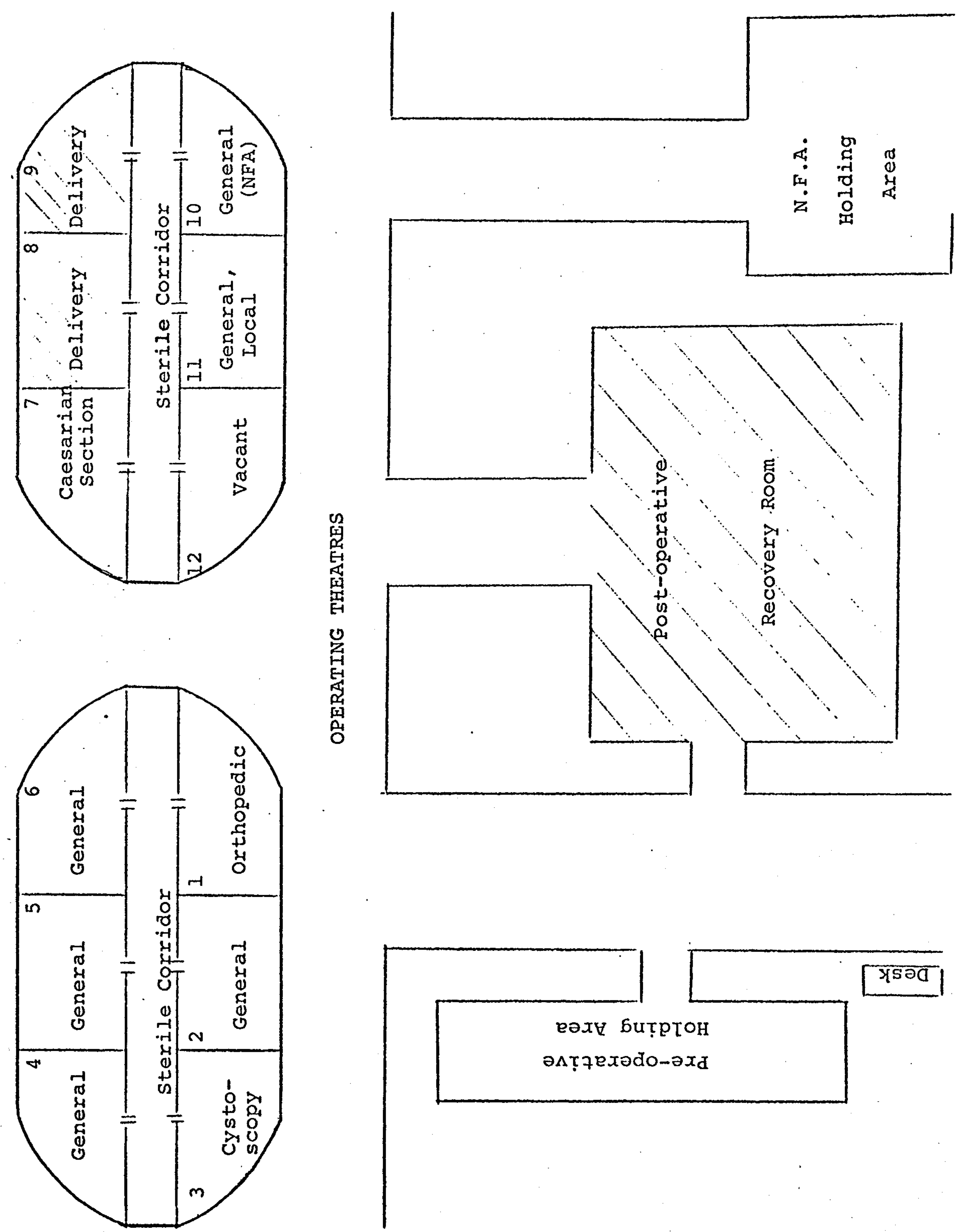
(a) Patient is admitted to the hospital prior to surgery for tests and preparation. Most of these patients arrive one day in advance.

(b) NFA (Not for Admission). Patient arrives a short time before surgery and leaves on the day he arrives.

(c) POA (Post-Operative Admission). Patient

Figure 1

Layout of surgical facilities at the Victoria General Hospital



arrives shortly before surgery, but remains in hospital afterwards for post-operative recovery.

Twelve operating theatres are in existence as shown in Figure 1. Of these, theatres 8 and 9 are used for deliveries and are under separate jurisdiction, while theatre 12, designated for endoscopy, is not presently in use.

Theatres 2, 4, 5, 6, 10 and 11 are labelled "general purpose", while room 1 is restricted to orthopedic surgery, room 3 to cystoscopies, and room 7 to Caesarian sections.

2.3 Specific slating procedures

A request for surgery is telephoned in to the slating clerk, who makes note of it on a "work slate".

In order to book an operation within his block, a surgeon must make a request to the slating clerk not later than 48 hours prior to his desired starting time. Otherwise, the surgeon's block time becomes "open" for other use.

A surgery request can be classified as being for a specific date in the future, or "as soon as possible".

As soon as a request comes in, a card is made up with the names of the patient and surgeon, surgery type and other pertinent data. The card is filed in a slot which is dated. The date indicates the day of the patient's scheduled arrival at the hospital.

The slating clerk books the operation for a length of time she thinks will be necessary, based on her previous experience. Upon a cancellation, bookings on the "work slate" are rearranged. Much dialogue exists between the slating clerk and the surgeon before a booking is made.

Maximal utilization of operating room facilities is the slating clerk's goal and, as a result, the operating rooms are never deliberately scheduled "empty" during regular operating hours.

The day a patient is to be admitted for an operation (that is not of the NFA variety), the request card is given to the admissions secretary. The secretary checks if a surgical bed is available and, if so, telephones the patient to come in. If no bed is available, the operation must be postponed, resulting in further slate rearrangements.

Occurrences of requests for emergency surgery at the VGH are fairly rare, allowing nearly all such cases to be performed after regular hours.

The final slate for a particular day is completed on the previous day. The slating clerk sends the "work slate" to the operating room supervisor for assignment of different theatres to the various operations scheduled. The sheet then goes back to the slating clerk, who comes up with a typed, finalized slate.

Abrupt cancellations of cases on the finalized slate are made by the slating clerk or by the operating room supervisor.

2.4 Factors influencing system efficiency

The established procedures do create several areas of concern with regard to maintaining the operating efficiency of the surgical slating system at a fairly high level. An estimated 15% of the scheduled operations are cancelled. In many cases, the cancellations occur too late for feasible rescheduling, leaving the operating room idle. The idleness of anesthetists is also increased by cancellation, suggesting an investigation into the number of anesthetists that could be used most effectively. Some surgeons appear to be postponing more cases than others because of lack of enough available block time. In addition, fragmentation of block time occurs when available time is left unscheduled solely because of lack of an available operating room or because of insufficient extra time for at least one additional case. Since eventual implementation of computerized slating would alter the slating system's structure significantly, a simulation modelling approach in order to pinpoint the bottlenecks more exactly, seems quite appropriate.

CHAPTER THREE

DESIGN OF THE MODEL

3.1 An analytic approach

In order to investigate the areas of concern in the system, a model of the surgical slating system was designed to study the effect of alternate block time allocation procedures on operating room and anesthetist utilization, as well as on throughput efficiency for surgical request. The system, functioning on a daily basis, was viewed as a series of component sub-systems: 1) the generation of exogenous demand, 2) the attempt of each request to satisfy the necessary criteria with respect to availability of surgeon's block time, availability of a bed for a surgical patient, and with respect to a possible request cancellation, 3) the attempt by a request not filtered by the previous sub-system (2), to locate an appropriate amount of time (block time for a general anesthetic) and an available operating room for the duration of the surgery.

Each sub-system was then designed in detail as a specific segment of the model, with a succession of events endogenous to it attempting to reflect a similar succession as observed at the VGH. In any such model, however, it is impossible and sometimes undesirable to reflect every detail. Even while restricting the modelled events to those of primary significance with regard to the model's eventual purpose, it becomes desirable to construct other assumptions and simplifications which alter somewhat the actual observed order. By the nature of the simplifications, their effect on the modelled system's evaluative measures should be either nonexistent or negligible.

3.2 The data base

With a particular modelling structure in mind, quantitative characterization of the entities and events of the system forms the next step. The surgical demand generation sub-system was the first to be investigated. Many of the surgical operations performed are related medically and require similar theatre occupancy times. A simplification was initiated whereby procedures with the same average duration as well as similar variability in duration were placed in the same class, provided they were related medically and could be performed in the same theatre(s). The result was a reduction from over 150 procedures to 37 surgery classes (Figure 2).

Since a major aim of experimentation was to evaluate alternate scheduling methods, and the only available estimate of the number of requests on a given day was from the day's slate, itself a function of one particular scheduling method, the information on hand was deemed insufficient. It was therefore necessary to collect "raw" data on daily surgical requests, as they came in to the slating clerk.

Figure 2

Surgery classes used in the model

Code	Description
1	Local-1
2	Local-2
3	Local-3
4	Local-4
5	Local-5
6	Local-6
7	Local-7
8	General-1
9	General-2
10	General-3
11	General-4
12	General-5
13	General-6
14	Gynecology-1
15	Gynecology-2
16	Urology-1
17	Urology-2
18	Urology-3
19	Urology-4
20	Obstetrics-1
21	Orthopedics-1
22	Orthopedics-2
23	Orthopedics-3
24	Orthopedics-4
25	Plastic-1
26	Plastic-2
27	Plastic-3
28	Thoracic-1
29	Thoracic-2
30	Ear-Nose-Throat-1
31	Ear-Nose-Throat-2
32	Ear-Nose-Throat-3
33	Neurological
34	Dental-1
35	Dental-2
36	Ophthalmology-1
37	Ophthalmology-2

A form (Figure 3) was designed with emphasis on the day the request came in, whether it was to be performed as soon as possible or on a definite day in the future, and the actual day the reqeust was slated for. Data were gathered by the slating clerk for a period of 10 weeks. In addition, information was obtained on request cancellations, with emphasis on whether there was sufficient time to replace the cancelled request. Requests made before the start of the study period for definite dates during the period were also recorded. Each of the requesting surgeons was identified by a code number (1-39) assigned to him. All the general practitioners, who perform surgery on relatively rare occasions, were grouped and considered as one surgeon, the General Practitioner, with a code number of 37.

Another noteworthy simplification was introduced into the data base for exogenous demand. Since the significance of the day in a surgical request is essentially the day the request is for, it was decided to merge the requests to be performed soon with those for a definite future date. Thus, each request in the gathered data base was labelled to be for a particular day, varying from 1 to 50. This labelling was achieved by considering the "as soon as possible" requests as requests to perform surgery two regular surgery days after the requests were reported. The reason for this was that surgeons are required to claim their block time 48 hours in advance. A frequency distribution of the number of requests for a given day was then formed. Since requests that were cancelled and subsequently

Figure 3

The form for incoming requests

INCOMING REQUESTS

DOCTOR CODE	DAY OF CALL	CLASS OF SURGERY	①-SOON ②-DEFINITE DATE	IS CASE POSTPONED? Y or N	DOES CASE GO ON WAIT-LIST?	DAY SLATED FOR	DAY REQUEST IS FOR	SHEET NO. 1 Comments
[illegible]	[illegible]	14	2	N	N	MAR 29	[illegible]	
[illegible]		10	2	N	N	MAR 17	17	
8		14	2	N	N	MAR 18	16	
31		11	1	Y	N	FEB 28	3	
15		10	[illegible]	N	N	[illegible]	12	
18		~~[illegible]~~ 10	2	N	N	[illegible]	[illegible]	
[illegible]		14	[illegible]	N	N	[illegible]	11	
[illegible]		[illegible]	[illegible]	N	[illegible]	[illegible]	23	
[illegible]		14	[illegible]	N	N	[illegible]	19	
[illegible]		15	[illegible]	[illegible]	N	[illegible]	9	
7		[illegible]	2	N	N	[illegible]	[illegible]	
7		30	2	N	N	[illegible]	[illegible]	
[illegible]		31	2	N	N	MAR 7	9	
14		10	2	N	N	APR 9	32	
[illegible]		10	2	N	N	[illegible] 5	7	
[illegible]		10	2	N	N	[illegible]	11	
[illegible]		30	2	N	N	MAR 7	9	
11		30	2	N	N	MAR 15	16	
[illegible]		11	1	N	N	FEB [illegible]	3	
7		4	1	N	N	FEB 28	3	
6		14	1	N	N	FEB [illegible]	3	
[illegible]		[illegible]	1	N	N	FEB [illegible]	3	
1		8	1	N	N	FEB 27	3	
34		2	2	N	N	FEB [illegible]	4	
[illegible]		14	1	Y	N	FEB [illegible]	3	
[illegible]		14	1	Y	N	FEB 28	3	
4		[illegible]	1	N	N	FEB 27	3	
36		4	1	Y	N	FEB 27	3	
3	29	14	1	N	N	FEB 28	3	

re-booked were entered again on the incoming request sheet, all cancelled requests were considered as being withdrawn from the system. A relative frequency of cancelled requests was calculated over all the classes, since there was no apparent indication from the hospital staff of requests for a particular class being cancelled more frequently. The approximate length of an operation from each class, was obtained, to the nearest 30 minutes, from the slating clerk.

In order to study bed availability for surgical patients that require admission into the hospital, it was necessary to obtain a value for post-operative length of stay (LOS) for each surgery class. Since LOS was not considered as a criterion for a surgical procedure's belonging to a particular surgery class, the procedures within a class were found not to be homogeneous with respect to LOS. To ensure homogeneity within a surgery class with respect to the LOS factor, in addition to average duration and medical and logistic compatibility, the following technique was applied. Procedures within a class were subdivided into three categories, those occurring i) often, ii) moderately often, and iii) rarely, with arbitrarily assigned probabilities of i).65, ii).25, and iii).10 respectively. Knowing the average LOS for every procedure in each of the three categories within a surgical class, allowed construction of a probability distribution of LOS homogeneous over all procedures in the class. For example, if category i contained three surgical procedures, two of which caused an average LOS of 3 days and one caused an average LOS of 4 days, category i would contribute a probability of 2/3 x .65, or .44 to an average LOS of 3 days and 1/3 x .65, or .21 to an average LOS of 4 days. Similar calculations for categories ii and iii would yield the desired distribution. Thus, LOS was taken to have a homogeneous distribution over all procedures in a given surgical class, but this distribution was estimated as a mixture distribution taking into account the relative frequency of LOS for each surgical procedure within the class. Factors such as the particular surgeon, the age of the patient, etc., were assumed not to affect the LOS distribution.

3.3 Structure of the model

3.3.1 Demand generation segment

The first segment of the model provides generation of demand for surgery. Its purpose is to use the collected data in such a way as to provide daily, an entire set of surgical requests for slating consideration. The model requires the distribution of the number of requests occurring per day, the probability distribution over the 39 surgeons that a request is made by a particular surgeon, the set of 39 distributions each defining the relative frequency of a surgeon's services over the 37 surgery classes, and the post-operative length of stay distributions for each surgery class.

After deciding on the number of requests to be considered for slating on a particular day, each request is classified as being from a particular surgeon for a particular surgery class, and producing a particular LOS.

Request classification is based on random and independent selection from cumulative distribution functions formed from the probability distributions required by the model. The complete set of requests for a given day is identified as the day's demand list, which is required as input to the next segment.

Several assumptions are implied in the demand generation segment. With regard to the distribution of the number of requests for a given day, no significance is attached to the day of the week. This follows as a result of a one-way analysis of variance test performed on the observed data. (The missing value for Good Friday was estimated from the other Friday figures.) The observed F-value with 4 and 45 degrees of freedom was 0.775, which did not exceed the tabulated F-value for significance at the 95% level of 2.57. The conclusion was, therefore, that the effect of the day of the week on the number of daily requests was statistically non-significant and thus it was thought that the factor need not be isolated in the model.

Although, in reality, surgeons occasionally requested two surgical procedures on the same patient to be performed in succession, this occurrence was rare enough (3% of the requests over the 50-day observation period) to be justifiably excluded from the model. The model treats two such requests as being for two different patients. This assumption does introduce a bias into the model, requiring up to twice the observed demand for surgical beds by the "double procedure" requests.

The demand produced by this segment is for elective requests only, since emergency surgery at the VGH is usually performed after regular hours.

3.3.2 Filtering segment

Unslated requests for previous days, now on the waiting list, as well as the day's requests, as provided by the demand generation segment, pass through a hierarchy of filters (Figure 4) as preparation for the day's actual slating attempt.

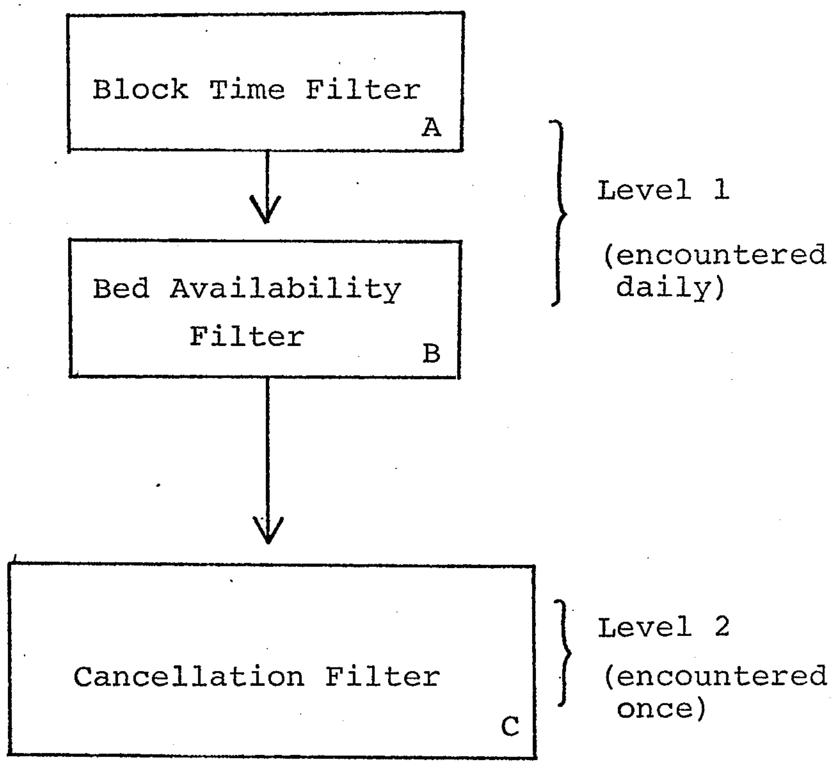
A request is taken from the waiting list, or, if it is empty, the demand list. If the surgery is to require a general anesthetic, the request encounters the surgeon block time filter (A). If the requesting surgeon does not have block time on that day, the request is placed on or remains on the waiting list.

If block time exists and the request is not of the "not for admission" (NFA) variety, the request then encounters the bed availability filter (B). A counter is kept on the number of surgical beds available by keeping track of the number of patients who will have already had surgery and are scheduled to depart each day.

Since most patients arrive in the hospital one day before surgery, the model, although considered to be functioning at a particular day in time, steps back one day at this point. The question is whether a bed was available yesterday to the

Figure 4

Hierarchy of filters for a surgical request



patient whose request is being processed today. This is an example of an alteration of the flow of events by time as observed in the real system, yet the model is simplified and yields the same net effect. A request finding all the beds full is postponed and remains on the waiting list, with the information on its having been filtered, recorded appropriately.

The last filter of the sequence (C), deals with request cancellation. It possesses a unique property in that a particular request can encounter this filter only once. In fact, it has been called the cancellation decision filter. Once a request passes through this filter, a decision is reached on its cancellation status: whether it will be cancelled by the slating clerk, if so, whether it will be a cancellation that can be replaced, if not, whether it will be cancelled by the operating room supervisor. This decision is made on a probabilistic basis from information compiled from the data base. A non-replaceable cancellation is passed on to the segment attempting to slate the request, with an indicator that this request is for a "gap" surgery, i.e. one which will cause idleness in the operating room for a prescribed length of time. A replaceable cancellation is deleted from the modelled system.

Should the first attempt to slate a request prove unsuccessful and should the request encounter the cancellation decision filter on a subsequent day, a cancellation decision indicator, associated with the request, will allow it to bypass this filter. This provision has been built in to the model to maintain the proportion of cancelled requests approximately equal to that observed, by not reversing the decision as to whether a particular request will have been cancelled.

A request that has passed through or by the filters in this segment is passed on to the following segment of the model.

3.3.3 Slating attempt segment

This segment is the most intricate in design since it actually attempts to slate each request passed to it by its predecessor segment. A request for surgery with a general anesthetic is examined in a different manner from that with a local anesthetic, since the former follows the block time allocation scheme, while the latter does not.

i) Requests for a general anesthetic

Under modelling assumptions, a surgeon may be allowed no more than two disjoint blocks of time per day, either with the same or with a different anesthetist. No block may be shared, therefore each surgeon's block is exclusively his own.

The first criterion for slating is the availability of sufficient block time for the requesting surgeon. If enough block time is not available, the request is placed on the waiting list. An attempt to slate the request is made later.

The duration of requested surgery that is postponed is kept track of as a statistic for each surgeon. It is to serve as a possible indicator of the amount of additional time a surgeon would need under a revised time allocation plan. The effect of a particular request's postponement and placement on the waiting list does not influence the postponement statistic each time that the request is processed. A postponement decision indicator ensures that the duration of a postponed request is accounted for only once.

With enough block time available, the problem of finding an appropriate operating room follows. The model attempts to retain a surgeon in the same operating room for successive operations, if this is at all possible. A room is chosen such that it will be available for the entire scheduled duration of surgery, beginning at the proposed start time designated by the block structure.

If no room is available, the model attempts to start surgery 30 minutes later than the originally proposed starting time. If still no available room is found, or if the scheduled finish time should exceed the end of the surgeon's block time (because of the 30 minute advance), the model adds to the counter for requests postponed because of lack of room, and places the request on the waiting list.

A particular problem occurs with requests for cystoscopic surgery. Operating room 3 is the only theatre in which these cases can be performed. The room is allocated to requests with either a general or a local anesthetic and since the latter do not follow the block time scheme, the room may often be found occupied. Since the occurrence of cystoscopies is not very frequent, the room allocation procedure for general anesthetic cystoscopies is the same as that for other requests and contains the provision for the 30 minute advance in proposed starting time. The provision is limited to 30 minutes since this time is not used in further scheduling, but causes a deliberately idle fragment in the surgeon's block time. For example, if the surgeon's block indicates a proposed start at 10:00, but room 3 is not free until 10:30 and the case is slated for 10:30, the half-hour between 10:00 and 10:30 will not be used by the surgeon on that day.

In cases where more than one theatre may be allocated to a request, as in "general purpose" surgery, where theatres 2, 4, 5, 6, 10 and 11 can be booked interchangeably, the search proceeds in ascending order of the operating room number.

If an appropriate room is located for the required duration, it is recorded as occupied for that time. The surgeon's scheduled location is noted and the request is considered slated. Once a request is slated for a given time, it is neither removed from the slate nor rearranged to start at a different time. This model characteristic can create non-optimal use of block time since the amount of time unused may be a function of the order of a surgeon's daily requests. For example, a surgeon with a 3 hour block asking for three procedures to last 2, $1\frac{1}{2}$, and $1\frac{1}{2}$ hours, will leave 1 hour unused with two requests on the waiting list. Had the order of the same requests been such that the procedures were to last $1\frac{1}{2}$, $1\frac{1}{2}$ and 2 hours, the surgeon's block time would be fully utilized with only one additional request on the waiting list.

After designating a request for the slate, the model proceeds to assign to the request the appropriate anesthetist from the block structure, along with the starting time and scheduled duration. The request is then actually attached to the day's slate. Since surgery for this request will have been performed on the day it is slated for, the previous day's surgical bed census is increased by 1, indicating the patient's arrival into the hospital one day prior to his scheduled surgery. From the LOS information, the day on which the patient will free his bed is also noted. Exceptions in this regard are made when slating NFA cases or "gap" surgery caused by irreplaceable (usually last minute) cancellations.

ii) Request for a local anesthetic

Requests of this nature are handled differently, since they do not utilize time from a surgeon's allotted block(s). In fact, the model ensures that a surgeon is not scheduled to perform any surgery with a local anesthetic during his block time.

A request for a cystoscopy with a local anesthetic is assigned to operating room 3, while every other local procedure is assigned to room 11. In either case, the procedure must share the operating room with general anesthetic surgery.

If a surgeon does have block time on a particular day, an attempt is made to schedule the local procedure immediately following the end of his first block. The search for enough consecutive free time in the appropriate operating room is continued, should no such time be found starting with the first attempted time. A check is made to ensure that there is no collision with the surgeon's second block. If time is unavailable following the end of the first block, a similar search is made attempting to schedule the case before the first block starts. The request is placed on the waiting list if the latter procedure is also unsuccessful, otherwise the request is slated.

If the requesting surgeon does not have block time assigned to him for the particular day, the only problem becomes to find enough consecutive free time in the required operating room. The search is started at the beginning of regular surgery time, 8:00 a.m.

iii) Rescan of the waiting list

After each request from both the waiting list and the day's demand list is processed, an updated waiting list is produced along with the day's slate. Since the blocking system only is used to schedule general surgery requests, block fragmentation and lack of requests from specific surgeons can cause a significant under-utilization of block time. To increase slating efficiency, the updated waiting list is rescanned in an attempt to fill unused portions of block time irrespective of the requesting surgeon.

The rescan procedure is limited to non-cystoscopic cases with a general anesthetic. Each request requiring hospital stay is passed through the bed availability filter.

If the cancellation status of a request has not yet been determined, the request is passed through the cancellation filter. An attempt at slating the request is then made. A scan is performed to find a surgeon who has enough idle block time for the request. If such a surgeon is found, a start and finish time is proposed for the requested procedure. The proposed time may collide with time for local anesthetic surgery that has already been slated for the requesting surgeon. It may also collide with the requesting surgeon's own block time(s). In either case, the request ceases to be considered for slating on the rescan and is returned to the waiting list. If no problem occurs with the proposed time and if an appropriate operating room is selected, a note is made of the block time being "given" by one surgeon, and "taken" by another. The request is then assigned appropriate information and attached to the slate. As a result of this rescan procedure, the waiting list is updated further and the number of cases slated is increased.

3.3.4 Summary segment

Throughout the attempt at slating, various counters are maintained to evaluate the modelled procedure. For example, the number of requests postponed and cancelled is recorded daily. The number of days a request remains on the waiting list before being slated, and the size of the waiting list each day are also kept track of by the model.

The purpose of the final segment of the model is to summarize the data obtained by day, by week, and by realization of the entire 50-day period. Thus, daily statistics are added to those for the week, which are in turn added to the overall accumulators. Utlization statistics on the operating rooms and anesthetists are calculated. An overall summary report consisting of the requests and their realizations, as slated, is also prepared. It is segregated first by surgeon and then by surgery class. This design of various evaluative measures is the basis for production of information reports, after the model is constructed for use on the digital computer.

3.4 An outline of the main assumptions

The analytic model of the system of surgical slating contains a number of assumptions and simplifications. They are outlined in this section for facility in understanding the underlying principles of the model's design:

3.4.1 Generation of demand

1) There are 5 surgical days per week and 8 hours per day, starting at 8:00 a.m., except for Wednesday which has 7 hours starting at 9:00 a.m.

2) One realization consists of 50 surgical days.

3) All requests are considered only as being for a certain day, irrespective of when they were actually made.

4) Requests for two operations in succession on the same patient are modelled as two distinct requests for different patients. This results in a somewhat higher demand for surgical beds in the model than in reality.

5) Thirty-nine different surgeons are requesting surgery with surgeon 37 representing the General Practitioner. Also, there are 37 surgery classes consisting of procedures that are related with respect to medical type, duration, and variability in duration.

6) Only the average duration for a procedure from each surgery class is considered. Also, a distribution of average post-operative length of stay (LOS) is associated with each class. The LOS has a homogeneous distribution over all procedures in a given class, and the distribution is not affected by the particular requesting surgeon.

7) Duration of a surgical procedure includes that of set-up time, anesthetist's preparation (if needed), surgeon's preparation, the operation itself, the post-operative instrument count (if needed) and the clean-up of the operating theatre.

8) Requests may require the patient's entry into the hospital one day prior to surgery as well as post-operative stay for recovery, or the requests may be classified Not for Admission (N.F.A.). Post-operative admission patients are not identified separately, but enter the modelled system one day before surgery.

9) The model is restricted to requests for elective surgery, since emergency cases are usually performed after hours.

3.4.2 The slating of requests

1) The surgical bed census is monitored daily along with a record of the number of post-surgical patients

scheduled to depart each day.

2) Patients depart at the start of each day before new arrivals are considered.

3) The model proceeds through time by days. However, in the case of a request for day n, although the modelled process is at day n in time, a retroactive bed availability check is made for the patient on day (n-1). The check is bypassed, however, for an NFA patient.

4) No distinction is made between surgeons or classes when estimating cancellation probability from the data base.

5) Cancellation of requests is performed either by the slating clerk (replaceable or non-replaceable) or the operating room supervisor (non-replaceable).

6) A decision regarding cancellation of a particular request is made only once during the entire realization.

7) All replaceable cancellations are eliminated from the modelled system, even though some are only postponed in reality. The distribution of incoming requests allows for this simplification.

8) Five anesthetists are present in the system, with provisions to increase the number to 7 for experimentation purposes.

9) A block time allocation scheme gives each surgeon a fixed amount of time each week for cases involving general anesthesia. Local anesthetic surgery is not done by a surgeon during his block time.

10) A surgeon is allocated at most two disjoint blocks per day. The allocation scheme does not allow sharing of blocks.

11) A request is placed on the waiting list on a given day because the surgeon does not have block time that day, or there is not enough block time, causing a postponement of the request, or because no operating room is available on time.

12) The time postponed for a given request is noted only once during a 50-day realization.

13) Operating theatre 1 is reserved for orthopedic surgery, while theatre 3 is for cystoscopies (regardless of anesthetic). Theatres 2, 4, 5, 6, 10 and 11 classified as "general purpose". Theatre 7 is restricted to Caesarian sections. All local anesthetic cases (except cystoscopies) are performed in theatre 11 only.

14) In the slating attempt, all requests on the waiting list are processed before the requests on the day's demand list.

15) If possible, a surgeon will continue in the same operating theatre with successive cases.

16) The time unused (at most 30 minutes per case) because of unavailability of an appropriate operating room at the first proposed starting time, is lost.

17) A non-replaceably cancelled request is slated similarly to other existing requests. It is labelled, however, as a request for "gap" surgery, and is included as such in the slate. This type of request, even if not

an NFA, does not alter the surgical bed census.

18) Once a request is slated for a particular time, it is not rescheduled, even if the order of a surgeon's requests should create unnecessarily vacant block time.

19) After scanning the waiting and demand lists in a daily slating attempt, the updated waiting list is rescanned, filling up a particular surgeon's unused block time with requests from other surgeons. The rescan is limited to non-cystoscopic cases with a general anesthetic.

The assumptions and simiplifications employed in the model are justified, bearing in mind that the main purpose of the model's design is the study of the effect of alternate block time allocation procedures. Despite the above mentioned alterations and innovations, the model nevertheless reflects the general structure of the actual system observed at the Victoria General Hospital.

3.5 General comments

The design of the model displays a unique characteristic feature. Although considered a time advance model with the unit of time being the day, the model "looks back" in time by one day when at the bed availability filter and when updating the surgical bed census. In addition, the incorporation of abruptly cancelled cases, as such, into the slates, provides them with definite information on the implied realization of the surgical processes that the slates generate. This can be viewed as "looking ahead" in events, if not in time. The net effect feature allows examination of the effects of a particular time allocation scheme on aspects of surgical processes which themselves need not be simulated in time. In short, the slate from the model, in addition to stating what should happen, gives insight into what will have happened. For example, we may know at slating time, that at a given hour a request will have been abruptly cancelled and will have left a particular operating theatre idle for 90 minutes. This feature proves to be especially effective in the computer application phase, where minimizing storage of future events is a definite goal.

The design demonstrates both stochastic and deterministic aspects. The number of daily requests and the number and type of cancellations are arrived at on the basis of empirical probability distributions. Meanwhile, the scheduled duration of a procedure from a particular surgery class as well as the post-operative length of stay are arrived at from a set of pre-determined, average figures. The latter aspect simplifies the model structure, but also narrows somewhat the scope of its effect.

As with a skyscraper or freeway overpass, the step following the design is actual construction. For the slating system model, this implies construction of a computer programme which will allow the system's digital simulation.

CHAPTER FOUR

CONSTRUCTION OF THE MODEL

4.1 Involvement of the computer

From the design, it is evident that the surgical slating system model possesses many dynamic properties. The model simulates a pass through time performing various activities such as creating daily demand, reforming the waiting list and producing the daily slate. Since these activities can be described adequately by logical abstraction and represented completely by numeric coding, involvement of a high speed digital computer in the system's simulation is inevitable. With the existing hardware technology and its supporting software, a realization of the slating process for 50 days can be simulated in a matter of several tens of seconds. The construction phase of the model, therefore, consists of choosing an appropriate programming language to reflect the design. Particular emphasis must be placed on efficient coded representation of the necessary events and entities by utilization of data structures which the chosen language supports.

4.2 A construction overview

In deciding on a language for the simulator, care was taken to ensure that the syntax of the language did not necessitate major alterations in the original design. An additional requirement was that the language be implemented and supported by the University of Manitoba's Computing Centre. Since the process to be simulated does not follow any of the classical situations taken care of by specific problem-oriented simulation languages, FORTRAN was chosen as the medium for computer application. Intended for scientific use, it allows representation of a variety of structures, although the coding may be somewhat laborious. The availability at the Centre of the WATFIV compiler with its lucid diagnostic messages speeded up the initial construction stages.

Since the model is designed as a series of segments, modularity is desirable in its programming. The SUBROUTINE feature is used throughout the coded model, allowing the construction and verification to be performed in stages. Besides the main supervisor routine, the modules are classed as being of either primary purpose or utility type. The programme follows the sequence of the design in isolating the four distinct phases, viz. input recognition, demand generation, slating, and output production. All information as to both exogenous and endogenous events and entities of the slating system is coded in structures easily acceptable by any FORTRAN compiler.

4.3 System representation

This section forms an exposition of the methods employed in storing the necessary information on the incoming requests as well as on system characteristics essential to the requests' processing.

4.3.1 Information on exogenous demand

Demand generation is based on observed relative frequency data. Following is a description of the types of FORTRAN structures used in producing requests for surgery.

The distribution of the number of requests for a particular day is read in as a cumulative distribution function (C.D.F.) and stored in a one-dimensional real valued array, DIST. Successive values of the step function stored in the array correspond to equally spaced points in the range of the random variable. This range consists of a number of points equal to the value of NOPTS. The range begins with the value of INDVAL. The values of the successive points in the range differ from each other by the value stored in IDELT. The actual technique of generating variates from a distribution represented in this manner, is explained in the next section.

The probability distribution of a given request's coming from a particular surgeon is read into PROBDR, a real valued one-dimensional array. Each of the 39 components of the array corresponds to the observed relative frequency of a request from the surgeon whose code is that of the component.

A distribution of a surgeon's services over all the surgery classes is also required. Since one such distribution exists for each of 39 surgeons, a two-dimensional real valued array DOCLAS is used. DOCLAS consists of 39 rows and 39 columns. Even though only 37 surgery classes exist, two "null" classes have been added throughout the programme, allowing for possible future extension. The distribution of services by surgeon i is read into the i^{th} row of DOCLAS. The values in PROBDR and in each row of DOCLAS are then successively cumulated to allow for generation of variates from these empirical distributions.

A post-operative length of stay distribution is associated with each surgery class. Since the number of points in the distribution varies with the class, the arrays of cumulative distribution values for all classes are concatenated into a large one-dimensional real valued array, LOS1, consisting of 82 components. The corresponding domain values, i.e. the LOS days, are stored in an integer valued array LOS2, also with 82 components. An integer array, INDEX (39) indicates where in LOS1, the C.D.F. for the length of stay for a particular surgery class can be found.

The information stored in the above mentioned structures is required before starting the simulation, to allow for the stochastic aspect of the model, which is called for in the design.

4.3.2 Information on the slating process

A priori quantitative information on several aspects of the slating process is also needed at the start of the simulation procedure.

Representation of the block time allocation scheme is a major requirement. For a given surgical day, 7 consecutive columns of the two-dimensional integer array BLOCK are associated with 7 different anesthetists. A column contains 8 rows, each representing one hour of surgery. Surgeon codes are entered in these rows, providing thc necessary block information. Only the first 5 columns contain non zero entries, since only 5 anesthetists are presently in use. With 5 surgical days per week, BLOCK consists of 8 rows and 35 columns. The representation used is very similar to that observed in reality at the VGH, although it may seem somewhat cryptic. Required information can be extracted from this structure by reading successive surgeon codes down the columns.

LENSUR (39), a one-dimensional integer array contains the average durations of procedures from each of the possible surgery classes. The time is given in minutes, to the nearest half-hour.

The boolean matrix OPRM with 39 rows and 12 columns indicates which surgery class is compatible with which operating theatre(s), with a '1' indicating compatibility.

Information is isolated regarding the day(s) of the week that each surgeon is allowed to perform surgery with a general anesthetic. The boolean matrix DOCAV (5,39) allows for easy reference on the matter without the necessity of searching through BLOCK.

As for operating room availability, the logical valued array XFRAG marks a particular room as being 'F'-free or 'T'-taken, for a specific half-hour period during the day. The array thus consists of 16 rows and 12 columns, with the columns corresponding to individual operating rooms.

Particular emphasis must be placed on the coded representation of surgical requests and their processing by the simulator programme. A 15 row, 800 column two-byte integer array RQFILE is designated as the storage file for complete information on each surgical request, as is necessary throughout the realization (Figure 5). A surgical request is represented as a column of RQFILE, containing such initial information as the day the request is for, the codes of the requesting surgeon and surgery class and the post-operative length of stay.

As a result of daily demand generation, the new requests are each stored, with their initial information, in RQFILE. In fact, the requests are joined by pointers to form a subset of RQFILE identified as the demand list. Zero valued entries in a request column are reserved at this stage for further information on the request viz. the number of days spent on the waiting list, or precise slating information e.g. room slated for, scheduled duration, type of anesthesia, code of the anesthetist and cancellation information.

Figure 5

A request in RQFILE

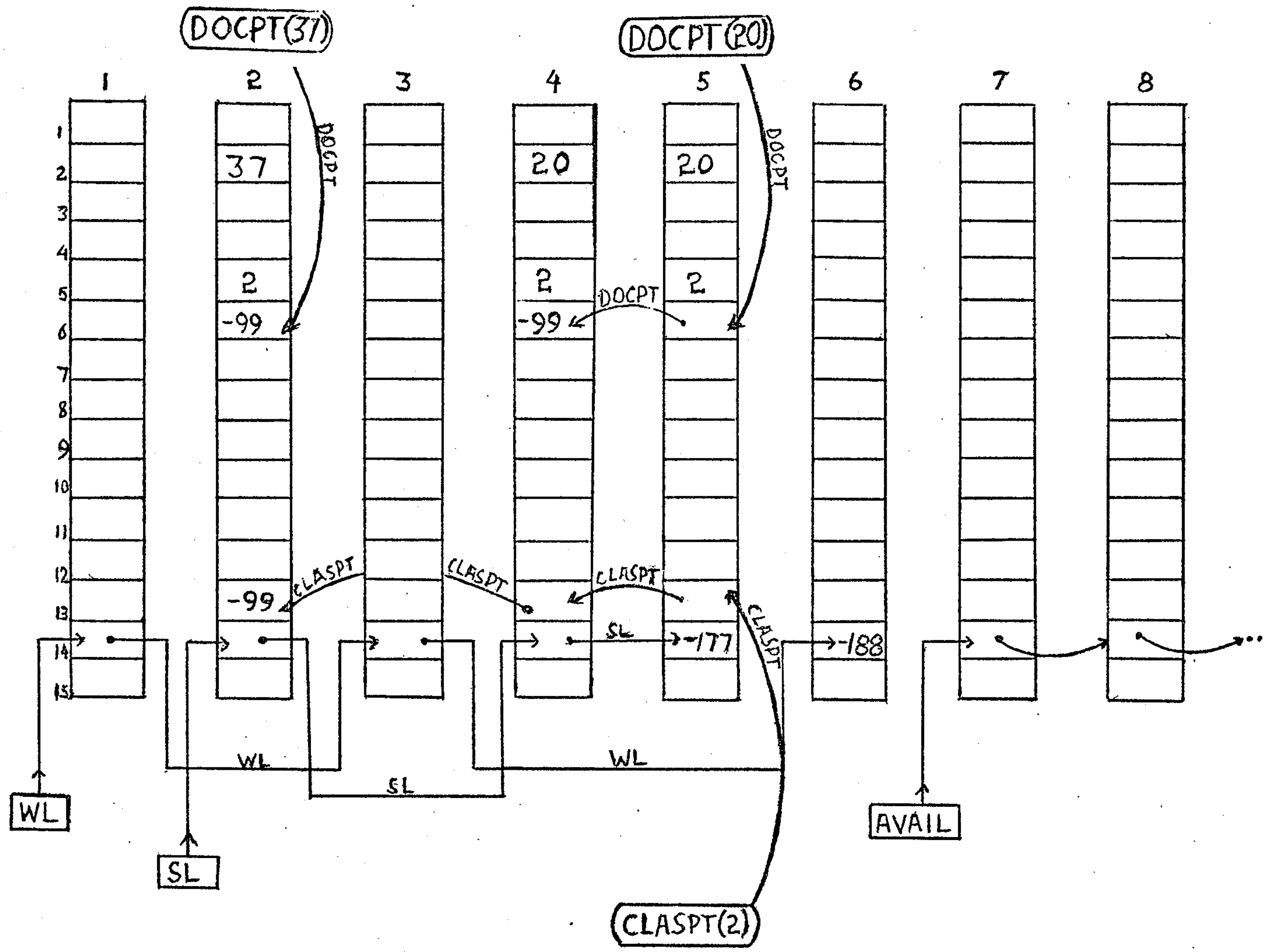
DAY THE REQUEST IS FOR (UPDATED)
SURGEON
SURGERY CLASS
LOS
OPERATING ROOM
LINK BY SURGEON
CANCELLATION/ POSTPONEMENT DECISION INDICATOR
SLATED STARTING TIME
SLATED DURATION
ANESTHESIA
ANESTHESIST
NO. OF DAYS ON WAITING LIST
LINK BY OPERATING ROOM
LINK FOR SLATE, WL, AVAILABLE SPACE
NON-REPLACEABLE CANCELLATION IDENTIFIER

After processing the first day's demand, RQFILE is divided into three distinct sublists: the waiting list, the slate, and the availability list which consists of nodes (columns) to be used for storage of future input. Whereas certain entries of a request node in RQFILE contain information on the nature of the request and its slating status, other entries form "pointer fields". As indicated in Figure 6, the elements within each sublist are joined to each other by pointers. The order in this linkage corresponds to the order in which the requests are generated. Links within each of the three major sublists are unidirectional and always point at the more recent entry onto the list. The leading node in the waiting list, the slate, and the availability list is identified by the value of an external pointer to it, represented by WL, SL, or AVAIL respectively. The last node on the waiting list contains a "dummy" pointer value of -188 while the value of the pointer field in the last node of the slate is -177.

The slate list itself is further subdivided into sublists by each scheduled operating room and sublists by each requesting surgeon. Each component of the one-dimensional array CLASPT (12) corresponds to one of the 12 operating rooms. The value of each component is a pointer to the most recently processed request node assigned to the appropriate room. If no such node exists, the value is a "dummy", -99. Previously processed request nodes that have been assigned to the same operating room are linked together by pointers.

Figure 6

Request linkage in RQFILE



These pointers are unidirectional and point away from the more recently processed node. The last node in a sublist of requests assigned to a particular theatre contains a "dummy" value of -99 in the room pointer field. Sublists by room are used when preparing a printout of the simulated slate, on which the information is segregated by operating room. A similarly structured linking process is employed to subdivide the slated requests by surgeon. The one-dimensional array, DOCPT (39), contains pointers to the most recent request slated for each surgeon. Should no such request exist for a given surgeon, his corresponding value in DOCPT is -99. Although the linking feature by surgeon is not used by the model, it is potentially valuable for outputting scheduled cases segregated by requesting surgeon.

Figure 6 illustrates the request linkage showing the first 8 nodes of RQFILE. The waiting list, identified by WL, consists of nodes 1, 3 and 6 while the slate, identified by SL is formed from nodes 2, 4 and 5. All other nodes, beginning with the 7th, form available space which is as yet unused. Since all the slated requests in the example are slated for room 2, they form an operating room sublist for theatre 2. The list is identified by the pointer value in the second component of CLASPT. Also, slated requests 4 and 5 are from surgeon 20 while request 2 is from surgeon 37. In linkage by surgeon, therefore, requests 4 and 5 form one sublist, which request 2 forms another. Appropriate values in the array DOCPT identify the two sublists.

After the day's slate is appropriately dealt with by the simulator, this list is cleared by SUBROUTINE CLEAR and its nodes are attached to the availability list for receipt of the next day's demand.

Although somewhat difficult to construct in FORTRAN, especially when dealing with "boundary" conditions, the above mentioned list processing features possessed by the simulator are of undeniable value. With core storage being both costly and limited, all information, especially that processed in large volume, must be efficiently represented in the programme. When no longer necessary, information must be abruptly removed to free valuable space. Since the mean number of requests for a given day is indeed fairly high, only efficient storage management makes computerization of the designed model feasible. With an insight into the techniques used in constructing some essential components of the simulator, a more detailed account of the entire programme's operation is now presented.

4.4 Programme operation

The supervisor of the entire simulator is the mainline routine DMAIN. It either performs or delegates to other primary routines the simulator's four main tasks, viz. a) receiving as input particular system characteristics, b) generation of the exogenous daily demand, c) formation of the daily slate, d) production of quantitative evaluative measures and generation of summary reports as output.

4.4.1 System characteristics

DMAIN reads in LOS1 and LOS2 as well as INDEX, providing the simulator with information on post-operative length of stay. DIST, containing the cumulative distribution function for the number of requests for a day, is also received. Calls are then made to particular routines DINFOR and SLINFO to obtain specific characteristics related to demand and slating. DINFOR provides the relative frequency distribution for the occurrence of a particular surgeon's request, as well as the 39 distributions for each surgeon's services over the existing surgery classes. The utility routine CUMUL forms cumulative distribution functions from these distributions. SLINFO provides information on surgery-theatre compatibility in OPRM, as well as availability of a particular surgeon to perform general anesthetic surgery on a particular day in DOCAV. The average length of a procedure from each surgery class is read into LENSUR and the essential information on the block time availability scheme to be used by the simulator is read into BLOCK. Also the availability nodes of RQFILE are initialized by SLINFO.

4.4.2 Exogenous daily demand

Upon a return from SLINFO, a portion of DMAIN is enclosed within a DO-loop, to be performed once for each day of the run. First the number of requests in demand for the day is decided upon by a call to REQGEN. This routine, with its utility EMPIR, makes use of the "Monte Carlo" digital simulation technique. Since the range of function values of a cumulative distribution function is the set of real numbers between 0 and 1, a value of the random variable, r, from the uniform probability density function on the interval (0, 1) is generated. Considering the graph of the C.D.F., a value of x that corresponds to the y-value of r is sought. Should the C.D.F. be strictly monotonically increasing, this inverse transformation method (Maisel & Gnugnoli, 1972, pp. 150-152) would produce a unique x for any r-value, the x-value being a random observation from the distribution the C.D.F. of which is used. However, since the empirical C.D.F. for the number of daily requests is a step function, the method may not yield a unique mapping of r onto x; two different x-values (even two different integers) may correspond to the same r-value. Therefore, in applying the inverse transformation, the graph of the C.D.F. is considered to consist of straight lines, with each line joining the two points with different successive C.D.F. values. This technique of linear interpolation by subroutine INTERP produces a smoothing of the C.D.F., particularly in cases where the C.D.F. value remains unchanged for two successive integers on the x-axis. The generated variate is truncated down to the nearest integer before being returned to the calling routine.

A very important requirement for a simulation of this type is the random pattern of variates generated from the unit interval, (0, 1). Since a programmed generator is, in fact, only pseudo-random, various tests must be performed to detect statistically significant departures from the generator's intended random output. The generator used should be free from both local and global trends. Since several uniform pseudo-random number generators have been developed and tested by qualified researchers, a generating routine of this sort need only be called. The simulator makes use of UNI, a generator of observations from the uniform distribution on the unit interval. The routine, developed and thoroughly tested by G. Marsaglia et al. at McGill University in 1972, will produce the same sequence of random numbers each time if calls to it are preceded by a call to the starter subroutine RSTART. The required random number is produced by an "exclusive or" of two pseudo-random integers, one generated by the congruential method, the other by the "binary shift" technique (Knuth, 1969, p.28). The routine is fast (44 microseconds per call) and well adapted to the System/370 with its 32-bit word size (Arnason, 1973). It is invoked throughout the simulator where a result such as it provides is necessary.

When the number of daily requests is established, a similar procedure is followed in "labelling" each of the requests. The cumulative distribution function for a particular surgeon, then that for a particular surgery class, given the surgeon, are employed to generate specific variates specifying the surgeon and the class for the request. A similar generation technique is used to determine the post-operative length of stay for the request, using the appropriate C.D.F. within LOS1 and LOS2. At this stage, the surgeon, class and LOS completely specify each request in the day's demand which is subsequently stored in RQFILE by a call from DMAIN to the utility routine STORE. With the demand list generated and filed, subroutine SLATER is used for the next segment of the model's design, viz. the actual slating attempt.

4.4.3 Slating attempt

The central routine of the entire simulator, SLATER, is the largest in number of statements as well as the most intricate in coding. It receives the RQFILE daily with the waiting list, the demand list, and a list of yet unused storage. SLATER's main function is to examine each request on the waiting and demand lists, and to employ coded system characteristics (e.g. the block allocation scheme) to produce a revised waiting list and a slate for the day.

After extracting necessary information from BLOCK and initializing various accumulators constructed to aid in slating evaluation, SLATER then examines a request, CURREQ, from RQFILE. The entire waiting list is scanned before the demand list. If the surgery code exceeds 7, the anesthetic is general and DOCAV indicates whether the surgeon has been allocated any block time for the day. If so, the routine ensures that the value of the surgical bed CENSUS does not exceed the limit, BEDLIM, should the request require a surgical bed. Passage through this filter is retroactive in time by one day to ensure an available bed upon arrival as indicated in the design. The cancellation decision filter is encountered next. A request on which a decision has been made regarding cancellation, will have a '1' in the seventh row of its node in RQFILE. Such a characteristic allows the request to bypass the filter for reasons indicated in Sec. 3.3.2. On a first encounter with the filter, UNI is called to decide whether a cancellation by the slating clerk will have occurred. The proposition is confirmed if the generated variate does not exceed the observed relative frequency of slating clerk cancellation, 0.146. Similar decisions are made regarding replaceability of the cancelled request and a possible cancellation by the operating room supervisor. Non-replaceable cancelled requests are assigned a "gap" code by adding 100 to the code of the surgery class. Replaceable cancellations are deleted from the list that supplied them, zeroed, and attached to the availability list.

A request that has passed through or by the above mentioned filters seeks entry onto the day's slate. If the anesthetic is general there must be sufficient block time for the surgeon and hence an available anesthetist. The time left in the first block of the day for surgeon i is recorded in TAVLD (i), with TAVLDA (i) denoting any time remaining in the second block of the day. At times, a request will be postponed at this stage. If this is the first postponement for the request during a 50-day realization, a code of 10 is added to its seventh row in RQFILE, representing the postponement decision indicator. A request possessing this indicator does not contribute to postponement statistics regarding number and time, both of which are recorded for each surgeon in the arrays WNPOST (LDOC) and WTPOST (LDOC).

Locating an appropriate operating room is the next problem. The array DOCLOC records the previous location for the surgeon involved, and that is the first proposed value for CHOICE. Exceptions are made for cystoscopic cases requiring theatre 3 and for 60% of the general anesthetic N.F.A. cases which are assigned directly to theatre 10. The non-zero entries of the array NPOSS constitute possible alternatives. A scan is made through the logical room occupancy array XFRAG, each column of which represents a different theatre. If the case can not begin at the proposed starting time in any of the possible locations, an attempt is made to schedule it 30 minutes later. However, information in ENDD (LDOC), or ENDDA (LDOC) must be examined to ensure that the time advance does not extend the surgical procedure past the end of the surgeon's block time. If no available room is located for the appropriate time, the request remains on or is attached to the waiting list after incrementing the counter LACKRM.

Should the anesthetic be local and the procedure a cystoscopy, operating room 3 is assigned to the request; if the local case is not a cystoscopy the room assigned is 11. Proposed starting time is set to the value of ENDD (LDOC) for the surgeon, i.e. the end of his first block. An XFRAG scan is performed to determine if the assigned room is available for the intended duration. If unavailable, the proposed start time is successively incremented by 30 minutes with an XFRAG scan each time until suitable time is found in the appropriate room. Should the time collide with the surgeon's second block for general anesthetic surgery, or should no suitable time be found following ENDD (LDOC), a similar attempt is made to schedule the entire operation before the start of the surgeon's first block, denoted by STARD (LDOC). Should the requesting surgeon not have block time on the day of his request for a local case, the problem of scheduling around his block(s) is eliminated. Proposed starting time is set at 8:00 and a search for enough consecutive time in the assigned operating room is started. Before admitting acceptance of a proposed time for a local anesthetic case, a check is also made to ensure that a surgeon to be slated for a period of time in room 11 has not already been scheduled for a local cystoscopy in room 3, and vice-versa. This check is accomplished by scanning all requests on the sublist of the current slate associated with the desired room. For example, if a surgeon is to be slated in room 11 from 11:00 to 12:00, all the cases scheduled for room 3 are scanned to see if the same surgeon has not already been scheduled in room 3 for at least some time between 11:00 and 12:00. The pointer to the sublist of requests slated for room 3 is given by CLASPT (3). An unsuccessful slating attempt results in the request's being placed or retained on the waiting list.

A request that is a candidate for the day's slate after the time and room have been agreed upon, is then actually assigned the necessary slating information (line 540). The code of the anesthetist is entered in the 11th row of the request node in RQFILE. The 5th row contains the room number while the 8th row contains the starting time. Length of surgery is located in the 9th row and type of anesthesia in the 10th. The request is "chained" on to its operating room sublist with the value of the pointer to the previously terminal node occupying row 13. Row 6 contains a pointer value with respect to the request's membership on a surgeon sublist. At this point the weekly block time actually used by the surgeon is updated in the array WTUSED (LDOC). Should the request have been postponed earlier the same week because of insufficient but existing block time, its contribution will be present in the value of the weekly accumulator WTPOST (LDOC). Since the purpose of the array WTPOST (39) is to record for each surgeon the weekly time postponed and not yet slated, the length of the operation about to be slated is subtracted from the appropriate component of WTPOST. With complete slating information coded in the node representing the surgical request, and with appropriate accumulators properly adjusted, the request is then attached onto the day's slate (line 31).

As far as programming is concerned, attaching an element of either the waiting or the demand lists to the slate, is fairly involved. As the waiting list is scanned, some of its nodes form the first portion of the linked slate list, while other remain on the waiting list. Requests are not removed from the waiting list according to a familiar last-in first-out or first-in first-out specification. For example, nodes located near the middle of the waiting list may be removed and added to the current end of the slate.

Nodes are not only removed according to an "irregular" pattern from one sublist of RQFILE, but they are, at the same time, attached to another sublist. Care must be taken in properly adjusting the values of the external identifying pointers for the slate and the waiting list, as well as in updating the pointer fields in each list upon a new entry or a deletion. As for the demand list, its nodes are attached to the waiting list, to the daily slate, or in the case of replaceable cancellation, to the availability list (in which case the entries are zeroed). Because rearrangements in each of the three main sublists occur during each simulated day, slate attachment requires particular care in the coding stage. Sufficient information on the operation of this section of the programme must be provided to aid in debugging.

Before actual linking onto the slate, a request that requires hospital admission and is not to be scheduled as a "gap" case causes an update in the previous day's CENSUS. Also, a record is kept on what day the patient is scheduled to leave, since it is known at this stage whether the case will have actually been performed on the day in question. The scheduled future departure is recorded in the array LEAVNG (IFUT), which contains a component corresponding to every day in the realization. For example, if it is known that a patient is scheduled to depart on day 30, the value of LEAVNG (30) is incremented by 1.

After the waiting and demand lists are completely scanned to produce the day's slate, the updated waiting list is rescanned (line 4708). After bypassing requests for local anesthetics, each remaining request, labelled FILREQ, encounters the bed availability and cancellation filters, the structures of which are identical to corresponding filters encountered upon a regular scan. A request passing by or through both filters is ready for a slating attempt. A surgeon JDOC is sought such that his unused first block time can be used to schedule the request from LDOC, the surgeon identified with FILREQ. If JDOC is located, and appropriate operating room is sought in the same manner as in the primary scanning process. For the proposed time which LDOC "takes" from JDOC to be accepted, a) an XFRAG scan must indicate an available operating room, b) there must be no collision with a local anesthetic case that may have already been scheduled for LDOC and, c) the proposed time must be outside the possible block time(s) of LDOC. Condition b) is tested by examining the sublist of all requests on the slates that were made by LDOC. This sublist is identified by the external pointer DOCPT (LDOC). Condition c) uses information on the start and finish times of blocks for LDOC, viz. STARD (LDOC), STARDA (LDOC), ENDD (LDOC), and ENDDA (LDOC). Upon satisfying the conditions, FILREQ is removed from the waiting list and chained onto the slate. In addition, appropriate accumulators on cancellation, postponement, etc. are adjusted along with proper components in the arrays TFIL and WTAKEN. TFIL (JDOC) indicates the amount of time in JDOC's first block that was filled by requests from other surgeons. WTAKEN (LDOC) keeps track of how much block time surgeon LDOC "took" from other surgeons on the rescan.

Throughout the entire slating attempt, particular counters in the form of single valued identifiers or entire arrays are employed to collect useful evaluative information in a logical manner and producing meaningful reports for the simulator's potential users.

4.4.4 Report generation

During a simulation and upon its completion, it is essential for the programme to print out enough relevant information that characterizes those aspects of the system which the simulator is intended to analyze. In addition, the output must be comprehensive enough to inform the analyst whether the machine is indeed performing what the design requires.

In addition to its previously mentioned functions, subroutine SLATER is responsible for outputting the results from an optional monitoring process which describes the processing of each request. SLATER also contains provision for summary reports daily, weekly, and over the entire run. It can output the blocking scheme, surgical bed census information and the simulated slate, for each simulated day.

As an aid in debugging and preliminary model validation, SLATER outputs upon the user's request, a detailed description of its daily workings. The first 160 columns of RQFILE are printed out both before and after the day's slating attempt, along with the pointers to each sublist.

Furthermore, each request processed is identified with the list it is taken from. The number of occupied surgical beds on the previous day is provided with each request, as is the cancellation decision. Should insufficient block time or lack of a free operating room not allow slating, the event is noted. Information is also provided on the choice(s) of operating room considered and proposed starting time(s). General and local anesthetic cystoscopies are specifically identified. In addition to monitoring the processing of individual requests, this "debug option" provides, at the end of each day, a reflection of XFRAG, which denotes scheduled occupancy for each operating room. The programmed commands to output this "debug" information are of the form IF (DEBUG) WRITE (6,xxx).... A value of .TRUE. for the logical variable DEBUG will activate the trace feature.

Besides monitoring information, the potential daily summary provided by SLATER is fairly extensive. The block time allocation scheme is printed out as an array with 8 rows and 7 columns, each column corresponding to an anesthetist. Surgeon codes form the components of the array, the information of which is to be read by column. Information follows on the previous day's census of occupied surgical beds. The census at the start of the day is reported, along with the number of scheduled departures. The next section of the report consists of a printout of the simulated effective slate. Information headings are: Room, Time, Surgery Class, Surgeon, Anesthetist, Schedules Duration and No. of Days on WL, before being slated. Slated requests are sorted by operating room, The starting time is on a 24-hour scale, and scheduled requests that will not have been performed are labelled with a '(G)' following the denotation of surgical class. Following the simulated slate printout is a daily summary which characterizes the schedule produced. Information is provided on the dynamics of the slating process, cancellation, and postponement. An attempted evaluation of the process is presented, followed by statistics on slated operating room utilization for each theatre individually and over all available theatres in total.

Information reported on the operation of the simulated slater (Figure 7) includes: 1) the number of requests on the waiting list from the previous day, 2) the number of requests slated from the WL, 3) the number of requests removed from the WL by replaceable cancellation, 4) the number of requests slated from the WL specifically during the rescanning process, 5) the size of the exogenous daily demand, 7) the number of requests added to the WL, 6) the number of demand requests replaceably cancelled, 8) the number of requests slated directly from the generated demand and, 9) the total number of requests for the day to be slated. The amount of information reported is quite sizeable, since the simulation is to provide as much insight as possible into the operation of the observed system.

The type of information produced also provides inherent consistency checks on the simulator's operation. When the number of requests slated from the WL on a particular

Figure 7

A daily summary report

SUMMARY FROM SIMULATED SLATE ON DAY 48

SLATING:

NO. OF REQUESTS ON WL FROM YESTERDAY: 395

NO. OF REQUESTS SLATED FROM WL: 28

NO. OF REQUESTS CANCELLED FROM WL: 1

NO. OF REQUESTS SLATED ON RESCAN OF WL: 1

EXOGENOUS DAILY DEMAND: 35

NO. OF DEMAND REQUESTS CANCELLED (REPLACEABLE): 4

NO. OF REQUESTS ADDED TO WL: 29

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 1

TOTAL NO. OF DAILY REQUESTS SLATED: 30

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 8

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 3

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 6

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 262

NO. OF AVAILABLE SURGICAL BEDS: 140

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 0

EVALUATION:

FRACTION OF EXAMINED REQUESTS WITH INSUFFICIENT (EXISTING) BLOCK TIME: 0.609

FRACTION OF EXAMINED REQUESTS SLATED: 0.070

AVERAGE NO. OF DAYS ON WL FOR A SLATED REQUEST: 9.448 ST. DEV.: 6.063

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	37.5	62.5	62.5	75.0	56.3	37.5	0.0	0.0	0.0	12.5	0.0	0.0
PERCENTAGE SLATED IDLE TIME	62.5	37.5	37.5	25.0	43.8	62.5	100.0	100.0	100.0	87.5	100.0	100.0

OVERALL PERFORMANCE:

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 38.19

PERCENTAGE SLATED IDLE TIME OVER ALL OPERATING ROOMS AVAILABLE: 61.81

day (2) plus the number of requests removed from the WL by cancellation (3) are subtracted from the sum of the number of requests on the WL from the previous day (1) and the number of requests added to WL (7), the net result should equal the number of requests on the WL (1), on the following day's report. Also, when the total number of daily requests slated (9) minus the number of requests slated from the waiting list (2), is added to the sum of the number of requests added on to the WL (7) and the number of demand requests cancelled (6), the net result should yield the value of the exogenous daily demand. Summarized, the verification procedures with respect to waiting list processing (I) and accounting for exogenous demand (II) can be written in equation form as follows:

I. $(1) - [(2) + (3)] + (7) = (1)^{*}$

* - next day's report

II. $(7) + (6) + (9) - (2) = (5)$

Cancellation and postponement information consists of the number of requests: 10) cancelled by the slating clerk, 11) cancelled by the O.R. supervisor, 12) "gapped" because of abrupt cancellation and, 13) postponed because of insufficient block time. Item 14, the number of available surgical beds is provided for reference, since it is followed by 15) the number of requests postponed because of an unavailable bed. Finally, 16) information on the number of requests postponed because of lack of a free operating room is reported.

The fraction of examined requests with insufficient but existing block time, along with the fraction of requests slated, attempt to provide quantitative evaluation of the slating process. An additional measure reported is the average number of days spent on the WL by a request not slated directly from the day's demand. As an indication of dispersion in the waiting time distribution, the standard deviation, is also produced.

Operating room utilization statistics provided in the daily report are the slated utilization and slated idle time percentages for each of the 12 existing theatres. These figures are summarized in the "overall performance" evaluation, by utilization and idleness percentages totalled over all those operating theatres that are not designated unuseable. It is to be noted that the utilization statistics are derived from the slate only and, therefore, no stochasticity is introduced into the length of each surgical procedure.

Besides the daily reports, weekly summary statistics are also provided by SLATER (Figure 8). Slating information consists of: 1) the number of requests on the WL at the start of the week, 2) the number of requests generated during the week, 3) the number of requests slated during the week and, 6) the fraction of requests slated. The number of requests slated directly from the daily demand (4), and 5) the number of requests slated on the rescan of the waiting list, are presented. Viewing the slating system as a "single server" process, 7) the average number of days a request that must

Figure 8

A weekly summary report

WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FOR WEEK # 10

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 382

NO. OF REQUESTS GENERATED DURING WEEK: 213

NO. OF REQUESTS SLATED: 170

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 28

NO. OF REQUESTS SLATED ON RESCAN OF WL: 10

FRACTION OF REQUESTS SLATED: 0.29

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 10.80 ST. DEV.: 57.53

AVERAGE NO. OF REQUESTS ON DAILY WL: 392.00 ST. DEV.: 8.49

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 32

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 24

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 31

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 158

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 10

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	33.8	86.3	35.0	82.5	43.8	52.5	0.0	0.0	0.0	63.8	21.3	0.0
PERCENTAGE SLATED IDLE TIME	66.3	13.8	65.0	17.5	56.3	47.5	100.0	100.0	100.0	36.3	78.8	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 46.53

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	68.8	80.0	76.3	77.5	82.5	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 77.00

wait remains on the WL and, 8) the average number of requests on the daily waiting list, are reported with their corresponding standard deviations. Information provided on cancellation, postponement, and utilization of operating rooms is similar to that in the daily report. An additional feature in the weekly summary is slated anesthetist utilization. The percentage of time each anesthetist in the system is occupied, is reported, with the programme's recognizing that an abruptly cancelled "gap" surgery will cause anesthetist idleness. These anesthetist occupancy figures are then averaged. Thus, the simulated system is evaluated from several points of view, viz. that of the patient and surgeon having to wait for the request to be scheduled, that of the operating room manager wishing to utilize the theatres as much as possible and that of the anesthetist, who is remunerated by the case and wishes to avoid idleness.

To allow further insight into the performance of a particular block time allocation scheme, several accumulated statistics and calculated indices are reported weekly by individual surgeon (Figure 9). For each of the 39 surgeons the block time allotted and that actually scheduled for use, are presented. In addition, the time each surgeon has "taken" from others during rescans of the waiting list is reported along with the block time "given away" by each surgeon to others during the week. Further, three performance indices are calculated for each surgeon:

1) The Block Utilization Index = (block time scheduled + block time given) ÷ (block time allotted).

Figure 9

A weekly report by surgeon

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYST

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	630	0	0	0.88	0.13	1.33
2	180	180	0	0	1.00	0.0	2.33
3	180	150	0	0	0.83	0.17	0.83
4	180	0	0	180	1.00	0.0	0.0
5	0	0	0	0	0.0	0.0	0.0
6	240	240	0	0	1.00	0.0	2.13
7	180	180	0	0	1.00	0.0	1.00
8	480	480	0	0	1.00	0.0	2.75
9	780	750	0	0	0.96	0.04	1.92
10	180	180	0	0	1.00	0.0	1.50
11	120	90	90	0	0.75	0.25	2.75
12	660	600	0	0	0.91	0.09	2.14
13	120	90	0	0	0.75	0.25	0.75
14	60	60	0	0	1.00	0.0	1.00
15	240	240	0	0	1.00	0.0	3.63
16	480	450	0	0	0.94	0.06	2.06
17	360	360	0	0	1.00	0.0	1.00
18	480	420	0	60	1.00	0.0	1.33
19	840	720	0	60	0.93	0.07	1.14
20	60	60	0	0	1.00	0.0	4.00
21	300	300	0	0	1.00	0.0	1.00
22	120	120	0	0	1.00	0.0	2.75
23	420	390	0	0	0.93	0.07	2.00
24	60	60	0	0	1.00	0.0	2.00
25	180	180	0	0	1.00	0.0	2.50
26	300	300	0	0	1.00	0.0	2.40
27	180	180	0	0	1.00	0.0	2.67
28	180	60	0	90	0.83	0.17	0.33
29	180	180	0	0	1.00	0.0	2.00
30	180	180	0	0	1.00	0.0	2.00
31	360	270	0	90	1.00	0.0	0.75
32	120	0	0	90	0.75	0.25	0.0
33	60	0	0	60	1.00	0.0	0.0
34	240	210	0	0	0.88	0.13	0.88
35	480	420	0	0	0.88	0.13	1.75
36	480	270	0	180	0.94	0.06	0.75
37	1080	1050	720	0	0.97	0.03	3.67
38	180	150	0	0	0.83	0.17	1.83
39	60	60	0	0	1.00	0.0	1.00

BLOCK UTILIZATION	MEAN:	0.92	STANDARD DEVIATION:	0.17
FRAGMENTATION INDICATORS	MEAN:	0.05	STANDARD DEVIATION:	0.08
REQUEST UTILIZATION	MEAN:	1.65	STANDARD DEVIATION:	1.03

****

This index measures the fraction of a surgeon's block time that has been scheduled for use.

2) The Fragmentation Index = (block time unused) ÷ (block time allotted). It measures the relative size of unused "fragments" in each surgeon's blocks.

3) The Request Utilization Index = (block time scheduled + block time taken + unslated time postponed) ÷ (block time allotted). The index provides information as to how much block time each surgeon would require, as compared to the amount of time he has been allotted.

With a request utilization of 2.88, for example, we know that the particular surgeon would have required 2.88 times his presently allotted block time in order to schedule all of his requests during the week.

Mean values and standard deviations, calculated over all surgeons, are provided for each of the three indices to end the weekly summary.

Upon completion of one 50-day realization of the slating process, summary statistics are provided for the entire run (Figure 10). The format resembles the weekly summary, including a detailed account of time utilization and fragmentation for every surgeon in the system.

Although the reports obtainable from the system are quite diverse and numerous, it may not be desirable to produce

Figure 10

A summary for the entire run

SLATING:

NO. OF REQUESTS ON WL AT START OF RUN: 0

NO. OF REQUESTS GENERATED DURING RUN: 2138

NO. OF REQUESTS SLATED: 1690

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 433

NO. OF REQUESTS SLATED ON RESCAN OF WL: 365

FRACTION OF REQUESTS SLATED: 0.79

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 3.17 ST. DEV.: 18.01

AVERAGE NO. OF REQUESTS ON DAILY WL: 86.42 ST. DEV.: 60.51

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 314

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 295

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 339

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 891

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 53

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	29.9	71.0	45.4	66.9	63.5	49.3	0.8	0.0	0.0	43.5	28.0	0.0
PERCENTAGE SLATED IDLE TIME	70.1	29.0	54.6	33.1	36.5	50.8	99.3	100.0	100.0	56.5	72.0	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 44.24

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	72.1	70.6	73.9	74.4	68.1	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 71.82

all of them during the entire run. Having on hand enough evaluative information in the weekly and the overall run summary, reports such as block and bed census information, the simulated slate and the daily summary, are relegated to a secondary status. They would be desired for only a short period of time, when more extensive monitoring of the system's behaviour is warranted. Thus, logical valued suppressor codes, COVER1, COVER2, and COVER3 are incorporated into the programme, with each suppressing the printout of particular information. A value of .TRUE. for COVER1 excludes the printout of block schemes, surgical bed census and daily slates. COVER2 suppresses daily summary reports, while COVER3 allows only the printout of the summary for the entire realization.

Report generation, however, is not limited to the subroutine SLATER. The calling supervisor, DMAIN, has provisions to output the daily exogenous demand, listing each request generated, and identifying the surgeon, the surgery class, and the post operative LOS. This listing precedes the daily slating reports and can also be suppressed. A particular routine has been constructed, however, to provide an overall summary linking the phases of demand generation and slating attempt in the simulator. SUBROUTINE REPGEN, a call to which is made only once by DMAIN, contains provisions for several reports to be provided upon completion of the simulation.

REPGEN produces reports on surgery requested and that actually performed, with information on the latter events being provided by the daily slates. The first report provides surgery "performance" ratios, by surgeon. The fraction of requests for surgery that the existing system has allowed each surgeon to perform, is reported along with the number of cases requested and performed. The second report produces performance ratios by surgery class. More detailed reports follow, indicating request and performance statistics by surgery class for each individual surgeon and by surgeon for each surgery class. Finally, a report on surgeon-class request frequencies, in 39 by 39 array form is provided, from which is obtained similarly formatted information on surgeon-class request probabilities. The latter can be compared to the values read into the model, with a good fit providing additional "trust" in the model. Following are similar reports on surgeon-class performance frequencies and probabilities, completing the volume of information that REPGEN may be called upon to produce.

A potential user of the model may be inclined to request for only a subset of the possible reports, since some may be either too general or too detailed for the user's particular purpose. Thus, in addition to the COVER codes, the main parameter of REPGEN is METHOD, an integer variable taking on a value between 1 and 4. This feature allows for variability in type and volume of reports generated, a very desirable feature in such a system which produces extensive information.

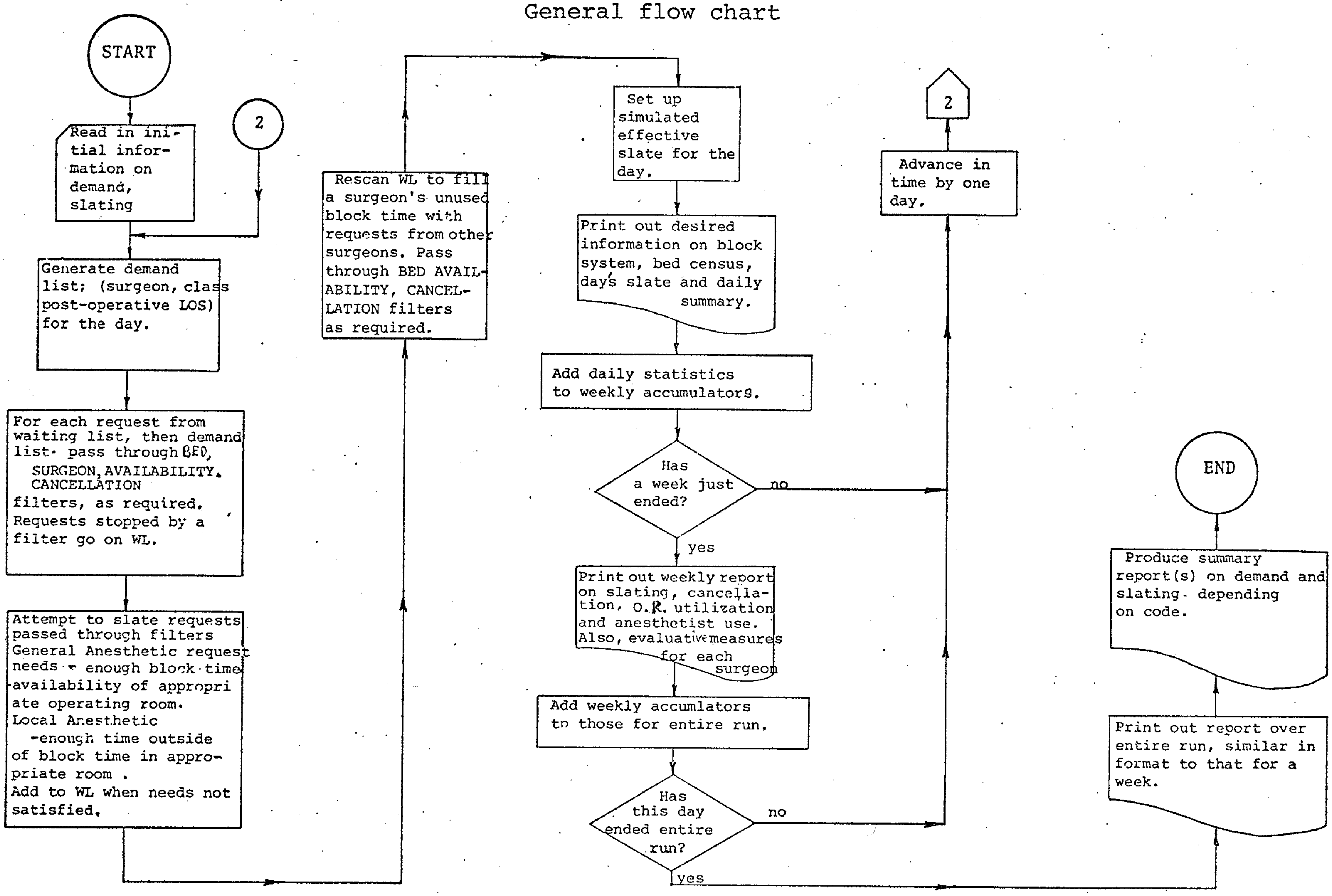
4.5 Summary

The constructed routines of the simulator follow the logic of the design. A modular programme written in a general purpose scientific application language allows an approach of construction in stages which are evident in the general flow chart (Figure 11). Moreover, it is the construction phase which links observed reality with available computer technology, illustrating a distinct area of contemporary computer application.

Generation of variates from supplied empirical distributions adds to the versatility of the model, while the various codes representing the simulated system's attributes illustrate the applicability of the analytic, structural viewpoint. The output from the programme is designed to contain, in precise numeric form, much meaningful information on the system's performance. The format of the output is intended to allow rapid orientation for a person familiar with the slating system, but not necessarily with modelling or programming detail. The volume of information provided may be extensive or brief, avoiding abuse of peripheral resources. With a constructed simulator ready for computer execution, the stage is set for several levels of model experimentation.

Figure 11

General flow chart



CHAPTER FIVE

EXPERIMENTATION WITH THE MODEL

5.1 Initial preparation

After the construction of a computer programme to simulate the main events of the surgical slating system, several preparatory steps were taken to ensure validity in experimentation. Since the functioning of the slating system depends largely on the nature of the exogenous demand, the demand generated for a period of 50 days was analyzed. It was necessary to ensure that there were no significant departures from the information in the observed data base. The cumulative distribution function (C.D.F.) for the observed number of requests for a given day was compared with that formed from the variates generated by the programme. The maximum difference between the two functions, taken over the entire range of the random variable, was 0.06. Because this difference was small, it was concluded that no error could be detected in generating variates from the distribution of the number of daily requests. In verifying the input further, the generated distributions of the number of requests from each surgeon, the number of requests for each surgery class and the distributions of post-operative LOS were compared with their observed counterparts. With the surgeon code and the observed relative frequency of the surgeon's requests, an empirical cumulative distribution function was formed, treating the surgeon code as the random variable. A similar C.D.F. was formed using programme generated relative frequencies. The maximum deviation between the two cumulative distribution functions was 0.03, indicating a very good fit. An identical procedure with the distribution of the number of requests from each surgery class yielded an even smaller maximum deviation of 0.02. A visual verification showed no apparent discrepancy between the generated length of stay figures and those input to the programme. This accurate generation of exogenous demand was not surprising, since variates were generated not from theoretical distributions, but from empirical cumulative distribution functions with which the resulting distributions were then compared.

After successful validation of the generated input, the entire simulator was put through several preliminary runs. Each run, simulating a period of 50 surgical days, was made with a "zero start", i.e. the system contained no requests on the waiting list and no recovering patients before the first simulated day. The internal structure of the existing slating system was closely reflected. The assigned block allocation scheme was quite similar to the one actually used during the observation period at the Victoria General Hospital. Five anesthetists were in use, with 130 surgical beds. Since it is essential to have a good indication that the programmed simulator is indeed operating without logic errors or programming "bugs", consistency checks mentioned in the previous chapter were performed on the daily output for several simulated weeks. In addition, the DEBUG option was activated for several days to ensure correct list processing in the handling of the waiting and daily demand lists.

Since the hospital was not empty when the 50-day data collection and observation period began, it was desired to eliminate any possible adverse effects of a "zero start" in the simulator. Values of various output measures were compared from the first few weekly reports. An attempt was made to determine at what point in time the simulated system would reach "steady state". According to Emshoff and Sisson (1970) steady state is achieved when any perceptible non-periodic time trends have disappeared from all variables describing the state of the system. Since the generated demand is labelled for a particular day, and since the rescanning process attempts to fill unused gaps in each surgeon's block time, stability was seemingly achieved in the first few weeks. The weekly number of requests slated oscillated around 170, the number of requests cancelled by the slating clerk, around 31, and the number of requests "gapped" around 34. The slated operating room utilization, averaged over 9 theatres, was a few percentage points from 48% throughout the first 8 weeks. The average percentage of time that an anesthetist is occupied showed no significant departure from 73%.

However, the effect of a"zero start"was not completely eliminated either by the net effect property of the generated demand or by the rescanning process. Surgeons who do not perform many cases per week did not ask for time until several weeks from the start of the run. The number of requests slated on rescan, which is reported weekly, showed a significant decline from 53 on week 1 to 17 on week 8. As more requests were generated and stored, surgeons filled up more of their own block time, since even those surgeons who make requests rarely had accumulated enough requests.

Two other major complications occurred in determining steady state. The waiting list, a conceptual mechanism introduced in the design of the model to identify a delay factor associated with each surgeon's request, was constantly increasing in size. It had grown from 0 requests at the start to 426 at the end of the tenth week. Surgical bed shortage became evident by the 7th week, resulting in a lower average block utilization, 0.86, as compared to a fairly stabilized 0.92 during the previous four weeks.

Since the large size of the waiting list was at least partially caused by a lack of beds, the bed availability question was investigated further. A request in reality may have been made and permanently cancelled before the question of bed availability arose. In the model, however, such a request will have been identified, passed through the bed availability filter, and only then probabilistically labelled as a replaceable cancellation. This, in turn, causes the number of cases postponed because of lack of beds to be higher in the model than in reality. Also, requests for two procedures on one patient in reality were modelled as two separate requests involving two patients, resulting in twice the bed demand for such occurrences. Based on the argument that the generated input consists of more requests than were actually handled in reality (although it represents quite well the number of requests considered by the real system), the upper limit on the bed census was raised to 140 beds, a number considered large enough to avoid excessive bed shortage that was not observed in reality.

Before rerunning the simulator with a new surgical bed limit, it was decided to adjust the model in such a way as to allow it to perform two consecutive 50-day realizations without interruption. The first 50 days (10 weeks) would act as a "work-up" period, which would provide a waiting list, bed census, and patient departure information for the second 50-day run. All other accumulators would be cleared and reinitialized after the "work-up" period. Since the postponement accumulators will have been zeroed, the postponement decision indicator would need to be eliminated from each request located on the waiting list before the second run. The second realization would provide more information on the behaviour of the waiting list and on the apparent stability of other output measures. With provisions made for two successive realizations, the simulator produced weekly reports on 20 consecutive simulated weeks.

The first 10 weeks were simulated under the same conditions as in the previous runs except for the increase in bed capacity. A significant difference in results was that the average block utilization did not fall below 0.90 during the 8th, 9th, and 10th weeks. The size of the waiting list, which was still ever increasing was reduced to 382 requests after 10 weeks from the previous 426. The second 10-week period confirmed stability of the model with regard to the weekly number of requests slated and the number of requests cancelled, both by slating clerk and by the operating room supervisor. The number of requests slated on the rescan of the waiting list settled down to approximately 18 per week.

However, except for a period of two weeks, the size of the waiting list showed no sign of stabilization and had risen to 621 at the end of the 20th week. The bed census, which had ceased to be a problem during the first 50-day run, was again causing the average block and anesthetist utilization figures to drop, from the 17th week on. At this stage, it was evident that a more detailed investigation was required into the behaviour of the waiting list and the inadequacy of the number of surgical beds.

5.2 Detailed model validation

5.2.1 The waiting list

Since most requests do pass through the bed availability filter and require a general anesthetic, the main structure influencing the placement of a request on the waiting list is the block time allocation scheme. Using average figures, a throughput analysis was done on the blocking system used by the model to determine the number of requests each surgeon's block(s) could slate. The block structure was viewed analytically as a "single-server", processing requests that arrive weekly. For each surgeon, a relative frequency distribution was obtained as to the number of his requests for procedures from particular surgery classes. With the duration assigned to these classes known, an average length of a surgeon's requested procedure was calculated. When this figure (in minutes) was divided into the total weekly block time allotted to the surgeon, an average number of requests put through by the surgeon's block(s) was obtained.

For example, if a surgeon had requested 20 procedures from class 5 and 30 procedures from class 14 over the observed 50 days, a relative frequency of 20/50 = .40 would be assigned to class 5 and 30/50 = .60 to class 14 for this surgeon. Knowing that the duration assigned to a class 5 operation is 30 minutes and that of a class 14 operation is 60 minutes, the average time per request for the surgeon would be calculated as .40 x 30 + .60 x 60 = 48 minutes. If this same surgeon had 240 minutes of block time per week, he would put through 5.0 requests weekly. The results of such calculations for all the surgeons, based on observed request data and assigned block time are presented in Table 1. Summing the weekly throughput statistics over all 39 surgeons; a figure of 164.3 was obtained.

Table 1

Weekly request throughput (average) for each surgeon

Surgeon	Avg. length/ procedure	Block time allotted (mins.)	Weekly throughput
1	77.4	720	9.3
2	75.3	180	2.4
3	62.2	180	2.9
4	91.4	180	2.0
5	0.0	0	0.0
6	72.1	240	3.3
7	89.7	180	2.0
8	60.3	480	8.0
9	67.8	780	11.5
10	85.2	180	2.1
11	82.0	120	1.5
12	60.1	660	11.0
13	73.1	120	1.6
14	60.0	60	1.0
15	89.7	240	2.7
16	60.4	480	8.0
17	60.1	360	6.0
18	88.8	480	5.4
19	78.6	840	10.7
20	60.0	60	1.0
21	74.0	300	4.1
22	89.4	120	1.3
23	69.5	420	6.1
24	60.0	60	1.0
25	70.4	180	2.6
26	64.6	300	4.6
27	60.0	180	3.0
28	76.6	180	2.3
29	79.5	180	2.3
30	83.9	180	2.2
31	84.9	360	4.3
32	105.0	120	1.1
33	60.0	60	1.0
34	67.2	240	3.6
35	67.6	480	7.1
36	93.4	480	5.1
37	65.7	1080	16.4
38	64.8	180	2.8
39	60.0	60	1.0

A weekly arrival rate for requests entering the blocking system was then calculated from the observed data base. With requests for two surgical procedures on the same patient considered as two different requests, and with an estimated 50 requests for Good Friday, 2344 requests were presented to the slating system in reality. From these, 243 were for a local anesthetic and did not require block time. Approximately 13% of the remaining 2101 requests were replaceable cancellations, leaving 1828 requests to be serviced by the blocking system in 10 weeks. Thus, with λ, the weekly arrival rate being 182.8 and μ, the weekly (maximum) service rate, 164.3, the blocking system used in the model posesses a utilization factor, $\rho = (\frac{\lambda}{\mu})$ of 1.11. From queueing theory (Hillier and Lieberman, 1967, p. 300) it is known that if ρ exceeds 1.0, the size of the queue for the single server will not reach equilibrium, but will continue increasing. It is noteworthy that this analytic approach does not assume any fragmentation of block time, which would make ρ even larger. Thus, the fact that the size of the waiting list in the model had not stablized in the preliminary runs is not unusual. It is evident that the surgical demand, which usually posesses seasonal variation in size, was relatively high during the 10 weeks of observation.

5.2.2 The surgical bed census

Apart from the instability of the waiting list, the lack of available surgical beds during the second of two consecutive 10-week periods, was investigated. The upper limit on the bed census had been increased to 140 and no problem in this area was encountered during the first 50 simulated days. After a thorough search, it was realized that while a 50-day "work-up" period directly preceeding the 50-day realization to be analyzed may have displayed some advantages, it did create an unforeseen problem. The demand distribution used in the model consists of requests labelled exclusively as for a certain day, irrespective of when these requests had actually been made. Thus, the demand distribution, with its net effect property, itself accounts for all requests made for a particular 50-day period, making the incoming waiting list cause excessive demand for the second 10-week realization. The 382 requests on the waiting list at the end of the 10th week, when added to 2271 generated for the following 10-week period, presented the system with 2653 requests for slating consideration. This figure was excessively high and did not represent reality. It was also identified as the main cause of the surgical bed shortage during the second 50-day realization.

5.2.3 Adjusting the demand distribution

A decision regarding strategy for further experimentation had to be made at this point. Since most evaluative measures stabilized within the first two or three weeks (except for the size of the waiting list and the number of requests slated on the rescan), a choice had to be made regarding the use of a "work-up" run. On the one hand, a "zero start" proved to have fewer disadvantages than had been anticipated. On the other hand, a "zero start" would make any output measures regarding the waiting list quite unrealistic. While the waiting list in the model is indeed only conceptual (being related to the waiting of all requests presented for slating consideration), it is nevertheless a well-defined performance measure of the simulated system. Since no exact counterpart exists in the system being simulated, it provides additional information which might be quite significant in evaluating other blocking system alternatives, where it might reach equilibrium. Should the waiting list be made use of following the "work-up" run, the demand distribution would have to be altered.

Since it was decided that the concept of a waiting list is indeed desirable, several runs were made whereby the mean of the distribution of the number of requests for a given day was decreased without otherwise changing the shape of the distribution. The procedure used was to shift the cumulative distribution function to the left so that the smallest x-value for which the C.D.F. value is not zero would be reduced. A necessary condition was that the number of requests generated from the C.D.F. for the second consecutive 50 days, when added to the size of the waiting list at the end of the first 50 days, would yield a number approximately equal to 2350 (since 2344 requests occurred in reality). A reduction by 3 of the mean daily demand yielded 2211 requests for the second 50 days, with an incoming waiting list of 178 requests.

This procedure in no way altered the distribution of the code of the surgeon making a particular request nor the distribution of the code of the surgery class asked for. The throughput efficiency of the slating system, in reality as well as in the model, depends largely on the number of requests that exist each day for slating consideration. Although the total demand generated for a given day from the adjusted distribution is, in expectation, smaller by 3 requests from the figure that the original distribution would have provided, there exists, nevertheless, a sizeable number of requests on the waiting list, which is considered for slating each day. Thus, the adjustment in the input distribution was not expected to cause major changes in the evaluative measures, and the model would not lose in validity, with all analysis limited to the second of two consecutive 50-day realizations. Henceforth, a "simulation run" will refer to this second realization only.

5.2.4 Further model verification

Having arrived at a "standard" demand distribution and having fixed the upper limit of 140 surgical requests, weekly reports (Appendix 5) from the simulation run were then analyzed in an attempt to ensure no further unexpected inconsistencies. The number of weekly requests slated varied from 163 to 178 over the 10 weeks. The number of cancellations varied from 42 to 75. The operating room utilzation percentage, averaged over the 9 rooms in use, showed a minimum value of 44.03% and a maximum of 49.86%.

The average anesthetist utilization ranged from 71.00% to 80.00%. The block utilization ratio, averaged weekly over the 39 surgeons vaired from 0.87 to 0.93, with 6 out of 10 observations being either 0.91 or 0.92. The values for each of the above mentioned measures, when examined in the order of their occurrence, showed considerable fluctuation between the reported minimal and maximal values, therefore no tendency of continual increase with time was observed. A bed shortage occurred only during the 9th week, but did not reappear in the 10th week. The size of the waiting list, which was expected to increase with time for the reasons given in Sec. 4.2.1, rose from 178 at the start of the run to 382 at the start of the 10th week. The above mentioned results demonstrate sufficient stability in the model's operation from week to week.

However, before using the model for experimentation, it is indeed essential to formulate a large degree of confidence in the model's adequate reflection of the system it was designed and constructed to simulate. Thus, in addition to having investigated stability over time, a test of the model's robustness with respect to a different seed value for the pseudo-random number generator was performed. Also, tests of the model's sensitivity were performed by increasing and decreasing the number of requests presented for slating. Finally, the summarized results for the entire simulated run were compared with related measures deduced from the data base characterizing the real slating system at the Victoria General Hospital.

5.2.5 Robustness of the model

As discussed in Sec. 4.4.2, the function UNI, which generates pseudo-random numbers, is started by a call to the subroutine RSTART. With the second of two seed values required as input to RSTART set to 0 permanently, the first seed value of 946316767 (seed a) had been used in all runs. Another seed value (seed b) which would not cause a reproduction of most of the same sequence of UNI variates, was obtained by calling the function IVNI (Arnason, 1973) at the end of the run. Results from a simulated run using the new seed value, which should not differ significantly from values produced in the previous run, were then compared. The summary from the run using seed a (run 1) is presented in Table 2, with the results of changing to seed b, (the value of which was -20576933) presented in Table 3 (run 2).

With regard to slating, both runs yielded a fraction of requests slated equalling 0.72. In run 1 2389 requests were examined, either generated during the run or from the incoming waiting list, while in run 2, the corresponding figure was 2345. 1714 requests were slated in run 1 and 1693 in run 2. The average number of days a waiting request remained on the waiting list was 7.89 in run 1 and 7.95 in run 2. The average number of requests on the daily waiting list was 264.84 in run 1 and 262.46 in run 2. As for cancellation, a total number of 586 requests were cancelled in run 1 and 615 in run 2. Out of these, 311 were not replaceable (gaps) in run 1,

Table 2

Summary from run 1

SUMMARY FROM ENTIRE RUN OF 50 SIMULATED DAYS AFTER A 50 DAY STABILIZATION PERIOD
****

SLATING:

NO. OF REQUESTS ON WL AT START OF RUN: 178

NO. OF REQUESTS GENERATED DURING RUN: 2211

NO. OF REQUESTS SLATED: 1714

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 298

NO. OF REQUESTS SLATED ON RESCAN OF WL: 195

FRACTION OF REQUESTS SLATED: 0.72

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 7.89 ST. DEV.: 42.54

AVERAGE NO. OF REQUESTS ON DAILY WL: 264.84 ST. DEV.: 82.11

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 331

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 255

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 311

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 1462

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 337

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 59

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	26.1	77.1	44.9	69.8	63.8	56.9	1.9	0.0	0.0	46.0	29.3	0.0
PERCENTAGE SLATED IDLE TIME	73.9	22.9	55.1	30.3	36.3	43.1	98.1	100.0	100.0	54.0	70.8	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 46.18

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	75.4	73.8	77.6	72.4	75.9	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 75.00

Table 3

Summary from run 2

SUMMARY FROM ENTIRE RUN OF 50 SIMULATED DAYS AFTER A 50 DAY STABILIZATION PERIOD
****

SLATING:

NO. OF REQUESTS ON WL AT START OF RUN: 215

NO. OF REQUESTS GENERATED DURING RUN: 2130

NO. OF REQUESTS SLATED: 1693

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 253

NO. OF REQUESTS SLATED ON RESCAN OF WL: 143

FRACTION OF REQUESTS SLATED: 0.72

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 7.95 ST. DEV.: 42.83

AVERAGE NO. OF REQUESTS ON DAILY WL: 262.46 ST. DEV.: 64.57

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 320

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 295

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 337

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 1489

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 81

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	36.1	69.0	41.9	66.3	61.6	51.4	0.8	0.0	0.0	47.9	26.4	0.0
PERCENTAGE SLATED IDLE TIME	63.9	31.0	58.1	33.8	38.4	48.6	99.3	100.0	100.0	52.1	73.6	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 44.58

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	68.1	75.5	71.9	73.9	74.9	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 72.85

and 337 in run 2. The number of requests which were postponed at some time during the simulated 10 weeks was 1462 in run 1 and 1489 in run 2. Run 1 showed 337 requests not finding a surgical bed (all during the 9th week), while run 2 did not report a surgical bed shortage. The utilization averages for operating room time, as slated, were 46.18% and 44.58% respectively for the two runs. These utilization percentages appeared quite low in both cases, since they were averages taken over all operating rooms available to the slating system, and some rooms (particularly 7) were rarely used. The average anesthetist occupancy percentages were 75.00% and 72.85%. Since the two runs are independent realizations of the same process in which randomness is involved, the close agreement in most output measures adds a degree of confidence to the model's operation. The agreement also shows that the utilization averages are calculated over a sufficient number of data points for the Central Limit Theorem (Freund, 1962, pp. 185-187) to operate and to reduce the variance of the means. The observed sample means are therefore close to the true "theoretical" mean, and their numerical values are trustworthy system descriptors. In addition, the fact that no bed shortage was evident in run 2 and that the bed census reached its limit during one week in run 1, indicated that an acute bed occupancy problem did not now exist in the simulated system.

5.2.6 Sensitivity tests

As a test of the model's sensitivity to change in input, the exogenous demand was increased to handle 2510 requests in the 50-day period (run 3). Another experiment decreased the demand, obtained from the incoming waiting list as well as generated, to only 1603 requests (run 4). To avoid predictable difficulties with bed availability, run 3 was assigned a bed census limit of 300. Changes in the evaluative measures were then observed for run 3 (Table 4) and compared to those from run 1, which handled a demand corresponding to reality.

The number of requests slated in run 3 was 1691, as compared with 1714 in run 1. The size of the incoming waiting list increased from 178 to 363 in run 3. The average waiting time increased from 7.89 days to 13.37 days and the average size of the daily waiting list increased from 264.84 to 450.36. A significant increase in run 3 was in the number of requests postponed because of lack of a free operating room, from 59 requests to 359. The average operating room and anesthetist utilization figures were 46.18% and 75.00% in run 1, and 45.10% and 73.57% in run 3. The block utilization, averaged over 39 surgeons, increased by only 0.01 in run 3. Thus, the model did prove sensitive to an increased demand, reflecting this in those output measures which are dependent on demand size. Nevertheless, the model also indicated an inherent limitation on the slating system's operation, since the number of requests slated, and the operating room and anesthetist utilization did not increase with a higher input of requests.

Results from run 4 (Table 5) demonstrated the

Table 4

Summary from run 3

SUMMARY FROM ENTIRE RUN OF 50 SIMULATED DAYS AFTER A 50 DAY STABILIZATION PERIOD
****

SLATING:

NO. OF REQUESTS ON WL AT START OF RUN: 363
NO. OF REQUESTS GENERATED DURING RUN: 2140
NO. OF REQUESTS SLATED: 1691
NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 296
NO. OF REQUESTS SLATED ON RESCAN OF WL: 169
FRACTION OF REQUESTS SLATED: 0.68
AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 13.37 ST. DEV.: 70.53
AVERAGE NO. OF REQUESTS ON DAILY WL: 450.36 ST. DEV.: 59.50

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 303
NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 271
NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 323
NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 1691
NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0
NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 359

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	33.0	71.6	43.4	65.8	67.3	50.8	1.1	0.0	0.0	41.8	31.3	0.0
PERCENTAGE SLATED IDLE TIME	67.0	28.4	56.6	34.3	32.8	49.3	98.9	100.0	100.0	58.3	68.8	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 45.10

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	72.4	73.4	75.5	73.9	72.8	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 73.57

Table 5

Summary from run 4

SUMMARY FROM ENTIRE RUN OF 50 SIMULATED DAYS AFTER A 50 DAY STABILIZATION PERIOD
****

SLATING:

NO. OF REQUESTS ON WL AT START OF RUN: 31

NO. OF REQUESTS GENERATED DURING RUN: 1572

NO. OF REQUESTS SLATED: 1361

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 578

NO. OF REQUESTS SLATED ON RESCAN OF WL: 575

FRACTION OF REQUESTS SLATED: 0.85

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 2.11 ST. DEV.: 10.26

AVERAGE NO. OF REQUESTS ON DAILY WL: 26.46 ST. DEV.: 5.19

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 254

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 260

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 300

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 248

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 30

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	24.0	71.0	37.3	56.9	48.5	35.0	1.5	0.0	0.0	19.9	21.1	0.0
PERCENTAGE SLATED IDLE TIME	76.0	29.0	62.8	43.1	51.5	65.0	98.5	100.0	100.0	80.1	78.9	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 35.01

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	66.4	61.4	62.0	43.6	55.9	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 57.85

model's sensitivity to a significant demand decrease. Only 1361 requests were slated, and more requests had to be slated on the rescan, since surgeons who do not request often did not request surgery every week. The operating room utilization average dropped from 46.18% in run 1 to 35.01% in run 4. Anesthetist utilization dropped from 75.00% to 57.85%. The average waiting time and the average size of the waiting list dropped considerably in the 4th run. In fact, stabilization of the waiting list was achieved. Table 6 shows the size of the waiting list at the start of each week in the run 4 realization. The results verify the fact that only an excessively high load in the other runs did not allow the waiting list to settle. In addition, the fraction of requests slated in run 4 was 0.85, which is indeed close to the maximum of 0.875 (since 0.125 of the requests are replaceable cancellations). Thus, the sensitivity tests give further evidence as to the model's validity.

5.2.7 Comparison with observed data

As a last major step in the validation procedure, the summary results from run 1 were compared to corresponding figures observed in reality. During the 50 surgical days for which data were gathered by the slating clerk, 2186 requests were made. Out of these, 447 requests were slated beyond the observation period, either because of the system's inability to slate them sooner (196) or because of the surgeons' specifically requesting a later time (251). 161 requests were placed in the waiting slot (hospital personnel call it their Waiting List), meaning that no

Table 6

Size of WL in simulation of the system with low demand

I = Week	Size of WL at start of week I
1	31
2	23
3	23
4	24
5	28
6	31
7	42
8	23
9	26
10	24

definite decision could be arrived at on their slating upon their arrival. It is unknown how many of the 161 requests were actually slated during the observation period.

Removing 447 + 161 from 2186 leaves 1578 requests considered as candidates for slating. An estimated 50 requests were added, assuring the system operated on Good Friday (since the one surgical day was missing from observed data), leaving 1628 candidates obtained during the observation period. In addition, 211 requests were recorded as having been made before the study period for times during the period which started with day 9. No record of such "outside" requests for days 1 to 8 was made, and a figure of 148 was estimated, yielding 359 candidates coming from before day 1 for slating during the 50 observed days. Adding 359 to 1628 gives 1987 candidates for slating. Since approximately 13% of the requests were replaceably cancelled and therefore not slated, the number of estimated requests slated in reality (including those to be later scratched off the slates) is at least 1987 x 0.87 = 1727. This figure is a lower bound because the number slated from the 161 requests placed in the waiting slot is not known. Had all 161 requests been slated during the observation period, the total number slated would be 1888, an upper bound. The total number of requests for the 50-day period was estimated as 1888 (slated at most) + 196 (not slated during period) + 260 (replaceable cancellations) = 2344. Thus, the fraction of requests slated in reality lies between 0.735 and 0.804. Copies of actual slates for the observation period, which would have provided a more accurate figure, were unavailable at the VGH at the time validation was being performed. Actual records for operating room and anesthetist utilization were not looked into.

Comparing results from run 1 with observed reality, the model considered 2389 requests and slated 1714; in reality 2344 requests were encountered and of these at least 1727 were slated. The model had a waiting list with 395 requests after 50 days; in reality, at most 357 requests could not be slated. The slating clerk cancelled 331 requests in the model and 318 requests in reality.

Regarding operating room utilization, anesthetist utilization and the utilization of block time, both the slating clerk and the operating room manager at the VGH were consulted. Indications were that the "general purpose" theatres are in use for a large portion of the day. The figures from the model may be biased towards a greater use of theatres 2 and 4 because the search for a room is made in ascending order of the room number. Room 7 is used rarely, agreeing with the model's results. In all, no significant discrepancy was indicated with regard to the model's report on slated utilization of the operating theatres. The figures for anesthetist utilization also generally agreed with reality. Although the block allocation scheme used by the model (Table 7) was not identical to

Table 7

Regular block time allocation scheme

Entries consist of surgeon codes; rows correspond to time of block reservation, columns correspond to anesthetists (1-7)

Monday

Time	1	2	3	4	5	6	7
800	1	4	6	9	10	0	0
900	1	4	6	9	10	0	0
1000	1	4	6	9	10	0	0
1100	1	19	6	9	11	0	0
1200	33	19	39	8	11	0	0
1300	38	19	37	8	36	0	0
1400	38	9	37	8	36	0	0
1500	38	9	37	8	36	0	0

Tuesday

Time	1	2	3	4	5	6	7
800	1	37	15	26	18	0	0
900	1	37	15	26	18	0	0
1000	1	37	15	26	18	0	0
1100	20	37	15	21	19	0	0
1200	12	37	17	21	19	0	0
1300	12	13	17	21	19	0	0
1400	12	13	17	21	19	0	0
1500	12	13	17	21	19	0	0

Wednesday

Time	1	2	3	4	5	6	7
800	0	0	0	0	0	0	0
900	1	25	28	12	9	0	0
1000	1	25	28	12	9	0	0
1100	1	26	28	12	17	0	0
1200	23	26	8	34	17	0	0
1300	23	27	29	34	19	0	0
1400	24	27	29	34	19	0	0
1500	37	27	29	34	19	0	0

Thursday

Time	1	2	3	4	5	6	7
800	1	22	30	23	37	0	0
900	1	22	30	23	37	0	0
1000	32	8	30	23	37	0	0
1100	32	8	9	23	37	0	0
1200	16	12	9	23	25	0	0
1300	16	12	9	31	3	0	0
1400	16	12	9	31	3	0	0
1500	16	12	9	31	3	0	0

Friday

Time	1	2	3	4	5	6	7
800	35	16	18	31	36	0	0
900	35	16	18	31	36	0	0
1000	35	16	18	31	36	0	0
1100	37	16	18	35	36	0	0
1200	37	8	18	35	36	0	0
1300	37	7	19	35	2	0	0
1400	37	7	19	35	2	0	0
1500	37	7	19	35	2	0	0

the scheme in reality, but was only based on it (for example, the modelled scheme does not allow sharing blocks), it was indicated that in reality approximately 92% of the block time is utilized for slating. Averaged over all surgeons, the model produced a mean block utilzation of 0.91 with a standard deviation of 0.16.

After a fairly extensive analysis of the modelled system, it became evident that the model does reflect the desired aspects of the real slating system in a satisfactory manner. The next step, therefore, was to plan several experiments to illustrate the model's use.

5.3 Experimentation strategy

The main purpose of modelling the surgical slating system at the Victoria General Hospital was to evaluate some effects of different block time allocation schemes without having to actually implement these schemes in the hospital setting. With a satisfactorily validated model on hand, experimentation can indeed prove worthwhile, particularly so in the case of digital computer simulation.

Because of the speed with which today's computer executes its instructions, it was possible to achieve a simulated 10-week realization of the slating process, including a 10-week "work-up" period, in a matter of tens of seconds. Using the resources of an IBM System 370/158 and the FORTRAN H compiler, 93.03 seconds of Central Processing Unit time were used. The particular compiler requires considerable core storage in exchange for a fast compilation, and its error messages are quite cryptic. The WATFIV compiler was therefore used in the initial runs of programme development, and required 191.54 seconds of C.P.U. time for the same job. With computing time being reasonable, several strategies were undertaken to provide quantitative bases for possible future planning.

Four different block time allocation methods were investigated. Method A corresponded to the system in use during the observation period. It contained five anesthetists and the blocking scheme in Table 7. Methods B and C used four and six anesthetists respectively. The blocking schemes were formed by basing the changes from the scheme in method A on each surgeon's request utilization statistics reported in the A summary (Table 8). Tables 9 and 10 show the exact nature of the time allocation used in methods B and C.

The size of the exogenous demand for each of the three methods was generated from the "standard" distribution used in run 1 of Sec. 4.2.3. In fact, the simulation run providing information on method A was none other than run 1 itself. As mentioned earlier, a run for each of the three methods originally called for a 50-day "work-up" period, followed by a realization of 50 days providing the evaluative output. In method B, however, with the demand being the same as for A, but with only 4 anesthetists on hand, a problem was experienced with the inclusion of a "work-up" period. The size of the waiting list in B increased much more

Table 8

Summary by surgeon from run A

SURGEON STATISTICS (OVER ENTIRE SIMULATION RUN):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	7200	6300	0	330	0.92	0.08	1.30
2	1800	990	0	690	0.93	0.07	0.90
3	1800	1620	0	90	0.95	0.05	1.68
4	1800	570	0	1110	0.93	0.07	0.42
5	0	0	0	0	0.0	0.0	0.0
6	2400	2130	390	210	0.97	0.02	1.81
7	1800	1140	0	540	0.93	0.07	0.67
8	4800	4620	690	0	0.96	0.04	2.52
9	7800	7260	1620	0	0.93	0.07	2.64
10	1800	1560	0	150	0.95	0.05	1.37
11	1200	900	510	60	0.80	0.20	2.57
12	6600	6240	450	0	0.95	0.05	2.31
13	1200	690	150	300	0.82	0.17	1.07
14	600	240	0	300	0.90	0.10	0.40
15	2400	1800	570	540	0.97	0.02	2.15
16	4800	4560	0	0	0.95	0.05	2.05
17	3600	2520	0	990	0.97	0.02	0.72
18	4800	3690	0	810	0.94	0.06	0.98
19	8400	5160	0	2490	0.91	0.09	0.80
20	600	600	0	0	1.00	0.0	2.80
21	3000	2490	0	360	0.95	0.05	0.95
22	1200	870	90	270	0.95	0.05	1.70
23	4200	3930	330	0	0.94	0.06	2.00
24	600	480	60	120	1.00	0.0	1.60
25	1800	1470	270	180	0.92	0.08	1.78
26	3000	2850	210	0	0.95	0.05	2.28
27	1800	1800	840	0	1.00	0.0	3.10
28	1800	990	0	570	0.87	0.13	0.58
29	1800	900	0	810	0.95	0.05	0.85
30	1800	1470	60	270	0.97	0.03	1.37
31	3600	2790	90	570	0.93	0.07	1.38
32	1200	540	90	390	0.77	0.22	0.60
33	600	0	0	600	1.00	0.0	0.0
34	2400	1980	0	120	0.88	0.13	1.26
35	4800	3960	150	0	0.82	0.17	1.49
36	4800	3840	90	810	0.97	0.03	1.31
37	10[illegible]00	10200	7260	0	0.94	0.06	3.91
38	1800	1740	60	0	0.97	0.03	2.23
39	600	300	0	300	1.00	0.0	0.80

BLOCK UTILIZATION	MEAN:	0.91	STANDARD DEVIATION:	0.16
FRAGMENTATION INDICATORS	MEAN:	0.06	STANDARD DEVIATION:	0.05
REQUEST UTILIZATION	MEAN:	1.50	STANDARD DEVIATION:	0.88

****

Table 9

Block time allocation with 4 anesthetists

Entries consist of surgeon codes; rows correspond to time of block reservation, columns correspond to anesthetists (1-7)

	Monday							Tuesday							Wednesday							Thursday							Friday						
Time	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7	1	2	3	4	5	6	7
800	1	4	6	9	0	0	0	1	37	15	26	0	0	0	0	0	0	0	0	0	0	1	22	30	23	0	0	0	35	16	18	31	0	0	0
900	1	4	6	9	0	0	0	1	37	15	26	0	0	0	1	25	28	12	0	0	0	1	22	30	23	0	0	0	35	16	18	31	0	0	0
1000	10	11	6	9	0	0	0	1	37	15	26	0	0	0	1	25	28	12	0	0	0	32	30	8	23	0	0	0	36	16	18	31	0	0	0
1100	10	11	6	36	0	0	0	20	37	18	21	0	0	0	1	26	17	12	0	0	0	32	37	8	3	0	0	0	36	16	18	35	0	0	0
1200	33	19	39	36	0	0	0	12	37	18	21	0	0	0	23	26	17	24	0	0	0	16	37	9	3	0	0	0	37	8	2	35	0	0	0
1300	38	19	37	8	0	0	0	12	13	17	21	0	0	0	23	27	29	34	0	0	0	16	12	9	3	0	0	0	37	19	2	35	0	0	0
1400	38	9	37	8	0	0	0	12	13	17	19	0	0	0	8	27	29	34	0	0	0	16	12	9	31	0	0	0	37	19	7	35	0	0	0
1500	38	9	37	8	0	0	0	36	14	17	19	0	0	0	9	27	29	34	0	0	0	16	12	9	31	0	0	0	37	19	7	35	0	0	0

Table 10

Block time allocation with 6 anesthetists

Entries consist of surgeon codes; rows correspond to time of block reservation, columns correspond to anesthetists (1-7)

Monday

Time	1	2	3	4	5	6	7
800	1	4	6	9	10	37	0
900	1	4	6	9	10	37	0
1000	1	4	6	9	10	37	0
1100	1	19	6	9	11	37	0
1200	33	19	39	8	11	20	0
1300	38	19	37	8	36	27	0
1400	38	9	37	8	36	16	0
1500	38	9	37	8	36	16	0

Tuesday

Time	1	2	3	4	5	6	7
800	1	37	15	26	18	8	0
900	1	37	15	26	18	8	0
1000	1	37	15	26	18	8	0
1100	20	37	15	21	19	8	0
1200	12	37	17	21	19	16	0
1300	12	13	17	21	19	38	0
1400	12	13	17	21	19	38	0
1500	12	14	17	21	19	38	0

Wednesday

Time	1	2	3	4	5	6	7
800	0	0	0	0	0	0	0
900	1	25	28	12	9	37	0
1000	1	25	28	12	9	37	0
1100	1	26	28	12	17	37	0
1200	23	26	8	34	17	37	0
1300	23	27	29	34	19	37	0
1400	24	27	29	34	19	12	0
1500	37	27	29	34	19	12	0

Thursday

Time	1	2	3	4	5	6	7
800	1	22	30	23	37	34	0
900	1	22	30	23	37	34	0
1000	32	8	30	23	37	35	0
1100	32	8	9	23	37	35	0
1200	16	12	9	23	25	35	0
1300	16	12	9	31	3	37	0
1400	16	12	9	31	3	37	0
1500	16	12	9	31	3	37	0

Friday

Time	1	2	3	4	5	6	7
800	35	16	18	31	36	9	0
900	35	16	18	31	36	9	0
1000	35	16	18	31	36	9	0
1100	37	16	18	35	36	9	0
1200	37	8	18	35	36	9	0
1300	37	7	19	35	2	27	0
1400	37	7	19	35	2	27	0
1500	37	7	19	35	2	20	0

rapidly than in A, leaving 482 requests on the list at the end of the first 50 days, compared to 178 such requests in A. As a result, the number of requests presented to B for slating during the second 50 days was abnormally high, causing a request file overflow in the simulator programme. It was therefore decided to increase the mean of the distribution of daily demand for method B, such that the generated demand would consist of approximately 2350 requests for the first 50-day period. Then, for method B only, results were recorded from the "work-up" period (with increased input) and not from the second 50-day realization. Because the rescanning feature (Sec. 4.4.3) causes rapid stabilization in nearly all evaluative measures except those concerning the waiting list, most results obtained from the first realization should be as reliable as those which would have followed a "work-up" run. Figures regarding the waiting list would not have the same meaning without a "work-up" and were therefore ignored for method B.

In addition, sensitivity tests, such as those that had been applied to method A during the validation process, were also performed on methods B and C. Thus, the three methods were examined with a below normal request input (yielding methods A-, B-, and C-), and subsequently with the size of the input being raised above the "standard" level (in methods A+, B+, and C+). As planned, results from the second 50-day period were recorded in each sensitivity test.

Method D examined yet another way of establishing an alterante block time allocation scheme, apart from varying the number of anesthetists. The "work-up" run of D was identical in all aspects to that of method A. In fact, since all the random aspects of the model make use of a sequence of programmed, pseudo-randomly generated variates, the output from the "work-up" of D was identical to that of A. The property of being able to perform the same experiment twice (or more) and to achieve entirely identical results, is a unique and very desirable feature found only in simulation experiments (Conway, 1963, p 52). However, after the first five weeks following the "work-up" in method D, the entire block allocation scheme was dynamically restructured. Additional coding was provided in subroutine SLATER which would zero the previous block array and produce a new structure. Request utilization ratios (block time used + block time taken + unslated time postponed) ÷ (block time allotted)), which had been calculated for each surgeon for the first 5-week period, were multiplied by the allotted weekly block times to form preliminary reallocation weights. When each of these weights was divided by the sum of the preliminary weight figures, actual reallocation weights resulted. These actual weights determined the amount of weekly block time each surgeon was to receive. For example, with only 2 surgeons in the system, surgeon 1, allocated 360 minutes with a utilization ratio of 0.33 would yield a preliminary weight of 360 x .33 = 120. Surgeon 2, allocated

420 minutes, with a utilization ratio of 3.0 would produce 420 x 3.0 = 1260 as a preliminary weight figure. With actual reallocation weights for the two surgeons being 120/1380 and 1260/1380, and with the total time available being 420 + 360 = 780 minutes, surgeon 1 would be assigned 68 minutes (120/1380 x 780), while surgeon 2 would be assigned 712 minutes (1260/1380 X 780). In order to adapt to the hourly allocation restriction, surgeon 1 would actually receive 60 minutes of block time and surgeon 2 would receive 720 minutes. An entirely new block allocation scheme was produced after the fifth simulated week. This scheme was adaptive to a measure of previous system performance (Table 11). Five anesthetists were retained throughout the method D realization, and sensitivity tests were not performed. The purpose of method D was to determine the effect of periodically restructuring the block allocation scheme, assuming the nature of the exogenous demand will not change.

5.3.1 Observed results

Main results from experiments using methods A, B, and C, along with their counterparts with intentionally decreased (A-, B-, C-) and increased (A+, B+, C+) demand distributions are summarized in Table 12. Information on request slating, operating room and anesthetist utilization and average utilization of surgeons' blocks is presented and analyzed.

The primary characteristics of each of these methods are first outlined for easy reference:

Table 11

Dynamically reallocated block time with 5 anesthetists

Entries consists of surgeon codes; rows correspond to time of block reservation, columns correspond to anesthetists (1-7)

Monday

Time	1	2	3	4	5	6	7
800	1	37	7	9	11	0	0
900	1	37	8	9	11	0	0
1000	1	37	8	9	12	0	0
1100	1	37	8	9	12	0	0
1200	1	37	8	9	12	0	0
1300	1	37	8	9	12	0	0
1400	1	37	8	9	12	0	0
1500	2	37	8	10	12	0	0

Tuesday

Time	1	2	3	4	5	6	7
800	37	16	37	21	23	0	0
900	37	16	37	21	23	0	0
1000	37	16	37	22	24	0	0
1100	37	16	37	23	25	0	0
1200	37	16	9	23	25	0	0
1300	37	17	9	23	26	0	0
1400	37	17	9	23	26	0	0
1500	37	18	9	23	26	0	0

Wednesday

Time	1	2	3	4	5	6	7
800	0	0	0	0	0	0	0
900	26	27	31	34	36	0	0
1000	26	28	31	35	36	0	0
1100	26	29	31	35	36	0	0
1200	27	30	31	35	37	0	0
1300	27	30	32	35	37	0	0
1400	27	31	33	36	37	0	0
1500	27	31	34	36	37	0	0

Thursday

Time	1	2	3	4	5	6	7
800	37	1	9	12	18	0	0
900	37	8	9	12	18	0	0
1000	37	8	9	12	19	0	0
1100	38	8	9	12	19	0	0
1200	38	8	9	23	19	0	0
1300	38	8	12	37	19	0	0
1400	39	9	12	37	19	0	0
1500	1	9	12	37	20	0	0

Friday

Time	1	2	3	4	5	6	7
800	9	37	37	3	12	0	0
900	9	37	37	3	13	0	0
1000	12	37	37	4	14	0	0
1100	10	37	37	5	15	0	0
1200	10	37	37	6	15	0	0
1300	10	37	37	6	15	0	0
1400	2	37	37	6	16	0	0
1500	2	37	37	6	16	0	0

Method A: "standard" demand distribution, 140 surgical beds, 5 anesthetists, intended to reflect reality.

Method A-: "low" demand distribution, 140 surgical beds, 5 anesthetists.

Method A+: "high" demand distribution, 300 surgical beds, 5 anesthetists.

Method B: "high" demand distribution, 140 surgical beds, 4 anesthetists, no "work-up" period!

Method B-: "low" demand distribution, 140 surgical beds, 4 anesthetists.

Method B+: "high" demand distribution, 300 surgical beds, 4 anesthetists.

Method C: "standard" demand distribution, 140 surgical beds, 6 anesthetists.

Method C-: "low" demand distribution, 140 surgical beds, 6 anesthetists.

Method C+: "high" demand distribution, 300 surgical beds, 6 anesthetists.

The primary purpose for performing these experiments was to investigate the effects of altering block allocation by reducing the number of anesthetists to four, and then increasing the number of six. Since the block time allocation structure is the central component of the slating system and since the structure is related directly to the number of anesthetists in use, experimental results provided some valuable insight into the slating system's operation.

Table 12

A summary of experimentation results

	Method	B	A	C	B-	A-	C-	B+	A+	C+
(1)	No. of requests considered	2185	2389	2215	1990	1603	1710	- *	2503	2409
(2)	Fraction of requests slated	0.66	0.72	0.82	0.68	0.85	0.87	-	0.68	0.82
(3)	Average waiting time/request	--	7.89	4.65	10.24	2.11	1.82	-	13.37	3.27
(4)	Average size of daily WL	--	264.84	132.28	287.78	26.46	17.20	-	450.36	80.92
(5)	Stabilization in WL ?	N	N	Y	N	Y	Y	N	N	Y
(6)	Insufficient block postponements	1393	1462	1091	1281	248	227	-	1691	902
(7)	Unavailable bed postponements	0	337	1647	0	0	0	-	0	0
(8)	O.R. lack postponements	26	59	596	31	30	134	-	359	809
(9)	Average O.R. utilization %	36.10	46.18	48.94	35.50	35.01	39.06	-	45.10	52.33
(10)	Average anesthetist utilization %	71.16	75.00	67.10	71.47	57.85	53.35	-	73.57	71.08
(11)	Average block time utilization	0.87	0.91	0.80	0.88	0.71	0.63	-	0.92	0.87
(12)	Standard deviation in (11)	0.17	0.16	0.19	0.17	0.24	0.27	-	0.16	0.18

* - no results available - request file overflow

a) A runs (5 anesthetists):

With the "standard" block structure, it was immediately noticed that the fraction of requests slated in A and A+ was sufficiently below the maximum of 0.87. Since the size of the waiting list did not reach equilibrium in methods A and A+, the demand proved too high for the system to handle. In A, the main reason for this fact was the evident lack of sufficient block time.

Method A+, with an even higher input, demonstrated that in addition to a lack of block time, a lack of operating rooms is apparent.

With a low demand, method A- showed the waiting list stabilizing. A request for a given day that was not slated on that day was required to "wait" an average of 2.11 days. This figure was considered reasonable.

The most interesting fact deduced from the A-runs, however, was found in operating room (O.R.) and anesthetist utilization. As the demand was increased in A+, the operating rooms and the anesthetists were not utilized more, implying that the system in A was already operating under a heavy load.

b) B runs (4 anesthetists):

When a reduction was made to 4 anesthetists, in the B-runs, the results were quite predictable. The fraction of requests slated dropped considerably because of a lack of block time previously associated with the 5th anesthetist. The waiting list did not stablize, as expected.

The number of requests in B postponed because of insufficient (existing) block time dropped from that in A, because only 4/5 of the existing block time in A was available in B.

The number of surgical beds was adequate as was the number of operating rooms. The operating rooms, were in use approximately 78% (36.10/46.18) of the time used in A. Thus, the percentage decrease in O.R. utilization was approximately equal to the percentage decrease in block time (80%) a hypothesis which, if corroborated by further experimentation, might prove to be quite useful.

On the average, an anesthetist in B was not more occupied than an anesthetist in A. Since, in reality, an anesthetist is assigned to one "column" of blocks covering the 8 hour time span for surgery, removal of one anesthetist should not necessarily increase the amount of time each remaining anesthetist (who is assigned to his own "column") is occupied. With a large enough demand, anesthetist utilization depends strictly on utilization of existing block time and on the number cases which have been cancelled and cannot be replaced in time.

With an increase in demand, the B+ run caused an overflow in the request file after the 4th week following the "work up". No results on this run were tabulated.

Use of a lower demand and a "work-up" period in B- did not change the O.R., anesthetist, and average block utilization figures from those in run B with no 50-day "work-up". Even with a lower demand, the waiting list did not stabilize in B-, indicating the demand was still too high for only 4 anesthetists.

c) C runs (6 anesthetists):

An increase to 6 anesthetists automatically provided 120% of the available block time offered by A. The extra block time aided considerably in the throughput of requests as evidenced by the stablization of the waiting list, even with a higher demand in method C+.

With an increase in throughput, however, a serious lack of both surgical beds and available operating rooms was noticed. With the bed census limit increased to 300 from 140 in C+, 809 requests were postponed because of a lack of an appropriate operating room. Primarily as a result of the lack of O.R. facilities, the block time utlization average was lower (0.87) in C+ than in A (0.91). A lack of surgical beds further lowered the block time utilization to 0.80 (in C).

The anesthetist, whose utilization is directly related to that of block time, was (on an average) occupied less than in A (67.10% in C and 71.08% in C+ as compared to 75.00% in A). An immediate benefit of adding the extra anesthetist, however, was that the waiting time was substantially reduced for a request that had not been slated directly from daily demand. Such a situation would be beneficial to both patient and surgeon.

The hypothesis arising from the B-runs that the percentage increase in block time should yield an approximately equal percentage increase in the average O.R. utilization, was difficult to verify, since O.R. and bed availability was not adequate. However, the fact was established that an adequate availability of operating rooms and surgical beds is a necessary (but perhaps not sufficient) condition for not rejecting the hypothesis.

5.3.2 A proposed alternative

Since operating room availability could actually be increased at the Victoria General Hospital (theatre 12 had been left deliberately idle), the results from the C runs initiated an analysis into the possibility of adding a 6th anesthetist to the actual slating system. While the results from method C leave no doubt as to the fact that an extra anesthetist would increase the request throughput and decrease waiting under the specified demand load, several questions had to be answered regarding the effect of such a decision on operating room and anesthetist utilization.

Since the number of surgical beds can not be increased in reality, results from C indicate that approximately 550 additional requests could have been slated in 10 weeks had sufficient operating theatre(s) been made available. Attempting to slate 55 requests per week in the additional theatre(s) would require at least 3575 minutes (using a conservative estimate of 65 minutes for the duration of a procedure with a general anesthetic). Since a maximum of 2400 minutes would be available in the extra room 12, at most 37 additional requests could be slated per week. A more realistic estimate, realizing that individual operating room utilization rarely exceeds 70% because of other constraints, would reduce 37 to 26. With an additional room in use 70% of the time, the O.R. utilization average would increase from 48.94% to 51.10%.

The hospital administration's objective is to maximize the throughput of patients in a given time, subject to structural constraints such as the surgical bed limit and the existing number of operating rooms. Results from run C imply that use of an additional operating room would indeed cause a higher weekly throughput of surgical patients. Such a decision, however, would create an extra cost for the use of all additional O.R. personnel and for such items as linen, necessary drugs, and other supplies. Should the number of patients put through per week seem satisfactory enough with 5 anesthetists, a detailed cost vs. benefit analysis for using the additional theatre would seem in order.

From the point of view of the five existing anesthetists, the addition of a 6th anesthetist, as modelled in run C, would be beneficial only if the average anesthetist utilization were to be greater than or equal to that in run A (i.e. 75%). The reason for this is that the group of working anesthetists is awarded a fee for each surgical procedure. The money accumulated for the group is then divided among all the members of the group. Thus, should a 6th anesthetist lower the average anesthetist utilization, his presence would lower the income of each of the initial five anesthetists. With no additional operating room provided and 6 anesthetists in use, run C showed that the anesthetist utilization figure did decrease from 75.00% to 67.10%.

Should room 12 be opened and utilized approximately 70% of the time, about 26 more cases would be slated per week.

Assuming equal distribution among all the anesthetists, an additional average of 4.33 requests would be slated by each anesthetist per week. Out of these 4.33, a certain "gap fraction" will consists of non-replaceable cancellations which do not contribute to anesthetist use. Since a "gap" request occurs when i) the cancellation is made by the slating clerk and is not replaceable or ii) the cancellation is not made by the slating clerk but by the operating room supervisor. The value of this "gap fraction" was obtained by applying results from probability theory (La Valle, 1970, p.83) to observed relative frequencies.

Prob (gap request) = Prob (cancellation by slating clerk AND non-replaceable cancellation)

+

Prob (no cancellation by slating clerk AND cancellation by O.R. supervisor).

= Prob (cancellation by slating clerk)

x

Prob (non-replaceable cancellation given that a cancellation by slating clerk has occurred)

+

Prob (no cancellation by slating clerk)

x

Prob (cancellation by O.R. supervisor given that no cancellation by slating clerk has occurred).

$\therefore$ Prob (gap request) = 0.15 x 0.15 + 0.85 x 0.17

= 0.167

With 0.167 as the "gap fraction", an average of only 3.61 additional requests per week would contribute to an anesthetist's utilization. Using the request duration figure of 65 minutes, each anesthetist would receive 235 extra minutes of work weekly, yielding an additional 9.8% average utilization. This would increase the anesthetist utilization figure from 67.10 in run C to 76.90, justifying the addition of a 6th anesthetist to the system, provided the demand had not been extraordinarily high during the observation period. Since several unsubstantiated assumptions (e.g. 70% utilization of the additional room, an even spread of additional cases over all anesthetists, average length of a surgical procedure) were used to arrive at this conclusion, further experimentation with the model would have to be performed in this regard before making definite recommendations.

5.3.3. Effects of adaptive blocking

As previously mentioned, an experiment was performed with method D, whereby the block allocation scheme of method A was entirely restructured by the simulator itself after the 5th week. The new blocking system was based on each surgeon's utilization of his initially assigned time. Table 11 shows the dynamically reallocated block times obtained in method D. A comparison of the 10-week summary results from D with those from A is presented in Table 13.

Table 13

Evaluative measures for an adaptive blocking system

	Method	A	D
(1)	Fraction of requests slated	0.72	0.74
(2)	Average waiting time/request	7.89	7.38
(3)	Average size of daily WL	264.84	237.40
(4)	Insufficient block postponements	1462.00	1469.00
(5)	Average O.R. utilization %	46.18	45.93
(6)	Average anesthetist utilization %	75.00	74.75
(7)	Average block time utilization	0.91	0.94
(8)	Standard deviation in (7)	0.16	0.05
(9)	Average request utilization	1.50	1.54
(10)	Standard deviation in (9)	0.88	0.66

Although the restructured block system was in effect for only the last 5 weeks, method D already showed an increase in the fraction of requests slated during a 10-week period. The average waiting time figure, although obtained for an unstabilized queueing system, showed signs of a decrease. A significant result occurred in the average block time utilization figures in which D showed an increase of .03 with noticeably less dispersion. This indicated a more uniform utilization fraction for each of the surgeons' blocks. Request utilization data showed less variability among the surgeons, indicating the blocking system in the last 5 weeks of D was indeed more "fair" with respect to distributing available time to all the surgeons.

The results from method D indicate that reallocation of block time based on data from the simulation can indeed create an improvement in the system.

Also, the results point out the need of an endogenous component of the slating system (viz. the blocking scheme) to adapt itself periodically to the exogenous demand which affects the system's efficiency. In reality, such block reallocations should be performed often enough to increase significantly the throughput efficiency, but not so often as to cause unwarranted discontent and confusion among the surgeons.

5.3.4 A summary of relevant conclusions

From the preparation and execution of the described experiments, several basic conclusions were drawn about the Victoria General Hospital's surgical slating system.

They are now summarized and presented.

1.) The system encountered a very high demand for surgery during the observation period. Since only 5 anesthetists were actually in use, the demand must show considerable seasonal variability.

2.) There are 3 main constraints on the throughput of requests for surgery:

i) the surgical bed limit (128 beds in reality)

ii) the available block time (related directly to the number of anesthetists used) and

iii) the availability of sufficient operating room space at the appropriate time.

3.) For a particular internal structure of the slating system, there exists an upper limit on anesthetist and operating room utilization. A larger input will have no effect on the utilization figures once this limit has been reached.

4.) Some experimental results yield the following hypothesis: "The percentage change in available block time is very nearly equal to the percentage change in average operating room utilization, provided that the availability of operating rooms and surgical beds is adequate." There is not enough evidence to confirm the hypothesis as fact.

5.) With a large enough demand, an anesthetist's utilization will not depend on the number of other anesthetists working with him.

6.) An additional (sixth) anesthetist would require at least one more operating room designated for "general purpose" procedures. Thus, the benefit of additional throughput would involve the cost of maintaining additional facilities.

7.) With one additional operating room opened for general use, indications are that a sixth anesthetist would prove quite beneficial provided the demand remained as high as during the observation period.

8.) Block time allocation should be periodically restructured. The procedure should be based not only on the surgeons' past utilization of their blocks, but also on the duration of cases that the surgeons had to postpone because of insufficient block time (as is accounted for in the model's request utilization indices).

5.4 General comments

Upon examining the results from experimentation, it is easy to realize that considerably more knowledge is obtained about a real life system by attempting to simulate it. New ways of analyzing the system become evident and more interrelationships are recognized among the system's components. With the experimental results ordered and outlined by an "operational researcher", management has a more solid base from which to make the ever necessary decisions.

The slating system simulator has demonstrated the ways in which it does reflect aspects of reality. The experiments performed have given an indication as to the model's potential use. Such experimentation, however, has also pointed out areas in which this "first generation" model can be improved, so that a future version would become even more reliable in its quantitative system evaluation. The revised model should also be extended to allow for a greater variety of possible experiments. Several proposed revisions and additions are outlined in the following chapter.

CHAPTER SIX

PROPOSITIONS FOR FURTHER DEVELOPMENT

6.1 Introduction

In producing a simulation model of the surgical slating system, the primary concerns were to construct a logically correct programme, to demonstrate confidence in the model's validity, and to perform several experiments indicating the model's potential use. With the value of the simulation model established, the main purpose of the model then becomes its actual use as an aid in decision making. If the model is to be used on a long term and more general basis, however, it is necessary to implement several improvements and extensions, the introduction of which was made obvious in primary experimentation. Propositions for development of a "second generation" simulator are outlined in the remainder of this chapter.

6.2 Simulating the performance of surgery

In an attempt to expand the model, the initial assumptions were reviewed to identify those postulates which, if altered appropriately could provide a more accurate reflection of the simulated system. For example, figures for duration of surgical procedures were entirely deterministic and depended only on the surgical class. In determining post-operative length of stay, no variability was involved after probabilistically identifying the type of procedure in a class (Sec. 3.2.). In practice, it is well known that two identical operations hardly ever last exactly the same amount of time. Effects on surgical duration of factors such as the identity of the surgeon, the age of the patient, and others, seem too significant to be ignored without justification. Also, a patient may recover from surgery more rapidly than expected, or he may remain in hospital beyond his expected discharge date.

The distributions of observed duration of procedures from each of the 37 classes should be thoroughly analyzed. The data may indicated that duration of a surgical procedure can be adequately represented by a theoretical probability distribution, such as the normal (Gaussian) distribution (Barnoon and Wolfe, 1968, p.281). An analysis of variance (Maisel and Gnugnoli, 1972, Chapter 6) should be performed on several factors suspected to cause considerable variation in the mean duration for a particular surgery class. With the statistically significant effects of some factors identified, a more precise effect of each factor on duration of surgery can be described by a linear regression equation (Winston, 1964). In any case, use of entirely deterministic figures for the duration of surgical procedures should be abandoned in favour of distributions of duration. Mean values for each distribution should be retained, however, for they could still be used at the slating stage.

In the "first generation" model, evaluative measures such as those on operating room and anesthetist utilization were based on the assumption that all surgical procedures will have been performed exactly as slated. The actual process of performing the operations generated by the daily slate was implied, but not simulated. Use of distributions of surgery lengths would prove beneficial not so much in the slating (since the clerk can not predict much of the variability that will arise) but in an additional section of the model devoted to surgery simulation. A simulation of the surgical processes every day, following the formation of the slate, would make the model more complete in its evaluation of the surgery system in general. It would add to the credibility of the existing evaluative measures and would allow introduction of other measures which depend on the randomness in the realization of surgical procedures. For example, amount of overtime beyond a surgeon's block and the number of late starts because of overtime in the previous case could be identified. Differences between scheduled time and starting time could be recorded in the model for each class, or even for each surgeon-class combination. Data on the timely arrival of all personnel required for a surgical operation could be analyzed and incorporated into the model. The effect on the O.R. utilization of a late arrival by a surgeon or an anesthetist could be reported. In all, introducing stochasticity into the duration of surgical procedures would allow not only an adequate analysis of slating, but a reflection of the activities created by each daily slate.

The randomness in post-operative LOS would give a more realistic picture of surgical bed availability, which has proven to be a constraining factor in situations where the demand is high. The surgical bed census should be monitored and printed out daily. The number of days in a run on which the limit has been reached should be reported, and the days identified.

6.3 Varying the scheduling algorithms

In the primary version, requests for general anesthetic surgery were scheduled within a surgeon's block strictly according to a first come, first served principle. As pointed out in Sec. 3.3.3, this procedure can cause unnecessary idle fragments in block time and is definitely not optimal. Several different ordering schemes should be attempted for cases within a block, with the effect of each on the evaluative measures noted. For example, the cases with the longest mean duration could be slated first. Another scheme would be to slate the shortest cases first. Goldman et al. (1969) suggest a policy which slates the most variable cases first. In order to test the effect of different algorithms satisfactorily, appropriate stochasticity is required in the duration of a surgical procedure. With this stochasticity present, attempts could be made to produce an optimal scheduling algorithm, that is, one which would cause the idle time of personnel and waiting time of patients to be held to a minimum.

In simulating actual performance of surgery, all procedures should be carried out in their assigned operating rooms as soon as possible, in spite of their slated starting times. In this way, fragmentation of one surgeon's block in the middle of the day would not cause unnecessary overtime for the operating room personnel. In the experiment on dynamic reallocation of block time, the block construction procedure was very rudimentary and would need to be refined. Each surgeon should receive an amount of consecutive block time with the same anesthetist equal to the maximum mean duration of all the surgery classes which the surgeon has requested. As much time as possible should be assigned in contiguous blocks. In addition, all block time in the revised model should be assigned by the half-hour and not by the hour.

6.4 Varying the exogenous demand

It is quite reasonable to assume that, in reality, the daily demand for surgery varies with the time of year. The surgical demand at the Victoria General Hospital is usually lower for July and August than it is for February and March. The demand for late December is not as high as the demand for early April. If the model is to reflect reality as far as the slating system is concerned, it must reflect reality with regard to the input affecting that system. Thus, a fairly detailed investigation into the seasonal variation in the demand would have to be performed. Techniques of linear regression (Draper and Smith, 1966) could be used to forecast the expected monthly demand based on past data. The forecasting model, which would update itself through time, should provide the appropriate input to the slating simulation model. Also, seasonal variation in the relative frequency distributions of a particular surgeon making a request and of a particular request being for a specific class would need to be analyzed and accounted for. The simulation model could then be run for at least 25 weeks, with an initial 10-week "work-up".

An additional feature would be to make use of two independent pseudo-random number generators. One would be used in producing the demand, with the other strictly for use by the simulators of slating and performance of surgical procedures. This would ensure independence of the nature of endogenously generated variates from the nature of the exogenous demand. Thus, for example, different slating procedures could be evaluated on their ability to cope with identical (but stochastically generated) realizations of daily demand.

6.5 Programming requirements

With the introduction of time varying demand, of a more precise selection method for slated duration, and of actual simulation of the surgical processes, the simulator programme would need to undergo several changes and additions. The demand generation segment would contain coding expressing the relationship of demand size to simulated time. Appropriate accumulators would allow the updating of this relationship at regular intervals. Should additional factors such as patient age or weight be required to identify a request more completely, the number of rows in the request file structure would have to be increased. Such factors would be associated with a particular request upon generation of variates from appropriate empirical distributions. For example, the cumulative distribution function for patient age (or, at least, age group) would be read in and stored.

Each surgeon-class combination would be associated with a particular distribution of duration (empirical, or perhaps analytic), since the identity of the surgeon would most likely have a bearing on the length of a procedure. The means of each distribution would need to be computed and stored, since the duration of surgery would remain deterministic in the slate production stage. However, in the additional surgery simulation segment, variates would be generated from the duration distributions. Factors such as patient age and weight could affect the simulated duration by inclusion of a linear regression model in the programme, as discussed by Esogbue (1968, p.96). New accumulators would be introduced to evaluate the performance of surgical operations. Patient waiting time, surgeon's waiting time, and actual (simulated), rather than slated operating room and anesthetist utilization would be recorded.

The simulation of slated surgery would be programmed as an "event advance" (Emshoff & Sisson, 1970, p.159) procedure, with each operating room viewed as a "server" in a queueing process. The arrival times would be obtained from the slate (i.e. deterministically), while service times would be treated as random variables. Each operating room in use would thus create a separate queueing system, since operating room designation for a particular case would not change after the slate has been produced.

Since the state of the simulated system changes only upon occurrence of an additional event in the "event advance" method, the surgery simulation segment would require another linked list structure representing future events. Upon realization of the events, nodes representing them in this structure would be zeroed and attached to the availability list. Care should be taken to produce efficient coding and to minimize the necessary computing time.

Presently developed segments of the simulator should be made adaptable to a more general situation, where, for example, the number of surgeons could exceed 39. Thus, attributes of many endogenous system components should not be assigned values in the programme, but should be characterized by appropriate input to the programmed simulator.

6.6 Controlling the system's operation

With the proposed additions and refinements described in this chapter, the "second generation" model, after having undergone extensive validation, should reflect surgical slating at the Victoria General Hospital with more accuracy and more detail. With the potential for a greater variety of experiments and with an increased amount of output, such a model could be run periodically, in "batch" mode, to aid hospital management in its operating decisions. The model would also prove valuable to the slating clerk in refining her technique.

Should the nature of the varying demand be successfully modelled, the combination of i) the demand forecasting model and ii) the slating and surgery simulation model, could be viewed as a "mathematical control model" of the entire surgical sub-system in the hospital environment. Its regular use with periodically updated input would allow the output from this model to control most of the hospital's activity related to surgery. With a "control model" on hand, management would be able to anticipate undesirable changes in the actual system's performance and could introduce preventive measures to keep the system's operation under control.

It is evident, however, that construction of such a refined model would require considerable time, effort, and, most of all, data. Since the data presently being gathered at the hospital are not extremely extensive, nor are they centralized, the lack of appropriate data could pose serious problems in the model's further development. However, with computerized data banks in sight as components of large scale automated "hospital information systems", much more data should be available in easily accessible form. This would allow the development and use of an even more refined surgical system model in conjunction with models of other hospital sub-systems.

CHAPTER SEVEN

THE MODEL WITHIN A HOSPITAL INFORMATION SYSTEM

7.1 Potential for further model use

The concept of a hospital information system (HIS), defined by Bekey and Schwartz (1972) as "a high-speed, computer-controlled multistation authorized access information flow network for the hospital", is receiving increasing attention in the involvement of computer systems in the health care field. The study initiated at the Victoria General Hospital (Sprague, 1972) indicated that an automated information system at the hospital is indeed feasible and should become reality in the not too distant future. At least two such extensive systems, the Kaiser-Permanente Medical Information System in Oakland, California (Van Brunt, 1970) and the Danderyd Hospital Computer System in Sweden (Abrahamsson et al., 1970) have already demonstrated their wide range of application with unquestionable benefits.

The main features of a hospital information system are its centralization of all data pertinent to hospital activity and its capacity for rapid retrieval of such data which are grouped appropriately and arranged for visual impact. In addition, the HIS is always developed modularly, making necessary the identification of particular hospital sub-systems (eg. slating) and their components. Since a simulation approach requires detailed system identification, extensive data and appropriate computing facilities, a HIS environment would undoubtedly stimulate interest in the use of more involved simulation models on a regular basis.

7.2 A "third generation" model

With the implementation of a hospital information system, the "second generation" model of surgical slating proposed in Chapter 6 could undergo even further alteration. Aspects of the system that were not considered because of nonexistent or insufficient data, could be included. For example, distributions of the actual arrival times of surgeons, anesthetists, and other required personnel relative to their scheduled arrivals, could be retrieved from a data bank in a matter of seconds. Special programmes could be introduced into the HIS to isolate significant factors affecting the length of a surgical procedure based on continually updated information. The demand for surgery and surgical bed occupancy would be reflected much more accurately, and many unexpected occurrences could be predicted.

Development of a "third generation" model of the surgical slating sub-system should be based not only on the availability of more information, but also on innovations suggested solely by repeated use of the "second generation" version. For example, the operating room designations could be made to vary according to the simulated time of year. Perhaps attempting yet another scheduling algorithm may be warranted. Should the proposed changes tend to alter significantly the structure of the first two versions, rewriting the entire programme might be worthwhile. The basic existing flow of logic (Appendix 2) could be retained.

In addition to existing simulation languages such as SIMSCRIPT and GPSS, new languages, oriented specifically toward simulation are being developed continually. The aim in this development is to provide for more versatility in application and to keep the programming done by the user to a minimum. By the time a hospital information system would be implemented at the Victoria General Hospital, it is safe to assume that construction of the latest version of the slating model in FORTRAN would not be advisable.

The "third generation" slating model would soon become a much relied upon management aid. Since a HIS would provide for on-line terminals, the simulator could be called from such a terminal in an interactive mode. The model programme would reside on auxiliary storage and would be allocated main core upon request. Use of the model would not be limited to a series of "batch" mode runs, but would allow considerable "conversation" between the model and the user. The user could alter simulated policy decisions during the course of a run, upon examining a variety of output available virtually upon request. For example, the economic consequences of adding or deleting resources would be displayed for the user in an easily understandable format. The user could then indicate in what manner the simulation should proceed. With this level of sophistication, extensive "control models" for many hospital sub-systems would become indispensable.

7.3 Computerized slating

In addition to modelling the slating system by computer, the HIS would involve the computing resources in the actual slating activities. Sprague (1972) reports that ".. the slating clerk can be assisted greatly by a computer based scheduling procedure". Refinements and additions to the main ideas developed in subroutine SLATER would create an on-line interactive computerized slater. The role of the slating clerk would then be to interface between the computerized slater and the requesting surgeons. Upon input of all relevant information, the slating clerk would receive an acknowledgment of the request and a proposed starting time. The computerized slater would need to be accessible throughout the regular working day. It would have rapid access to files with information on predicted surgical bed census and on previously slated requests, in addition to information used by the slating simulator. An optimal scheduling algorithm would be used, improving the utilization of facilities. With the load on the slating system at the Victoria General Hospital expected to increase substantially because of increasing urban development in the vicinity, the aid of the computer in the daily slating procedure will be required and appreciated.

7.4 Conclusion

The concept of a system is receiving an increasing amount of attention in our current culture. Everyday occurrences in various institutions are no longer viewed as distinct activities, but as components of more complex systems. The aim of this "component thinking" is to discover those system components whose measures of performance are truly related to the performance of the overall system. In the extensive HIS as well as in the "first generation" simulator, the synthesis of components is clearly evident. In fact, much of the value of computer simulation models lies in the fact that they are conceived and developed according to a "system philosophy", and can bring to light operational characteristics that may have otherwise never been noticed.

It has long been said that "fortune favors the prepared mind". With a more global outlook and a vision of the future through effective simulation, it is hoped that everyone concerned will indeed be better prepared to deal with the increasing complexities which are arising in the delivery of adequate health care.

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APPENDIX 1

PROCEDURES IN EACH SURGERY CLASS

A LIST OF PROCEDURES IN EACH SURGERY CLASS

Local Anesthetic

1. LOCAL-I:

   Circumcision
   Vasectomy

2. LOCAL-2:

   Cystoscopy
   Cystoscopy-panendoscopy

3. LOCAL-3:

   Cysto-retrograde pyelogram

4. LOCAL-4:

   Toenail removal
   Closed reduction of fracture
   Needle biopsy of vertebra
   Removal of K-wires

5. LOCAL-5:

   Bronchoscopy
   Laryngoscopy
   Otoscopy
   Tracheoscopy
   Tympanostomy
   Myringotomy
   Sigmoidoscopy
   Excision of polyp
   Excision of cysts
   Excision of nevus
   Removal of tatoos
   Biopsy

6. LOCAL-6:

   Complete exodontia
   Impactions
   Extractions
   Excision of hypertrophied tissue of mouth
   Excision of oral antral fistula

7. LOCAL-7:

Extraction of cataract
Ectropian excision
Chalazion excision
Pterygium excision
Xanthoma eyelid excision

General Anesthetic

8. GENERAL-I:

Appendectomy
Circumcision
Breast biopsy
Anal fissurectomy
Sigmoidoscopy
Hemorrhoidectomy
Excision of pilonidal cyst
Excision of lipoma
Excision of mammary duct system
Vasectomy

9. GENERAL-2:

Gland biopsy

10. GENERAL-3:

Herniorrhaphy
Cholecystectomy
Varicose vein ligation and stripping
Simple mastectomy
Thyroidectomy
Repair of prolapsed rectum
Colostomy closure
Orchiopexy

11. GENERAL-4:

Common bile duct exploration
Vagotomy & gastroenterostomy
Partial gastrectomy
Radical mastectomy
Femoral-popliteal bypass
Aorta-femoral bypass
Jejuno-ileal bypass
Staging laparotomy
Hemicolectomy

12. GENERAL-5:

Radical gland biopsy

13. GENERAL-6:

Abdominal perineal bowel resection
Removal of abdominal aneurysm

14. GYNECOLOGY-1:

Tubal ligation
Cone biopsy of cervix
Cervical amputation
Cervical cauterization
Dilatation & curettage
Excision of Bartholin gland
Hymenectomy
Salpingectomy
Oophorectomy
Laparoscopy
Polypectomy
Perineotomy

15. GYNECOLOGY-2:

Hysterotomy
Abdominal hysterectomy
Vaginal hysterectomy
Anterior vaginal repair
Posterior vaginal repair
A & P vaginal repair
Salpingo-oophorectomy
Tuboplasty

16. UROLOGY-1:

Cystoscopy-panendoscopy
Cystoscopy & manipulation of stone
Cystoscopy & needle biopsy
Cystotomy
Urethrotomy
Transurethral resection of bladder neck
Fulguration of lesion
Dilatation of stricture

17. UROLOGY-2:

Cystoscopy & retrograde pyelogram

18. UROLOGY-3:

Cystoplasty
Orchidectomy
Hydrocelectomy

19. UROLOGY-4:

Ureterolithotomy
Nephrolithotomy
Suprapubic prostatectomy
Retropubic prostatectomy
Transurethral resection of prostate
Pyeloplasty
Ureterosigmoid anastomosis
Ureteronephrocystostomy
Exploration of kidney
Marshall-Marchetti procedure
Pereyra procedure

20. OBSTETRICS-1:

Caesarian section
Shirodkar suture of cervix
McDonald stitch of cervix

21. ORTHOPEDICS-1:

Closed reduction of fracture or dislocation

22. ORTHOPEDICS-2:

Simple amputation
Anthrodesis
Bunionectomy
Excision of ganglion
Release of Dupuytren's contracture
Menisectomy
Anthroscopy
Release of carpal tunnel
Bursectomy

23. ORTHOPEDICS-3:

Major amputation
Laminectomy
Bone graft
Wedge tarsectomy
Tendon repair
Spinal disc resection
Open reduction of fracture

24. ORTHOPEDICS-4:

    Spinal fusion
    Arthroplasty

25. PLASTIC-1:

    Dermabrasion
    Z-plasty
    Pedicle skin graft
    Breast augmentation
    other 1-hour plastic procedures

26. PLASTIC-2:

    Repair of bilateral lop-ears
    Transposition & neuroplasty of ulnar nerve
    Breast reduction
    other 2-hour plastic procedures

27. PLASTIC-3:

    3-hour plastic procedures

28. THORACIC-1:

    Mediastinoscopy

29. THORACIC-2:

    Lobectomy
    Mediastinoscopy & lobectomy
    Pneumenectomy
    Mediastinoscopy & thoracotomy

30. EAR-NOSE-THROAT-1:

    Bronchoscopy
    Laryngoscopy
    Otoscopy
    Tracheoscopy
    Tracheotomy
    Tympanostomy
    Removal of Papilloma pharynx
    Tubing of ear
    Tonsillectomy
    Adenoidectomy
    Tonsillectomy & adenoidectomy

31. EAR-NOSE-THROAT-2:

    Laryngotomy
    Myringotomy
    Rhinoplasty
    Submucous resection
    Tympanoplasty
    Exploration of ear

32. EAR-NOSE-THROAT-3:

    Mastoidectomy
    Stapedectomy
    Rhinoplasty & submucous resection
    Myringoplasty
    Myringoplasty revision
    Reconstruction of ossicular chain

33. NEUROLOGICAL:

    Cervical sympathectomy
    Lumbar sympathectomy

34. DENTAL-1:

    Impactions
    Extractions
    Complete exodontia
    Excision of cysts of the mandible
    Excision of hypertrophied tissue of mouth

35. DENTAL-2:

    2-hour dental procedure

36. OPHTHALMOLOGY-1:

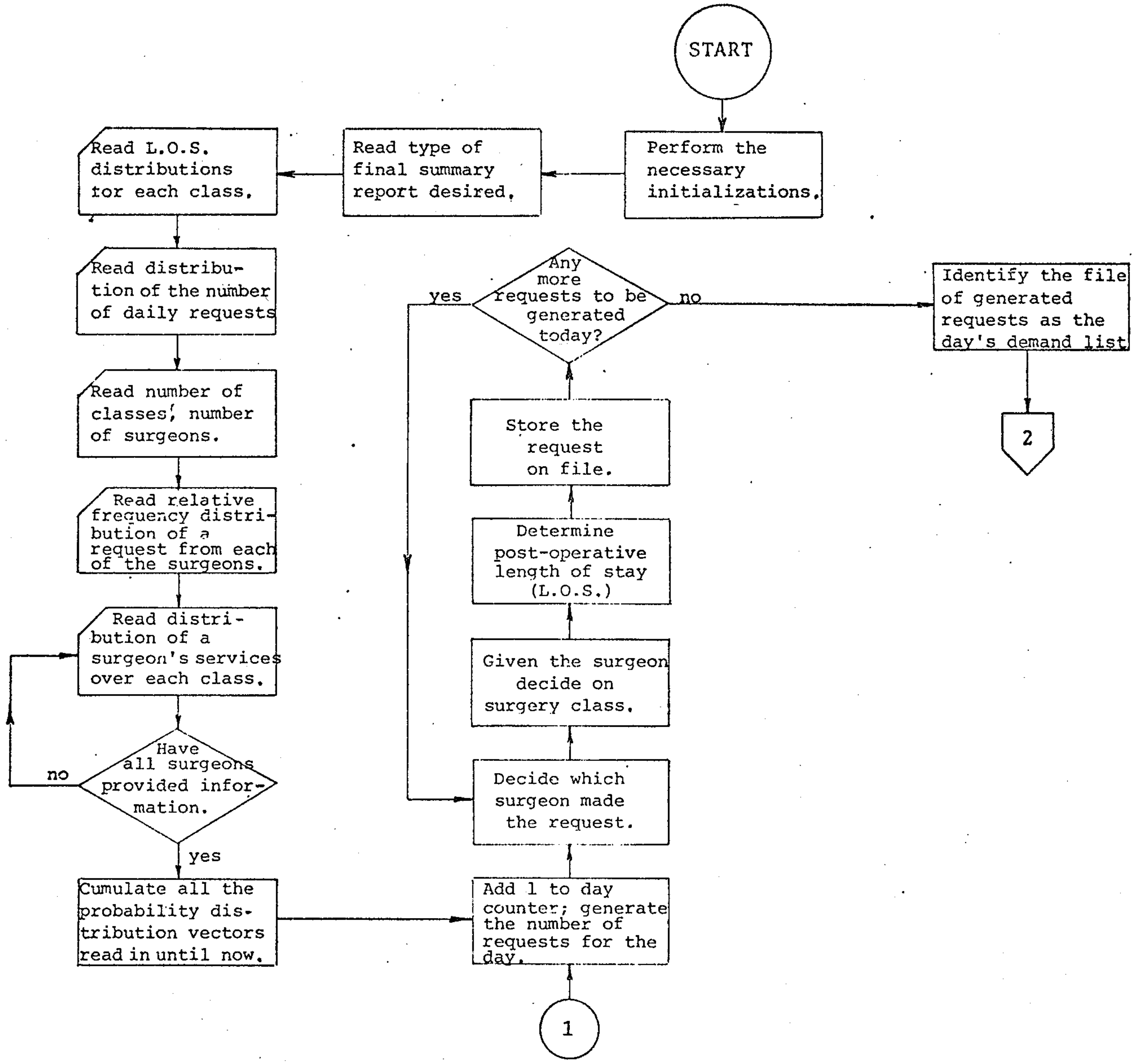
    Cataract extraction
    Strabismus correction
    Ectropian excision
    Chalazion excision
    Pterygium excision
    Blepharoplasty

37. OPHTHALMOLOGY-2:

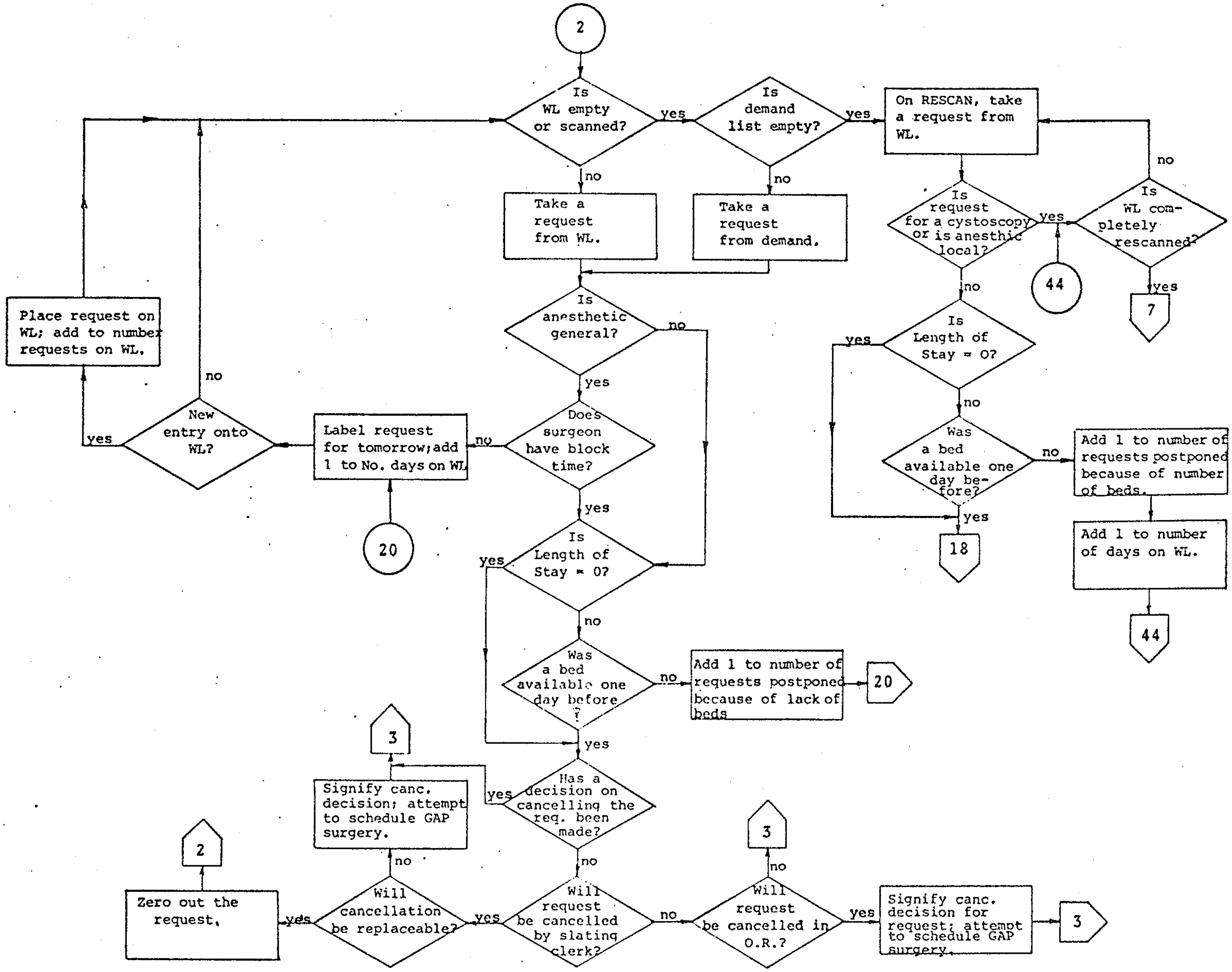
    Dacrocystorhinostomy

APPENDIX 2

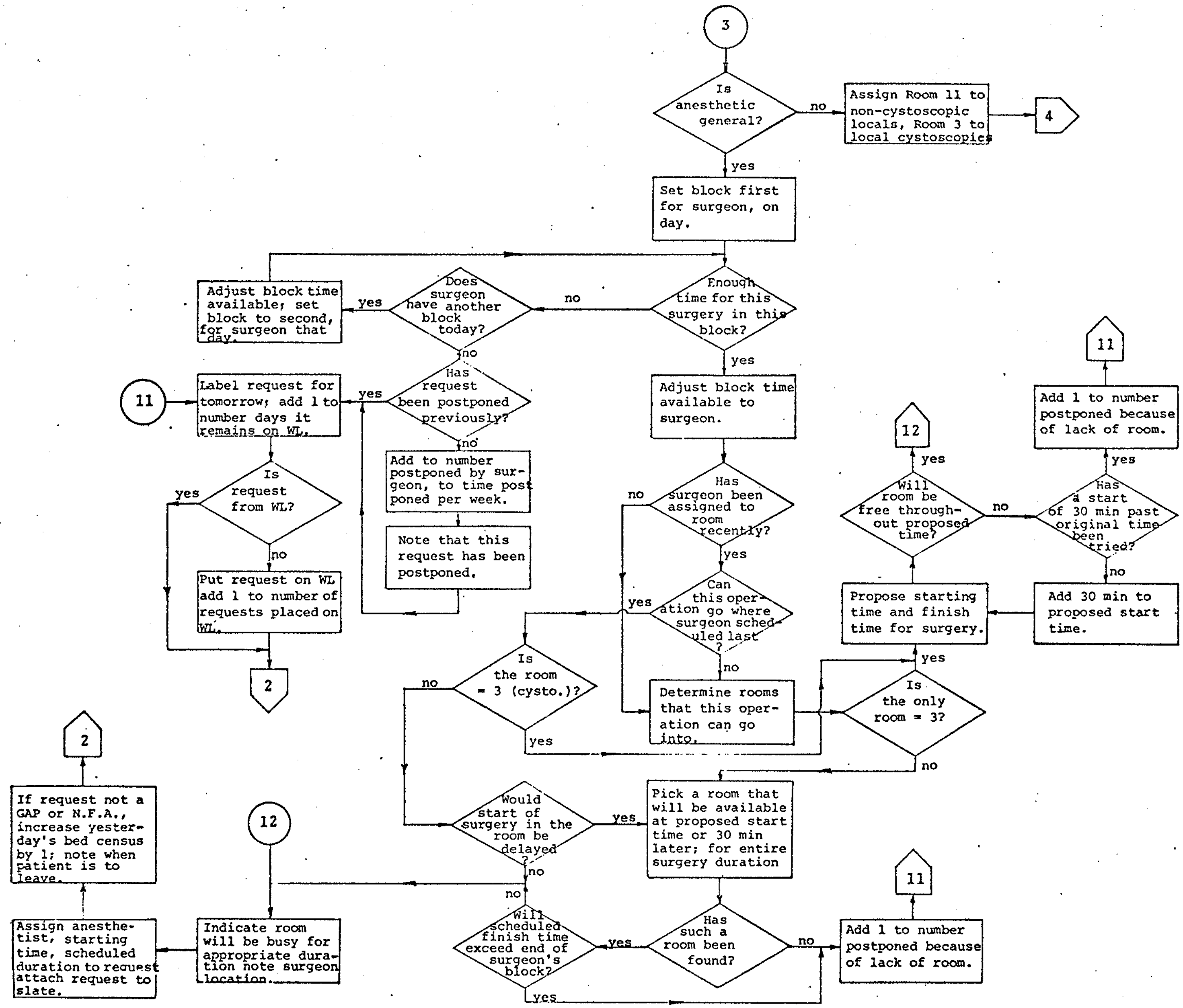
DETAILED MODEL FLOW-CHART



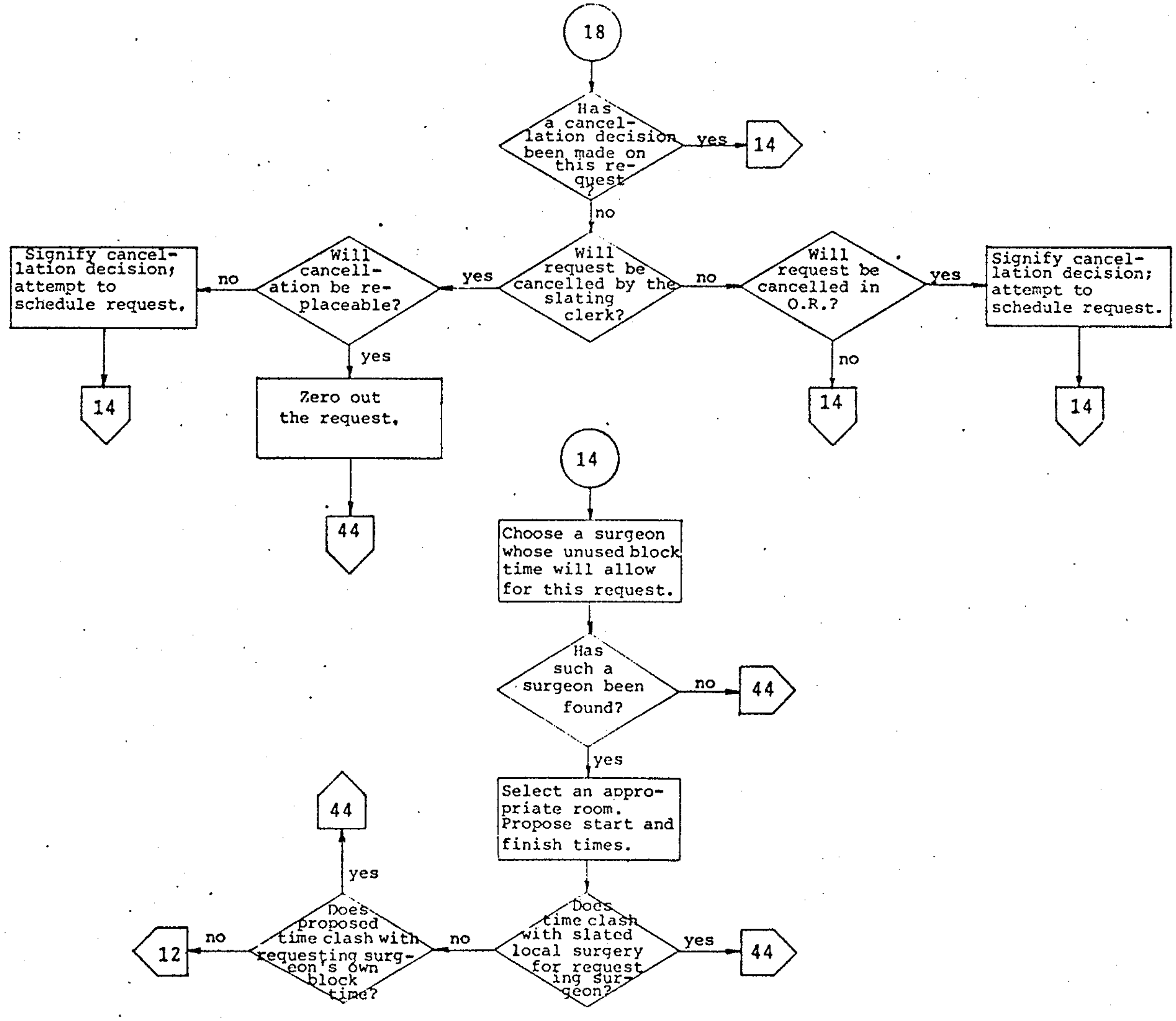
DEMAND GENERATION SEGMENT



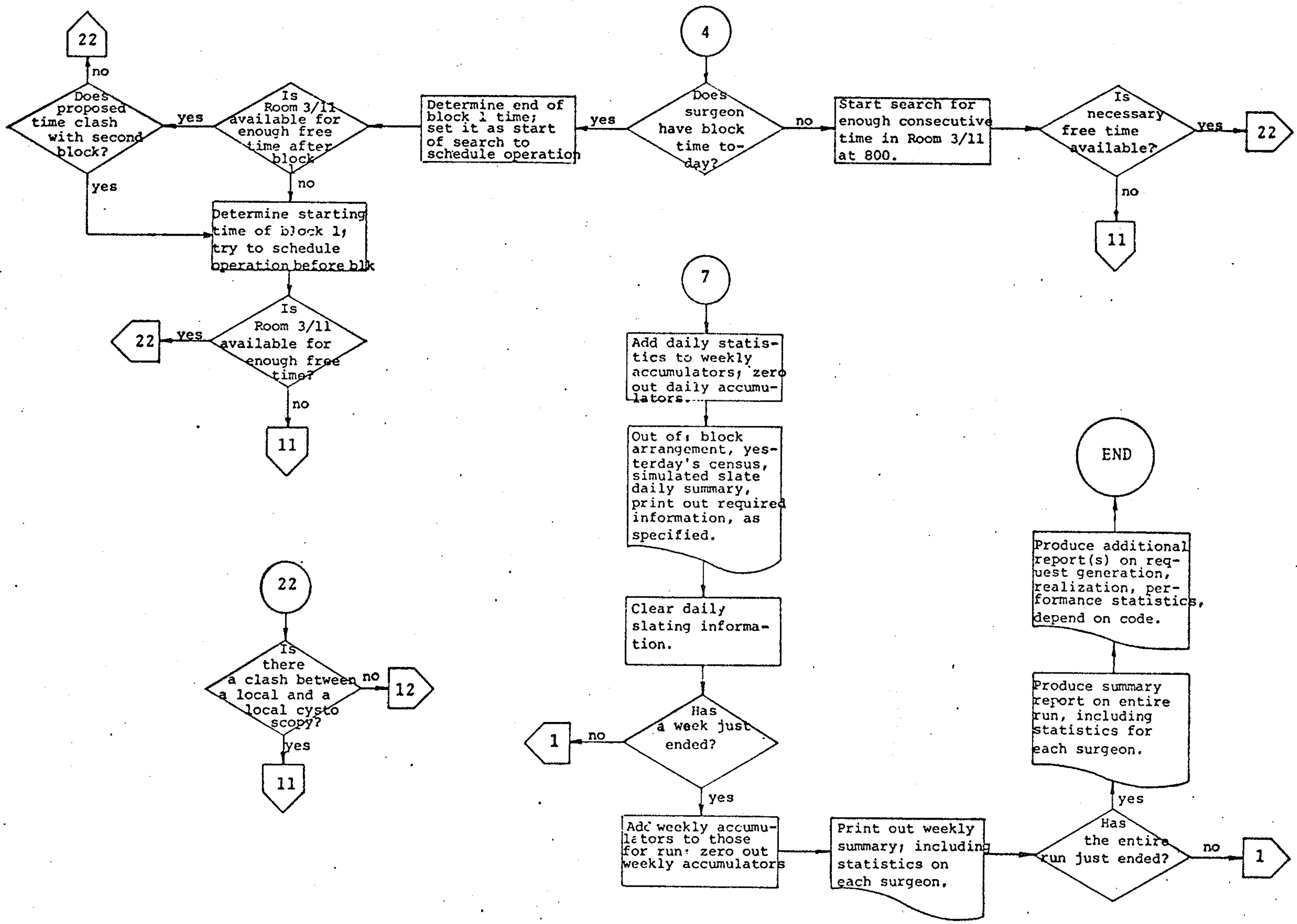
REQUEST FILTERING SEGMENT



SLATING ATTEMPT SEGMENT (GENERAL) - I



SLATING ATTEMPT (GENERAL) - II



SLATING ATTEMPT SEGMENT (LOCAL) / SUMMARY SEGMENT

APPENDIX 3

PROGRAMME LISTING

```
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C
C                        *** PROGRAMME SURSCHED ***
C                         A DIGITAL SIMULATION MODEL
C                    OF THE SCHEDULING OF SURGICAL REQUESTS
C                       AT THE VICTORIA GENERAL HOSPITAL
C                              WINNIPEG, MANITOBA
C
C
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C
C          THIS MAIN ROUTINE SIMULATES SURGICAL REQUEST OCCURRENCES
C       AND PLACES THE REQUESTS IN A FILE FOR USE BY THE SLATER ROUTINE
C        IT ALSO PRODUCES A MANAGEMENT INFORMATION REPORT AFTER
C       THE LAST SIMULATED DAY
C
C
      INTEGER*2 INDEX (39)
      INTEGER*2 FINAL(39,39),PERFOR(39,39)
      INTEGER*2 AVAIL,LAST
      INTEGER*2 NSURG,NTYPE,LENGTH
      INTEGER*2 WKDAY,DAY,CLASPT(12),DOCPT(39),RQFILE(15,800)
      INTEGER*2 WL,SL,WLAST,SLAST,IDEMD
      INTEGER *2 OPRM(39,12),DOCAV(5,39),BLOCK(8,35)
      INTEGER*2 FINDAY
      INTEGER LENSUR(39),RTAVLD(39),RTUSED(39),RDTLOC(39),
     *RTPOST(39),RNPOST(39),WNREQ,RNREQ,WOPUT(12),ROPUT(12),
     *RTGAP,RNOROM,RCANOR,RCANCL,RNOBED,RWAIT,RREWL
      INTEGER WTAKEN(39),RTAKEN(39)
      INTEGER CENSUS,LEAVNG(50)
      INTEGER DCANCL,DCANOR,DNOBED
      INTEGER WNREML,RNREML,RIDCAN
      INTEGER WSLAT,WNREWL,TWAIT,WNOBED,WCANCL,WNOROM,WTGAP,WNPOST(39),
     $WTPOST(39),WDTLOC(39),WTAVLD(39),WTUSED(39),WCANOR
      INTEGER LOS2(85)
      REAL LOS1 (85)
      REAL RUTRAT(39),RWLDAY,UTRAT(39),WLDAY,RFBIND(39),RBLUT(39)
      REAL CMPRDR(39), CMCLAS (39,39)
      REAL DIST (50)
      LOGICAL*1 COVER1,COVER2,COVER3
      INTEGER CLCODE(39,4),WANOCC(7),RANOCC(7),RSLAT,DSTAB,WTFIL(39)
     *,RTFIL(39),WNFILL,RNFILL
      COMMON /SCHED/ LEAVNG,LENSUR,RTAVLD,RTUSED,RDTLOC
     *,RTPOST,RNPOST,RUTRAT,WNPOST,WTPOST,WDTLOC,WTAVLD,WTUSED,UTRAT,
     *WTFIL,RTFIL,WTAKEN,RTAKEN,
     *WSLAT,WLDAY,WNREWL,TWAIT,WNOBED,WCANCL,WCANOR,WNOROM,WTGAP,
     *WNREML,RNREML,RIDCAN,IWLSRT,IRLSRT,WNFILL,RNFILL,
     *RREWL,RWLDAY,WNREQ,RNREQ,CENSUS,ROPUT,WOPUT,BLOCK,OPRM,DOCAV
      COMMON /STATE/ CMPRDR,CMCLAS,NOCLAS,NODOCS
      COMMON /FILE/ RQFILE,AVAIL,LAST,CLASPT,DOCPT,SL,WL,WLAST,SLAST,
     *IDEMD
      COMMON /CODE/ CLCODE
      COMMON /OUT/ FINAL, PERFOR
      COMMON /STAY/ LOS1, LOS2,INDEX
      COMMON /XTRA/ RFRIND,RBLUT,WANOCC,RANOCC,DSTAB,RSLAT,RCANCL,RCANOR
     *,RTGAP,RNOBED,RNOROM,IRNWL,IRNWL2,RWLDA2,FINDAY,COVER1,COVER2,
     *COVER3
```

```
C
C        READ IN TYPE OF REPORT DESIRED
      READ (5,35) NREPT
 35   FORMAT (I4)
C
C      INITIALIZATION OF PSEUDO-RANDOM NUMBER GENERATOR
      CALL RSTART(946316767,0)
C
C      INFORMATION ON POST-OPERATIVE LOS AND ON SURGICAL CLASS NAMES
C     IS READ IN
      READ (5,400) (INDEX(I),I=1,39)
 400  FORMAT (39I2)
      READ(5,401) (LOS1(I), I=1,82)
 401  FORMAT (20 F4.2)
      READ (5,402) (LOS2(J), J=1,82)
 402  FORMAT (20I4)
      DO 55 J=1,39
      READ(5,27) (CLCODE(J,I),I=1,4)
  27  FORMAT (4A4)
 55   CONTINUE
C
C        PARAMETERS FOR DISTRIBUTION OF DAILY REQUESTS
C     ARE INPUT
      READ (5,100) NOPTS, INDVAL, IDELT
  100 FORMAT (3I5)
      READ (5,101) (DIST(J), J=1,NOPTS)
 101  FORMAT (10F5.2)
C
C      CALL ROUTINE PROVIDING FURTHER INFORMATION ON SURGICAL DEMAND
          CALL DINFOR
C
      MPARAM = 1
C      PROVISION IS MADE FOR A "WORK-UP" RUN
      DO 777 ITER = 1,2
      CALL SLINFO(MPARAM)
       DO 50 K=1,FINDAY
      IF(COVER1) GO TO 9001
      WRITE(6,600)
  600 FORMAT('1',20X,'*** EXOGENOUS DEMAND FOR SURGICAL REQUESTS ***',/)
      WRITE(6,700) K
  700 FORMAT(' ',30X,' DAY:  ',I2)
 9001 DAY = K
C     GENERATE THE NUMBER OF REQUESTS FOR THE DAY
      CALL REQGEN(IX,NOPTS,IDELT,INDVAL,DIST,NREQ)
      IF(COVER1) GO TO 9002
      WRITE (6,702) NREQ
 702  FORMAT(' ',' NO. OF REQUESTS:    ',I3,/)
      IF (NREPT .EQ. 4)  WRITE(6,704)
 704  FORMAT(' ',15X,'SURGEON',20X,'SURGERY CLASS',15X,'LENGTH OF STAY (
     *DAYS)')
C
C      INITIALIZE POINTERS TO SUBLISTS BY OPERATING ROOM AND SURGEON
C     FOR FUTURE SUBDIVISION OF SLATED REQUESTS
 9002 DO 17 J=1,12
  17  CLASPT(J) = -99
      DO 18 J=1,NODOCS
  18  DOCPT(J) = -99
C
      DO 99 MM=1,NREQ
      YFL = UNI(0)
C        WHICH SURGEON IS MAKING THE REQUEST?
      DO 9 I=1,NODOCS
      IF (YFL .GT. CMPRDR (I)) GO TO 9
```

```
      NSURG = I
      GO TO 900
 9    CONTINUE
  900 YFL = UNI(0)
C        WHAT CLASS OF SURGERY?
      DO 10 I=1,37
      IF (YFL .GT. CMCLAS (NSURG,I)) GO TO 10
      NTYPE = I
C        WHAT IS THE AVERAGE LENGTH OF STAY?
      YFL = UNI(0)
      INDC = INDEX(NTYPE)
      LIMIT = INDC + 10
       DO 505 J=INDC,LIMIT
      IF (YFL .GT. LOS1(J) ) GO TO 505
      LENGTH = LOS2(J)
      GO TO 701
 505  CONTINUE
  10  CONTINUE
C        THIS REQUEST IS FOR NTYPE OF SURGERY
  701 IF(COVER1) GO TO 9003
      IF (NREPT .EQ. 4) WRITE(6,706) NSURG,(CLCODE(NTYPE,LL),LL=1,4),
     *LENGTH
 706  FORMAT (' ',18X,I3,22X,4A4,20X,I4)
C
 9003 FINAL(NSURG,NTYPE) = FINAL(NSURG,NTYPE) + 1
C        STORE THIS REQUEST ON FILE
      CALL STORE (DAY,NSURG,NTYPE,LENGTH)
C
 99   CONTINUE
C
      CALL SLATER(DAY,NREQ)
C
C      CLEAR THE PREVIOUS DAY'S SLATE FROM THE FILE
          CALL CLEAR
C
  50  C O N T I N U E
C
      IF(MPARAM.EQ.2) GO TO 777
      DO 778 I=1,39
      DO 778 J=1,39
 778  FINAL(I,J) = 0
      MPARAM = MPARAM + 1
      DSTAB = DSTAB + 50
 777  CONTINUE
C
C
C      CALL THE REPORT GENERATION ROUTINE
      CALL REPGEN(NREPT,NOCLAS,NODOCS,COVER1,COVER2,COVER3)
C
C      A PROPERTY OF THE GENERATOR IS EXTRACTED
      NNRN = IVNI(0)
      WRITE(6,5999) NNRN
 5999 FORMAT('1',///,25X,' IVNI: ',I12)
C
      STOP
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE DINFOR
C
C        ROUTINE READS IN EXOGENOUS DEMAND INFORMATION
C        COLLECTED FROM HOSPITAL DATA
C
      INTEGER*2 FINAL(39,39),PERFOR(39,39)
      REAL PROBDR(39),DOCLAS(39,39)
      REAL BUFF(39) /39*0.0/
      COMMON /STATE/ PROBDR,DOCLAS,NOCLAS,NODOCS
      COMMON /OUT/ FINAL, PERFOR
      DO 27 I=1,39
      DO 27 J=1,39
 27   FINAL (I,J) = 0
      READ (5,200) NOCLAS
      READ (5,200) NODOCS
 200  FORMAT (I3)
C        PROBABILITY OF OCCURRENCE OF A PARTICULAR SURGEON'S REQUEST
      READ(5,100) (PROBDR(I),I=1,NODOCS)
 205  FORMAT (20F4.3)
 100  FORMAT (20F4.3)
C        DISTRIBUTION OF A DOCTOR'S SERVICES OVER THE SURGERY CLASSES
      DO 5 I=1,NODOCS
  5   READ (5,205) (DOCLAS (I,J),J=1,NOCLAS)
C        CUMULATE THE INPUT PROBABILITIES
          CALL CUMUL (PROBDR,NODOCS)
         DO 8 JJ = 1, NODOCS
      DO 9 KK=1,NOCLAS
  9   BUFF(KK) = DOCLAS(JJ,KK)
      CALL CUMUL (BUFF,39)
      DO 10 KK=1,NOCLAS
  10  DOCLAS (JJ,KK) = BUFF(KK)
      DO 11 KK=1,39
  11  BUFF (KK) =0.0
  8      CONTINUE
      RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE SLINFO (MPARAM)
C
C        ROUTINE READS IN BLOCK TIME ALLOCATION SCHEME AND OTHER
C     INFORMATION DESCRIBING THE STRUCTURE OF THE SLATING SUB-SYSTEM
C
      INTEGER*2 WL,SL,WLAST,SLAST,IDEMD
      INTEGER*2 AVAIL,LAST
      INTEGER*2 DAY,CLASPT(12),DOCPT(39),RQFILE(15,800)
      INTEGER*2 OPRM(39,12),DOCAV(5,39),BLOCK(8,35)
      INTEGER*2 FINAL(39,39),PERFOR(39,39)
      INTEGER*2 FINDAY
      INTEGER WNREML,RNREML,RIDCAN,WTFIL(39),RTFIL(39),WNFILL,RNFILL
      INTEGER WTAKEN(39),RTAKEN(39)
      INTEGER LENSUR(39),RTAVLD(39),RTUSED(39),RDTLOC(39),
     *RTPOST(39),RNPOST(39),WNREQ,RNREQ,WOPUT(12),ROPUT(12),
     *RTGAP,RNOROM,RCANOR,RCANCL,RNOBED,RWAIT,RREWL,LEAVNG(50),CENSUS
      INTEGER WSLAT,WNREWL,TWAIT,WNOBED,WCANCL,WNOROM,WTGAP,WNPOST(39),
     *WTPOST(39),WDTLOC(39),WTAVLD(39),WTUSED(39),WCANOR
      INTEGER WANOCC(7), RANOCC(7),RSLAT,DSTAB
      REAL RUTRAT(39),RWLDAY,UTRAT(39),WLDAY,RFRIND(39),RBLUT(39)
      LOGICAL*1 COVER1,COVER2,COVER3
      COMMON /SCHED/ LEAVNG,LENSUR,RTAVLD,RTUSED,RDTLOC
     *,RTPOST,RNPOST,RUTRAT,WNPOST,WTPOST,WDTLOC,WTAVLD,WTUSED,UTRAT,
     *WTFIL,RTFIL,WTAKEN,RTAKEN,
     *WSLAT,WLDAY,WNREWL,TWAIT,WNOBED,WCANCL,WCANOR,WNOROM,WTGAP,
     *WNREML,RNREML,RIDCAN,IWLSRT,IRLSRT,WNFILL,RNFILL,
     *RREWL,RWLDAY,WNREQ,RNREQ,CENSUS,ROPUT,WOPUT,BLOCK,OPRM,DOCAV
      COMMON /FILE/ RQFILE,AVAIL,LAST,CLASPT,DOCPT,SL,WL,WLAST,SLAST,
     *IDEMD
      COMMON /OUT/ FINAL, PERFOR
      COMMON /XTRA/ RFRIND,RBLUT,WANOCC,RANOCC,DSTAB,RSLAT,RCANCL,RCANOR
     *,RTGAP,RNOBED,RNOROM,IRNWL,IRNWL2,RWLDA2,FINDAY,COVER1,COVER2,
     *COVER3
C       THE REQUEST FILE, RQFILE, IS INITIALIZED UPON THE FIRST CALL
C      TO SLINFO, I.E. WHEN MPARAM EQUALS 1
      IF(MPARAM .GT. 1) GO TO 777
C       INFORMATION IS PROVIDED ON OPERATING ROOM-SURGICAL CLASS
C      COMPATIBILITY
      DO 56 K=1,39
 56   READ(5,66) (OPRM(K,J), J=1,12)
  66  FORMAT (12I4)
C     AVAILABILITY OF A SURGEON'S BLOCK TIME EACH WEEK DAY
      DO 57 K=1,5
 57   READ (5,67) (DOCAV(K,J),J=1,39)
  67  FORMAT (39I2)
C        AVERAGE LENGTH OF EACH SURGICAL CLASS IS READ IN
      READ(5,97) (LENSUR(J),J=1,39)
  97  FORMAT(20I4)
C        READ IN INFORMATION ON BLOCK TIME ALLOTTED
C      FOR SURGERY WITH GENERAL ANESTHETIC
      DO 90 K=1,35
      READ(5,77) (BLOCK(J,K),J=1,8)
  77  FORMAT(8I4)
  90  CONTINUE
C
C       SUPPRESSION CODES FOR INFORMATION PRINTOUT
      COVER1 = .TRUE.
      COVER2 = .TRUE.
      COVER3 = .FALSE.
```

```
C
C       INITIALIZE STRUCTURES REQUIRED FOR ACTUAL SLATING
      DO 58 K=1,799
      DO 70 JJ=1,13
   70 ROFILE (JJ,K) = 0
      ROFILE (14,K) = K+1
   58 CONTINUE
      ROFILE (14,800) = -99
      DO 71 JJ=1,800
   71 ROFILE(15,JJ) = 0
      DO 60 J=1,50
   60 LEAVNG(J) = 0
      AVAIL = 1
      LAST = -99
      SL = -77
      WL = -88
      SLAST = -77
      WLAST = -88
      CENSUS = 0
      IDEMD = 1
      DSTAB = 0
C      LAST DAY OF RUN
      FINDAY = 50
C
C       INITIALIZE OVERALL ACCUMULATORS FOR ONE SIMULATION RUN
C
  777 IRNWL = 0
      RIDCAN = 0
      RNREML = 0
      RSLAT = 0
      RWLDAY = 0.
      RREWL = 0
      RNREQ = 0
      RWAIT = 0
      RNOBED = 0
      RCANCL = 0
      RCANOR = 0
      RNOROM = 0
      RTGAP = 0
      RNFILL = 0
      IRLSRT = 0
      IRNWL2 = 0
      RWLDA2 = 0.
      DO 100 J=1,39
      RTPOST(J) = 0
      RTFIL(J) = 0
      RTAKEN(J) = 0
      RNPOST(J) = 0
      RDTLOC(J) = 0
      RTUSED(J) = 0
      RTAVLD(J) = 0
      RFRIND(J) = 0.
      RBLUT(J) = 0.
  100 RUTRAT (J) = 0.
      DO 101 J=1,12
  101 ROPUT(J) = 0
      DO 45 I=1,7
   45 RANOCC(I) = 0
C      NO. OF OPERATIONS SCHEDULED TO BE PERFORMED BY EACH SURGEON
C     IS INITIALIZED
      DO 44 I=1,39
      DO 44 J=1,39
   44 PERFOR(I,J) = 0
      RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE REQGEN (NSEED,NOPTS,IDELT,INDVAL,DIST,NREQ)
C
C        GENERATE THE NUMBER OF SURGICAL REQUESTS FOR A GIVEN DAY
C       FROM A GIVEN DISTRIBUTION
C      PARAMETERS:
C        NSEED - FOR USE BY RANDOM NUMBER GENERATOR
C         NOPTS- NO. OF POINTS OF C.D.F. PROVIDED
C         IDELT- INTERVAL BETWEEN TABULATION VALUES OF THE RANDOM
C       VARIABLE REPRESENTING THE NUMBER OF DAILY REQUESTS.
C        INDVAL - INITIAL DISTRIBUTION VALUE
C         DIST- CORRESPONDING C.D.F. VALUES FOR NOPTS POINTS
C       REPRESENTING DAILY REQUESTS.
C        NREQ- VALUE RETURNED BY ONE CALL TO THIS ROUTINE.
C
      REAL DIST (50)
C
C        CALL A ROUTINE WHICH GENERATES VARIATES FROM AN EMPIRICAL DISTRIBUTIO
C       IT WILL RETURN A VALUE FOR NREQ
C
      CALL EMPIR (NSEED,INDVAL,IDELT,DIST,REQ,NOPTS)
      NREQ = IFIX(REQ)
      RETURN
      END
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE EMPIR(ISEED,STVAL,INCR,CUMPR,VAR,IDIM)
C
C        GENERATES VARIATES FROM A SUPPLIED EMPIRICAL
C       CUMULATIVE DISTRIBUTION FUNCTION.
C        USES LINEAR INTERPOLATION.
C      PARAMETERS
C        ISEED- FOR R.N. GENERATOR
C        STVAL- STARTING VALUE FOR RANGE OF RANDOM VARIABLE.
C         INCR- VALUE USED TO INCREMENT R.V. WHEN FORMING C.D.F.
C         CUMPR - VECTOR DENOTING THE CUMULATIVE DISTRIBUTION FUNCTION.
C         VAR - VARIATE OBTAINED FROM THE DISTRIBUTION
C         IDIM - DIMENSION OF CUMPR ON THIS CALL
C
      REAL CUMPR (50), LOPROB
      INTEGER STVAL
      INTEGER HIBD
      YFL = UNI(0)
       DO 5 K =1,IDIM
       IF(YFL.LE.CUMPR (K)) GO TO 6
    5 CONTINUE
    6 LOBD = STVAL + INCR *(K-2)
      HIBD = LOBD + INCR
      KLK = K+1
      IF(KLK.GE.IDIM) GO TO 17
      IF(CUMPR(KLK).EQ.CUMPR(K)) HIBD = HIBD + INCR
   17 RLOBD = FLOAT(LOBD)
      RHIBD = FLOAT(HIBD)
      HIPROB = CUMPR(K)
      IF (K .EQ. 1 ) GO TO 7
      J=K-1
      LOPROB =CUMPR (J)
      GO TO 8
    7 LOPROB = 0.0
    8 CALL INTERP (YFL,RLOBD,RHIBD,LOPROB,HIPROB,VAR)
      RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE INTERP (RAN,SMB,BGB,SMP,BGP,VAR)
C
C         LINEAR INTERPOLATOR
C         USES TWO-POINT FORM OF LINEAR EQUATION.
C         SMB,BGB - BOUNDS ON RANDOM VARIABLE
C         SMP,BGP - C.D.F. BOUNDS TO BE USED IN INTERPOLATION.
C
      VAR = SMB + ((RAN-SMP)*(BGB-SMB))/(BGP-SMP)
      RETURN
      END
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE CUMUL (ARRAY,IDIM)
C
C         A UTILITY ROUTINE TO CUMULATE THE ENTRIES
C        OF A ONE DIMENSIONAL ARRAY.
C
      REAL ARRAY (IDIM)
      DO 5 K=2,IDIM
      ARRAY (K) = ARRAY(K-1) + ARRAY (K)
    5 CONTINUE
       IF (ARRAY (IDIM) .EQ. 1.0) RETURN
      ARRAY(IDIM) = 1.0
      RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE STORE (DAY,DOCTOR,CLASS,LCODE)
C
C         ROUTINE STORES SURGERY REQUEST IN FILE
C       PARAMETERS:
C         DAY - THE DAY FOR WHICH THE REQUEST IS MADE
C         DOCTOR - CODE OF THE SURGEON
C         CLASS - CODE OF SURGERY CLASS REQUESTED
C         LCODE - AVERAGE POST OPERATIVE LENGTH OF STAY
C        FOR THIS OPERATION
C
      INTEGER*2 RQFILE(15,800),CLASPT(12),DOCPT(39)
      INTEGER*2 DAY,DOCTOR,CLASS,LCODE,AVAIL,LAST
      INTEGER*2 SL,WL,WLAST,SLAST,IDEMD,IAV
      COMMON /FILE/ RQFILE,AVAIL,LAST,CLASPT,DOCPT,SL,WL,WLAST,SLAST,
     *IDEMD
C       SL - POINTS TO THE STORED REQUEST LIST TO BE USED BY SLATER
      IF(SL .EQ. -77) SL = AVAIL
      IF (SLAST .NE. -77) RQFILE(14,SLAST) = AVAIL
C     NODE TO BE FILLED PRESENTLY IS LOCATED
      SLAST = AVAIL
      AVAIL = RQFILE (14,AVAIL)
C     SIGNAL END OF SLATE, IN CASE NO MORE REQUESTS ARE INPUT
      RQFILE(14,SLAST) = -177
C     BEGIN ACTUAL STORING OF INFORMATION ON THIS REQUEST
      RQFILE(1,SLAST) = DAY
      RQFILE(2,SLAST) = DOCTOR
      RQFILE(3,SLAST) = CLASS
      RQFILE(4,SLAST) = LCODE
      IDEMD = SL
      IF (AVAIL .EQ. -99) WRITE (6,9)
    9 FORMAT (' ', '***REQUEST FILE IS FULL ***' )
      RETURN
      END
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE CLEAR
C
C       SLATE NODES IN RQFILE ARE CLEARED
C     TO MAKE ROOM FOR THE NEXT DAY'S DEMAND
C
      INTEGER*2 RQFILE(15,800),AVAIL,LAST,CLASPT(12),DOCPT(39)
      INTEGER*2 SL,WL,SLAST,WLAST,IST,IPT,OLDPT
      INTEGER*2 IDEMD
      COMMON /FILE/ RQFILE,AVAIL,LAST,CLASPT,DOCPT,SL,WL,WLAST,SLAST,
     *IDEMD
      IST = SL
      IPT = SL
   10 DO 25 K=1,13
   25 RQFILE (K,IPT) = 0
      RQFILE(15,IPT) = 0
      OLDPT = IPT
      IPT = RQFILE (14,IPT)
      IF (IPT .NE. -177) GO TO 10
      RQFILE (14,OLDPT) = AVAIL
      AVAIL = IST
C         SLATE IS NOW EMPTY
      SL = -77
      LAST = -99
      SLAST = -77
      RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE REPGEN (METHOD,NOCLAS,NODOCS,COVER1,COVER2,COVER3)
C
C        THIS ROUTINE GENERATES INFORMATION REPORTS ON THE REQUESTS
C      PARAMETERS:
C        METHOD: TYPE OF REPORT DESIRED (CODE)
C        NOCLAS: NUMBER OF SURGERY CLASSES
C        NODOCS: NUMBER OF SURGEONS
C
      INTEGER*2 FINAL(39,39),PERFOR(39,39)
      INTEGER*2 DAY,RQFILE(15,800),CLASPT(12),DOCPT(39),AVAIL,LAST,IDEMD
      INTEGER*2 SL,WL,WLAST,SLAST
      INTEGER CLCODE (39,4)
      REAL RBUF(39)
      LOGICAL*1 COVER1,COVER2,COVER3
      COMMON /FILE/ RQFILE,AVAIL,LAST,CLASPT,DOCPT,SL,WL,WLAST,SLAST,
     *IDEMD
      COMMON /CODE/ CLCODE
      COMMON /OUT/ FINAL, PERFOR
C
C             REPORT ON SURGERY REQUESTED AND THAT PERFORMED
C
      IF(COVER3) GO TO 4555
      WRITE(6,400)
  400 FORMAT('1',//,30X,'SURGERY PERFORMANCE RATIOS  BY SURGEON',//)
      WRITE(6,401)
  401 FORMAT(' ',15X,'SURGEON',10X,'# REQUESTED',10X,'# PERFORMED',10X,
     *'RATIO',/)
      DO 402 J=1,39
      IRSUMS = 0
      IPSUMS = 0
      DO 403 K=1,39
      IRSUMS = IRSUMS + FINAL(J,K)
  403 IPSUMS = IPSUMS + PERFOR(J,K)
      IF(IRSUMS.NE.0) FRAC = FLOAT(IPSUMS)/FLOAT(IRSUMS)
      IF(IRSUMS.EQ.0) FRAC = 0.
      WRITE(6,405)J,IRSUMS,IPSUMS,FRAC
  405 FORMAT(' ',15X,I4,13X,I5,14X,I5,18X,F5.3)
      RBUF(J) = FRAC
  402 CONTINUE
      CALL USTAT(RBUF,RM,RD)
      WRITE(6,5405)RM,RD
 5405 FORMAT(' ',///, 24X ,' RATIO MEAN:  ',F6.3,5X,'ST. DEV.:  ',F6.3)
C
      WRITE(6,500)
  500  FORMAT('1',//,30X,'SURGERY PERFORMANCE RATIOS  BY SURGERY-CLASS',
     *//)
      WRITE(6,501)
  501 FORMAT(' ',15X,' CLASS ',10X,'# REQUESTED',10X,'# PERFORMED',10X,
     *'RATIO',/)
      DO 502 K=1,39
      IRSUMS = 0
      IPSUMS = 0
      DO 503 J=1,39
      IRSUMS = IRSUMS + FINAL (J,K)
  503 IPSUMS = IPSUMS + PERFOR (J,K)
      IF (IRSUMS.NE.0) FRAC = FLOAT(IPSUMS)/FLOAT(IRSUMS)
      IF (IRSUMS .EQ. 0) FRAC = 0.
      WRITE(6,505) (CLCODE(K,LL),LL=1,4),IRSUMS,IPSUMS,FRAC
  505 FORMAT(' ',12X,4A4,10X,I5,14X,I5,14X,F5.3)
```

```
      RBUF(K) = FRAC
  502 CONTINUE
      CALL USTAT(RBUF,RM,RD)
      WRITE(6,5405)RM,RD
C
C        ADDITIONAL REPORTS  -  SPECIFIED BY METHOD
C
C        METHOD:
C      1 - REPORT BY SURGEON
C      2 - REPORT BY CLASS
C      3 - SURGEON-CLASS SUMMARY
C      4 - COMPREHENSIVE REPORT
C
      GO TO(12,15,19,12), METHOD
C
C        LIST BY SURGEONS
C
   12 WRITE(6,101)
  101 FORMAT('1','REPORT ON REQUESTS AND PERFORMANCE OF INDIVIDUAL SURGE
     *ONS',///)
C
      WRITE (6,105)
      DO 9 KK=1,NODOCS
      WRITE(6,103) KK
 103  FORMAT(' ','SURGEON:  ',I4 )
  105 FORMAT(' ',' ',9X,'SURGERY CLASS',15X,'NO. REQUESTED',15X,'NO. PER
     *FORMED')
      ITOT = 0
      NTOT = 0
      DO 100 J=1,NOCLAS
      NRQ = FINAL (KK,J)
      MRQ = PERFOR(KK,J)
      ITOT = ITOT + NRQ
      NTOT = NTOT + MRQ
      IF (NRQ .EQ. 0) GO TO 100
      WRITE(6,7) (CLCODE(J,JK),JK=1,4),NRQ,MRQ
    7 FORMAT(' ',10X,4A4,20X,I4,20X,I4)
 100  CONTINUE
      WRITE(6,57) ITOT,NTOT
   57 FORMAT(' ',38X,'TOTAL: ',I3,15X,'TOTAL: ',I3,///)
    9 CONTINUE
      IF (METHOD .EQ. 4) GO TO 15
      RETURN
C
C        LIST BY SURGERY CLASS
C
   15 WRITE (6,201)
  201 FORMAT('1','REPORT ON REQUESTS AND PERFORMANCE BY SURGERY CLASS',
     *///)
C
      DO 10 KK  =  1,NOCLAS
      WRITE (6,203) (CLCODE(KK,MM), MM=1,4)
  203 FORMAT (' ','CLASS:     ',5X,4A4)
      WRITE (6,205)
  205 FORMAT(' ',5X,'SURGEON',22X,'NO. REQUESTED',15X,'NO. PERFORMED')
      ITOT = 0
      NTOT = 0
      DO 200 J =1,NODOCS
      NRQ = FINAL (J,KK)
      MRQ = PERFOR(J,KK)
      ITOT = ITOT + NRQ
      NTOT = NTOT + MRQ
      IF (NRQ .EQ. 0) GO TO 200
```

```
      WRITE(6,8)J,NRQ,MRQ
  8   FORMAT(' ',10X,I3,20X,I4,24X,I4)
 200  CONTINUE
      WRITE (6,58) ITOT,NTOT
  58  FORMAT(' ',34X,'TOTAL: ',I3,15X,'TOTAL: ',I3,///)
  10  CONTINUE
 4555 IF(METHOD .EQ. 4) GO TO 19
      RETURN
C
C   SUMMARY REPORT FOR THE PERIOD OF STUDY
C
  19  WRITE(6,20)
 20   FORMAT('1',' SUMMARY:  SURGEON-CLASS REQUEST FREQUENCIES',//)
      WRITE(6,51)
  51  FORMAT('-','SURGEON',25X,'SURGERY CLASS',/)
      WRITE(6,61) (J,J=1,39)
  61  FORMAT(' ',8X,39I3,/)
      DO 39 K=1,NODOCS
  39  WRITE(6,21) K, (FINAL(K,J),J=1,39)
  21  FORMAT(' ',I3,5X,39I3)
      WRITE (6,40)
 40   FORMAT('1','SUMMARY:  SURGEON-CLASS REQUEST PROBABILITIES',//)
      NCODE = 1
  59  WRITE(6,51)
  50  WRITE (6,17) (J,J=1,20)
  17  FORMAT (' ',5X,20I6)
      WRITE(6,18) (J,J=21,39)
 18   FORMAT (' ',7X,19I6,//)
      IF (NCODE .EQ. 2) GO TO 79
      IF (NCODE .EQ. 3) GO TO 89
      DO 71 K = 1,17
      ISUM = 0
      DO 171 J =1,39
 171  ISUM = ISUM + FINAL (K,J)
      CALL OUTPRO (K,ISUM,FINAL)
  71  CONTINUE
      WRITE (6,705)
      NCODE = 2
      GO TO 59
  79  DO 81 K=18,34
      ISUM = 0
      DO 181 J =1,39
 181  ISUM = ISUM + FINAL (K,J)
      CALL OUTPRO (K,ISUM,FINAL)
 81   CONTINUE
      WRITE (6,705)
      NCODE = 3
      GO TO 59
 89   DO 91 K=35,39
      ISUM = 0
      DO 191 J=1,39
 191  ISUM = ISUM + FINAL (K,J)
      CALL OUTPRO (K,ISUM,FINAL)
 91   CONTINUE
C
      WRITE(6,300)
 300  FORMAT('1',' SUMMARY:  SURGEON-CLASS PERFORMANCE FREQUENCIES',//)
      WRITE(6,51)
      WRITE(6,61) (J,J=1,39)
      DO 301 K=1,NODOCS
 301  WRITE(6,21) K,(PERFOR(K,J),J=1,39)
      WRITE(6,302)
 302  FORMAT('1','SUMMARY:  SURGEON-CLASS PERFORMANCE PROBABILITIES',//)
```

```
      NCODE = 1
  359 WRITE(6,51)
  350 WRITE(6,17)  (J,J=1,20)
      WRITE(6,18)  (J,J=21,39)
      IF  (NCODE .EQ.2) GO TO 379
      IF  (NCODE .EQ. 3) GO TO 389
      DO 371 K=1,17
      ISUM = 0
      DO 3171 J=1,39
 3171 ISUM = ISUM + PERFOR(K,J)
      CALL OUTPRO  (K,ISUM,PERFOR)
  371 CONTINUE
      WRITE(6,705)
      NCODE = 2
      GO TO 359
  379 DO 381 K=18,34
      ISUM = 0
      DO 3181 J=1,39
 3181 ISUM = ISUM + PERFOR(K,J)
      CALL OUTPRO(K,ISUM,PERFOR)
  381 CONTINUE
      WRITE(6,705)
      NCODE = 3
      GO TO 359
  389 DO 391 K=35,39
      ISUM = 0
      DO 3191 J=1,39
 3191 ISUM = ISUM + PERFOR(K,J)
      CALL OUTPRO(K,ISUM,PERFOR)
  391 CONTINUE
      WRITE(6,750)
  750 FORMAT(' ',35X,'*** -END OF SUMMARY REPORT- ***')
      WRITE(6,705)
 705  FORMAT  ('1',/)
      RETURN
      END

C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE OUTPRO(LINE,N,FINAL)
C
C      UTILITY FOR CALCULATING AND PRINTING SUMMARY PROBABILITIES
C
      INTEGER TEMP(39)
      INTEGER*2 FINAL(39,39)
      REAL VECTOR(39)
      IF  (N .NE. 0) GO TO 7
      DO 9 I=1,39
  9   VECTOR(I)  = 0.0
      GO TO 19
  7   DO 8 K=1,39
      TEMP  (K)  = FINAL  (LINE,K)
  8   VECTOR(K)  = FLOAT  (TEMP(K))/FLOAT(N)
  19  WRITE  (6,10)  LINE,(VECTOR(K),K=1,20)
   10 FORMAT  (' ',I3,5X,20F6.3)
      WRITE  (6,11)  (VECTOR(K)  ,  K=21,39)
  11  FORMAT  (' ',9X,19F6.3,/)
      RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C
C
      SUBROUTINE SLATER(DAY,NREQ)
C
C
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C         DETERMINES THE EFFECTIVE SLATE FOR ITS INPUT PARAMETER,
C       THE SIMULATED DAY.
C         NREQ REPRESENTS THE SIZE OF THE EXOGENOUS DAILY DEMAND
C* * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * * *
C
C
      INTEGER*2 RQFILE(15,800),CLASPT(12),DOCPT(39),AVAIL,LAST
      INTEGER*2 CURREQ,WKDAY,LDOC,DAY,YEST,ILOS,FIRST,RFSL,RFWL
      INTEGER*2 FINAL(39,39),PERFOR(39,39),DWLCAN,DSLCAN
      INTEGER*2 SL,WL,WLAST,SLAST,IDEMD,ISLTKE,IWLTKE
      INTEGER*2 IAN,IBLK,T,FT,EAT,EDUR,ENDSLT,TEM1,TEM2,TEM3,TEM4,
     *LAVPTR,LCYPTR,TOLD,PROPEN
      INTEGER*2 OPRM(39,12),DOCAV(5,39),BLOCK(8,35),DOCLOC(39),
     *DAYBLK(39),ANES1(39),ANES2(39),NPOSS(10)
      INTEGER*2 TEMP(16,7),BUFFER(7),BEDLIM
      INTEGER*2 FINDAY,OPLEN
C
      INTEGER FILREQ,WNFILL,RNFILL,TFIL(39),WTFIL(39),RTFIL(39)
      INTEGER ASSIGN(39)
      INTEGER RANOCC(7),DSTAB,RSLAT,WTAKEN(39),RTAKEN(39)
      INTEGER LENSUR(39),CHOICE,CLCODE(39,4),WANOCC(7)
      INTEGER TAVLD(39),TAVLDA(39),STARD(39),STARDA(39),ENDD(39),
     *ENDDA(39),RREWL,NREWL,WNREWL,TWAIT,RWAIT,DNOBED,WNOBED,RNOBED,
     *CENSUS,DCANCL,WCANCL,RCANCL,DCANOR,WCANOR,RCANOR,LEAVNG(50),
     $TORAVL(12),WNOROM,RNOROM,DTGAP,WTGAP,RTGAP,WNPOST(39),RNPOST(39),
     *WTPOST(39),RTPOST(39),LAVTIM(30),LCYSOC(30),WDTLOC(39),RDTLOC(39),
     *GCYSTL,WTUSED(39),RTUSED(39),WTAVLD(39),RTAVLD(39),DSLAT,WSLAT,
     *OPUT(12),WOPUT(12),ROPUT(12),WNREQ,RNREQ,DNPOST,WNREML,WIDCAN
     *,RIDCAN,RNREML
C
      REAL WEIGHT(39)
      REAL RUTRAT(39),RWLDAY,WLDAY,UTRAT(39),SLUR(12),PERCID(12),FRIND
     *(39),BLUT(39),PERCAN(7),RBLUT(39),RFRIND(39)
      INTEGER BLANK/'    '/,GAP/' (G)'/,CHAR
      LOGICAL*1 XFRAG(16,12),DEBUG,COVER1,COVER2,COVER3
C
      COMMON /FILE/ RQFILE,AVAIL,LAST,CLASPT,DOCPT,SL,WL,WLAST,SLAST,
     *IDEMD
      COMMON /SCHED/ LEAVNG,LENSUR,RTAVLD,RTUSED,RDTLOC
     *,RTPOST,RNPOST,RUTRAT,WNPOST,WTPOST,WDTLOC,WTAVLD,WTUSED,UTRAT,
     *WTFIL,RTFIL,WTAKEN,RTAKEN,
     *WSLAT,WLDAY,WNREWL,TWAIT,WNOBED,WCANCL,WCANOR,WNOROM,WTGAP,
     *WNREML,RNREML,RIDCAN,IWLSRT,IRLSRT,WNFILL,RNFILL,
     *RREWL,RWLDAY,WNREQ,RNREQ,CENSUS,ROPUT,WOPUT,BLOCK,OPRM,DOCAV
      COMMON /OUT/ FINAL, PERFOR
      COMMON/CODE/ CLCODE
      COMMON /XTRA/ RFRIND,RBLUT,WANOCC,RANOCC,DSTAB,RSLAT,RCANCL,RCANOR
     *,RTGAP,RNOBED,RNOROM,IRNWL,IRNWL2,RWLDA2,FINDAY,COVER1,COVER2,
     *COVER3
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
```

```
C         THE ROUTINE RECEIVES A WAITING LIST (WL) AND A LIST OF DEMAND
C       FOR THE DAY (SL)
C       IT PRODUCES AN UPDATED WAITING LIST AND A LIST OF SLATED REQUESTS
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C
C         DESCRIPTION OF ACCUMULATORS USED FOR SLATE EVALUATION
C
C    DAILY COUNTERS:
C       NREWL - NO. OF REQUESTS FROM DEMAND LIST THAT HAVE BEEN PLACED
C             ON WAITING LIST
C       DNOBED - NO. OF REQUESTS PLACED ON WL BECAUSE OF UNAVAILABILITY
C             OF BEDS
C       DCANCL - NO. OF CANCELLATIONS BY SLATING CLERK
C       DCANOR - NO. OF CANCELLATIONS BY O.R. SUPERVISOR
C       LACKRM - NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE
C             OPERATING THEATRE FOR THE REQUIRED DURATION
C       DSLAT - NO. OF REQUESTS PLACED ON SLATE IN A DAY
C       DTGAP - AMOUNT OF TIME "GAPPED" BECAUSE OF ABRUPT CANCELLATION
C       NREMWL - NO. OF REQUESTS SLATED FROM PREVIOUS DAY'S WAITING LIST
C       IDCAN - NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND
C       NNWL - NO. OF REQUESTS ON WL FROM YESTERDAY
C       NFILL - NO. OF REQUESTS SLATED ON RESCAN OF WL
C       DWLCAN - NO. OF REQUESTS CANCELLED (REPLACEABLE) FROM WL
C       DSLCAN - NO. OF REQUESTS CANCELLED (REPLACEABLE) FROM DAILY DEMAND
C
C
C   WEEKLY COUNTERS:
C       WLDAY - AVERAGE NO. OF DAYS A REQUEST SPENDS ON WAITING LIST
C             BEFORE BEING SLATED
C       WSLAT - NO. OF REQUESTS PLACED ON SLATE IN A WEEK
C       WNREWL - NO. OF REQUESTS PLACED ON WAITING LIST
C       TWAIT - TOTAL NO. OF DAYS WAITED BY ALL REQUESTS ON WL
C             BEFORE BEING SLATED
C       WNOBED - NO. OF REQUESTS PLACED ON WL BECAUSE OF
C             BED UNAVAILABILITY
C       WCANCL - NO. OF CANCELLATIONS BY SLATING CLERK PER WEEK
C       WCANOR - NO. OF CANCELLATIONS BY O.R.
C       WNOROM - NO. OF REQUESTS POSTPONED BECAUSE OF
C             LACK OF FREE OPERATING THEATRE
C       IWLSRT - NO. OF REQUESTS ON WL AT THE START OF THE WEEK
C       WIDCAN - NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND
C       WNFILL - NO. OF REQUESTS SLATED ON RESCAN OF WL
C       WTGAP - WEEKLY AMOUNT OF TIME "GAPPED"
C       WANOCC(7) - TIME EACH ANESTHETIST IS SLATED TO WORK
C       WOPUT(12) - TIME EACH OPERATING ROOM IS SLATED FOR USE
C       WTFIL(39) - UNUSED BLOCK TIME GIVEN AWAY BY A SURGEON TO OTHERS
C       WTAKEN(39) - EXTRA BLOCK TIME TAKEN BY A SURGEON FROM OTHERS
C       WTPOST(39) - UNSLATED TIME POSTPONED FOR EACH SURGEON BECAUSE OF
C             INSUFFICIENT BLOCK TIME
C       WTUSED(39) - TIME GIVEN BY SLATER(BASED ON BLOCKS)
C             TO EACH SURGEON FOR GENERAL SURGERY
C       WTAVLD(39) - TIME ALLOTTED BY BLOCK TO EACH SURGEON
C       UTRAT(39) - (BLOCK TIME USED + BLOCK TIME TAKEN + UNSLATED TIME
C             POSTPONED) / (BLOCK TIME ALLOTTED TO THE SURGEON)
C
C
C   OVERALL RUN ACCUMULATORS:
C
C       NAME - COUNTERPART OF WEEKLY COUNTER
C       ----                   -------------------
C       RWLDAY       -         WLDAY
```

```
C       RREWL         -     WNREWL
C       RWAIT         -     TWAIT
C       RNOBED        -     WNOBED
C       RCANCL        -     WCANCL
C       RCANOR        -     WCANOR
C       RNOROM        -     WNOROM
C       RTGAP         -     WTGAP
C       RWLSRT        -     IWLSRT
C       RIDCAN        -     WIDCAN
C       RNFILL        -     WNFILL
C       RANOCC(7)       -   WANOCC(7)
C       ROPUT(12)       -   WOPUT(12)
C       RTFIL(39)       -   WTFIL(39)
C       RTAKEN(39)      -   WTAKEN(39)
C       RTPOST(39)      -   WTPOST(39)
C       RTAVLD(39)      -   WTAVLD(39)
C       RTUSED(39)      -   WTUSED(39)
C       RUTRAT(39)  - OVERALL UTILIZATION RATIO FOR EACH SURGEON
C                  DESIGNED AS AN EFFECTIVENESS MEASURE FOR THE BLOCKING SYSTEM.
C
C
C
      COVER3 = .TRUE.
      IF(DSTAB.GT.0) COVER3 = .FALSE.
      IF(DAY.GE.45 .AND. DSTAB .GT.0) COVER2 = .FALSE.
      IF(DAY.GE.45 .AND. DSTAB .GT.0) COVER1 = .FALSE.
      GO TO 9600
C
C      THIS PORTION OF THE PROGRAMME IS INVOKED ONLY IN EXPERIMENTATION
C     WITH ADAPTIVE SCHEDULING
C
C      ATTEMPT TO RESCHEDULE BLOCK TIME IN AN ADAPTIVE MODE
C     BASED ON CUMULATED UTILIZATION RATIOS FOR 25 DAYS
      DO9680 K=1,39
      DO 9680 J=1,5
 9680 DOCAV(J,K) = 0
      DO 9691 J=1,8
      DO 9691 K=1,35
 9691 BLOCK(J,K) = 0
      RUTRAT(5) = 0.
      DO 9681 J=1,39
      IF(J.EQ.5) GO TO 9681
      RUTRAT(J) = (RTPOST(J)+RTAKEN(J)+RTUSED(J))/FLOAT(RTAVLD(J) )
 9681 CONTINUE
C      WEIGHTS ARE CALCULATED FOR AMOUNT OF TIME TO BE ASSIGNED
C     TO EACH SURGEON
      DO 9601 J=1,39
 9601 WEIGHT(J) = RUTRAT(J)*WTAVLD(J)
      RUTSUM = 0
      DO 9602 J=1,39
 9602 RUTSUM = RUTSUM + WEIGHT(J)
      DO 2345 J=1,39
 2345 WEIGHT(J) = WEIGHT(J) / RUTSUM
      RUTSUM = 0
      TOTIME = 11700
      DO 9603 J=1,39
      WEIGHT(J) = WEIGHT(J) * TOTIME
 9603 RUTSUM = RUTSUM + WEIGHT(J)
      IF(RUTSUM.GE.TOTIME) GO TO 9604
      WEIGHT(37) = WEIGHT(37) + (TOTIME-RUTSUM)
C      ASSURE A MINIMUM OF 60 MINUTES FOR EACH SURGEON
 9604 RUTSUM = 0
      DO 9605 J=1,39
```

```
      IF (WEIGHT(J) .GE. 60.0) GO TO 9605
      RUTSUM = (60.0 - WEIGHT(J)) + RUTSUM
      WEIGHT(J) = 60.0
 9605 CONTINUE
C      SUBTRACT EXTRA ADDED TIME FROM THAT ALLOTTED TO SURGEON 37
      WEIGHT(37) = WEIGHT(37) - RUTSUM
C
C        REFORM ENTIRE BLOCK SYSTEM
C
C      DECIDE ON NO. OF HOURS TO BE GIVEN EACH SURGEON
      RUTSUM = 0
      DO 9606 J=1,39
      WT = WEIGHT(J) /60.0
      ASSIGN(J) = IFIX(WT)
C      COLLECT LEFTOVER MINUTES
      IWT = ASSIGN(J)*60
      RUTSUM = RUTSUM + (WEIGHT(J) - FLOAT(IWT))
 9606 CONTINUE
      ASSIGN(37) = ASSIGN(37) + RUTSUM/60.0
C
C      ROW AND COLUMN TO BE FILLED
      NNC = 1
      NNR = 1
      NPASS = 1
C      SURGEON IS DESIGNATED
      J = 1
 9660 NOLEFT = 0
C      NO. OF HOURS TO BE ASSIGNED ON THIS PASS
      NOHORS = MINO(ASSIGN(J),7)
      IF(NOHORS.EQ.0) GO TO 9661
C      NO. OF HOURS CURRENT ANESTHETIST CAN ACCOMMODATE
      NABLE = 8 - NNR + 1
      IF (NABLE .LT.NOHORS) NOLEFT = NOHORS - NABLE
      LIM = NNR + NOHORS - 1
      IF(LIM .GT.8) LIM = 8
      DO 9650 K=NNR,LIM
 9650 BLOCK(K,NNC) = J
      IF(NNC.LE.7) MMDAY = 1
      IF(NNC.GT.7 .AND. NNC .LE.14) MMDAY = 2
      IF(NNC.GT.14 .AND. NNC.LE.21) MMDAY = 3
      IF(NNC.GT.21 .AND. NNC.LE.28) MMDAY = 4
      IF(NNC.GT.28 .AND. NNC.LE.35) MMDAY = 5
C      REFORM THE DOCTOR AVAILABILITY TABLE
      DOCAV(MMDAY,J) = 1
      ASSIGN(J) = ASSIGN(J) - (LIM-NNR+1)
      NNR = LIM + 1
      IF(NNR .LE.8) GO TO 9661
      NNR = 1
C      IN-SERVICE MODELLED
      NNC = NNC + 1
      NCOL = MOD(NNC,7)
C      ALLOW FOR ONLY 5 ANESTHETISTS
      IF(NNC.EQ.6 .OR. NNC.EQ.7)  NNC = NNC + 2
      IF(NNC.EQ.8 .OR. NNC.EQ.9) GO TO 9697
      IF(NCOL.EQ.0 .OR. NCOL.EQ.6) NNC = NNC + 2
 9697 IF(NNC.GT.35) GO TO 9662
      IF(NNC.GT.14 .AND. NNC.LT.21) NNR = 2
      IF (NOLEFT .EQ. 0) GO TO 9661
C      FILL UP COLUMN WITH LEFTOVER TIME
C    FROM PREVIOUS ANESTHETIST
      LIM = NNR + NOLEFT - 1
      DO 9651 K=NNR,LIM
 9651 BLOCK(K,NNC) = J
```

```
      ASSIGN(J) = ASSIGN(J) - (LIM - NNR + 1)
      NNR = LIM + 1
      IF(NNR.LE.8) GO TO 9699
      NNR = 1
      NNC = NNC + 1
      NCOL = MOD(NNC,7)
      IF(NCOL.EQ.6) NNC = NNC + 2
      IF(NNC.GT.14 .AND. NNC.LT.21 .AND. NNR.EQ.1) NNR = 2
 9699 CONTINUE
C
C      CHANGE SURGEON
C
 9661 J=J+1
      IF (J.LE.39) GO TO 9660
      NPASS = NPASS + 1
      IF (NPASS .GT.4) GO TO 9666
C
C      BEGIN A NEW PASS
C
 9665 J=1
      GO TO 9660
C    CHECK THAT ALL ASSIGNED TIME HAS BEEN ALLOCATED
 9666 ISUM = 0
      DO 9667 K=1,39
 9667 ISUM = ISUM + ASSIGN(K)
      IF(ISUM .GT. 1) GO TO 9665
C    WRITE OUT NEW BLOCKING SYSTEM
 9662 CONTINUE
C
C      INTERCHANGE SOME OF FRIDAY'S ALLOCATIONS WITH THOSE ON MONDAY
C      AND TUESDAY, TO ELIMINATE BLOCK OVERLAP ON FRIDAY
C
      I1 = 2
      I2 = 32
      ID1 = 1
      ID2 = 5
 9781 DO 9780 KK=1,8
      LTEM = BLOCK(KK,I1)
      MTEM = BLOCK(KK,I2)
      DOCAV(ID1,MTEM) = 1
      BLOCK(KK,I1) = MTEM
      DOCAV(ID2,LTEM) = 1
 9780 BLOCK(KK,I2) = LTEM
      IF(I1 .EQ. 8) GO TO 9782
      I1 = 8
      I2 = 33
      ID1 = 2
      GO TO 9781
 9782 CONTINUE
C
      WRITE(6,9669)
 9669 FORMAT('1',20X,' REARRANGED BLOCK STRUCTURE',/)
      WRITE(6,9670) (J,J=1,35)
 9670 FORMAT (' ',/,5(7I3,3X) )
      DO 9682 J=1,39
 9682 RUTRAT(J) = 0.
      DO9671 J=1,8
 9671 WRITE(6,9670)  (BLOCK(J,K),K=1,35)
C
C      THE REMAINDER OF SUBROUTINE SLATER IS INVOKED DAILY
C
 9600 IF(COVER1) GO TO 4531
C      PRINT OUT BLOCK INFORMATION
```

```
      WRITE(6,900)
 900  FORMAT ('1',25X,'GENERAL SURGERY BLOCK-TIME ARRANGEMENT',//)
      WRITE(6,901)
 901  FORMAT(' ',/,40X,'ANESTHETISTS',///)
      WRITE(6,902) (J,J=1,7)
 902  FORMAT(' ',30X,7(6X,I4),//)
      WRITE(6,903)
 903  FORMAT(' ',11X,'TIME',40X,'SURGEON-CODES',/)
4531  NDAY = DAY
      WKDAY = MOD(NDAY,5)
      IF (WKDAY .EQ. 0) WKDAY = 5
      ISTR = (WKDAY-1)*7 + 1
      IFNN = ISTR + 6
      ITME = 800
      K = 1
      IF (COVER1) GO TO 4532
 905  WRITE(6,907) ITME,(BLOCK(K,J),J=ISTR,IFNN)
      ITME = ITME + 100
      K = K+1
      IF (K .LT. 9) GO TO 905
 907  FORMAT(' ',10X,I5,15X,7(6X,I4),/)
C
C        INITIALIZE VECTORS WHICH EXTRACT BLOCK INFORMATION
C
4532  DO 910 J=1,39
      TAVLD(J) = 0
      TAVLDA(J) = 0
      STARD (J) = 0
      STARDA(J) = 0
      ENDD (J) = 0
      ENDDA(J) = 0
      ANES1(J) = -1
 910  ANES2(J) = -1
C      EXTRACT PERTINENT BLOCK INFORMATION FOR USE IN SLATING
      IR = 1
      IC = ISTR - 1
 913  IC = IC + 1
      NOLDR = -1
      IF (IC .GT. IFNN) GO TO 916
 912  IDCTR = BLOCK(IR,IC)
C      DISREGARD SURGEON CODE OF 0
      IF(IDCTR.NE. 0) GO TO 917
      IR = IR + 1
      IF (IR .LE. 8) GO TO 912
      IR = 1
      GO TO 913
 917  IF (IR .EQ. 1) GO TO 911
C      CHECK FOR START OF A DIFFERENT SURGEON'S BLOCK
      IF (IDCTR .EQ. NOLDR) GO TO 911
      IF (NOLDR.EQ.-1) GO TO 911
      IF (ENDD(NOLDR) .GT. 0) ENDDA(NOLDR) = 800 +(IR-1) *100
      IF (ENDD (NOLDR) .EQ. 0) ENDD(NOLDR) = 800 + (IR-1)*100
 911  IF(ENDD(IDCTR).GT.0) GO TO 918
      TAVLD(IDCTR) = TAVLD(IDCTR) + 60
      IF (STARD(IDCTR) .EQ. 0) STARD(IDCTR) = 800 +(IR-1)*100
      IF(ANES1(IDCTR).EQ.-1)ANES1(IDCTR) =MOD(IC,7)
      IF (ANES1(IDCTR) .EQ.0) ANES1(IDCTR) = 7
      GO TO 915
 918  TAVLDA(IDCTR) = TAVLDA(IDCTR) + 60
      IF (STARDA(IDCTR) .EQ. 0) STARDA(IDCTR) = 800 + (IR-1)* 100
      IF (ANES2(IDCTR) .EQ.-1) ANES2(IDCTR) = MOD(IC,7)
      IF (ANES2(IDCTR) .EQ.0) ANES2 (IDCTR) = 7
C
```

```
  915  NOLDR = IDCTR
       IR = IR + 1
       IF (IR .LE. 8) GO TO 912
       IF (ENDD(NOLDR) .GT.0) ENDDA(NOLDR) = 1600
       IF (ENDD(NOLDR) .EQ.0) ENDD(NOLDR) = 1600
       IR = 1
       GO TO 913
C
C       SWITCH BLOCKS SO THAT FIRST BLOCK WOULD OCCUR AT THE EARLIER TIME
C
  916  DO 1916 LDOC = 1,39
       IF( (STARD(LDOC) .LE. STARDA(LDOC)) .OR. (STARDA(LDOC).EQ.0)   )
      *GO TO 1916
       TEM1 = STARD (LDOC)
       TEM2 = ENDD (LDOC)
       TEM3 = TAVLD (LDOC)
       TEM4 = ANES1 (LDOC)
       STARD(LDOC) = STARDA (LDOC)
       ENDD (LDOC) = ENDDA (LDOC)
       TAVLD (LDOC) = TAVLDA(LDOC)
       ANES1 (LDOC) = ANES2 (LDOC)
       STARDA(LDOC) = TEM1
       ENDDA (LDOC) = TEM2
       TAVLDA (LDOC) = TEM3
       ANES2 (LDOC) = TEM4
 1916  CONTINUE
C
C     IS PRINTOUT FOR DEBUGGING DESIRED?
       DEBUG = .FALSE.
C
C
C         INITIALIZE ALL OTHER ACCUMULATORS
C         REQUIRED FOR SLATE EVALUATION
C
       LDOC = 0
       IAN = -55
       DSLAT = 0
       DCANCL = 0
       DNOBED =0
       DCANOR = 0
       NREWL = 0
       LACKRM = 0
       DTGAP = 0
       DSLCAN = 0
       DWLCAN = 0
       NREMWL = 0
       NFILL = 0
       GCYSTL = 0
       DNPOST = 0
       NNWL = 0
       NWAIT2 = 0
       NWAIT = 0
C       UPPER LIMIT ON SURGICAL BED CENSUS
       BEDLIM = 140
C
       DO 3336 J=1,10
 3336  NPOSS(J) = 0
       DO 9501 J=1,12
 9501  OPUT(J) = 0
       DO 3339 I=1,12
       DO 3339 J=1,16
 3339  XFRAG(J,I) = .FALSE.
       DO 801 I=1,39
```

```
      TFIL(I) = 0
      DOCLOC(I) = -1
 801  DAYBLK(I) = 1
C
      IF (WKDAY .NE. 1) GO TO 920
C
C  WEEKLY ACCUMULATORS:
C              (WILL HAVE BEEN ADDED TO RUN ACCUMULATORS
C          AND PRINTED AT END OF EACH WEEK)
C
      WLDAY = 0.
      WNREWL = 0
      TWAIT = 0
      WNOBED = 0
      WNREQ = 0
      WCANCL = 0
      IWNWL = 0
      WCANOR = 0
      IWNWL2 = 0
      WLDAY2 = 0.
      WNREML = 0
      WIDCAN = 0
      WSLAT = 0
      WTGAP = 0
      WNOROM = 0
      WNFILL = 0
      NWPST = 0
      DO 803 J=1,39
      WNPOST(J) = 0
      WTFIL(J) = 0
      WTPOST(J) = 0
      WDTLOC(J) = 0
      WTAKEN(J) = 0
      WTUSED(J) = 0
      WTAVLD(J) = 0
      FRIND(J) = 0.
      BLUT(J) = 0.
 803  UTRAT(J) = 0.
      DO 804 J=1,12
 804  WOPUT(J) = 0
      DO 805 J=1,7
 805  WANOCC(J) = 0
C
C         TOTAL TIME AVAILABLE TO EACH SURGEON FOR GENERAL SURGERY
C       THIS WEEK
C
 920  DO 921 J=1,39
 921  WTAVLD(J) = WTAVLD(J) + TAVLD(J) + TAVLDA(J)
C
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C
C         ROFILE NOW CONSISTS OF A WAITING LIST, A LIST OF REQUESTS TO BE
C     SLATED, AND AN AVAILABILITY LIST
C
C         THIS PORTION PASSES THE SET OF DAILY REQUESTS THROUGH
C      TWO FILTERS:
C
C         1 BED AVAILABILITY
C         2 CANCELLATION
C
C         THE WAITING LIST IS SCANNED FIRST, THEN THE DEMAND LIST IS EXAMINED.
```

```
C
C       A REQUEST IS EITHER:
C                             1)  PLACED OR KEPT ON WL
C                             2)  PLACED ON THE SLATE
C                             3)  CANCELLED
C
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C
      IF(COVER2) GO TO 4543
      IF(COVER1) WRITE(6,720)
      WRITE(6,4050)
 4050 FORMAT(' ',//////////,25X,'SURGICAL BED CENSUS INFORMATION',///)
      WRITE(6,4051) DAY
 4051 FORMAT(' ',38X,'BEFORE SIMULATION OF SLATING ON DAY:   ',I3,//)
C
C       SWITCHES ARE INITIALIZED INDICATING THAT A REQUEST HAS BEEN
C      TAKEN FROM THE WAITING LIST OR THE DEMAND LIST
 4543 IWLTKE = 0
      ISLTKE = 0
      NSLOT = 0
      LWLPRO = 0
      YEST = DAY - 1
      FIRST = 1
C
      IF(COVER2) GO TO 4544
      WRITE(6,4052) YEST,CENSUS
 4052 FORMAT(' ',45X,'CENSUS AT START OF DAY ',I3,' BEFORE DEPARTURES WA
     *S: ',I4,//)
C
C       THE CENSUS ON THE DAY PRECEDING THE SIMULATED DAY IS ADJUSTED
C      BY REMOVING THE PATIENTS SCHEDULED TO LEAVE.
C
 4544 IF(DAY.EQ.1) YEST = 50
      CENSUS = CENSUS - LEAVNG(YEST)
      LVN = LEAVNG(YEST)
      LEAVNG(YEST) = 0
      IF(COVER2) GO TO 4545
      IF (DAY .NE. 1) WRITE(6,4053) YEST,LVN
 4053 FORMAT(' ',45X,'NO. SCHEDULED TO DEPART ON DAY ',I3,' WAS: ',I4)
 4545 IF(DEBUG) GO TO 700
C
C       IS THE NEXT REQUEST TO COME FROM WAITING LIST OR FROM THE
C      DEMAND LIST?
C
   2  RFWL = 0
      IF( (WL .EQ. -88) .OR. (ISLTKE .EQ. 1) ) GO TO 142
C        WAITING LIST IS NOT EMPTY
      IF (LWLPRO .NE. 0) GO TO 71
C       LAST NODE FROM WL THAT IS TO BE PROCESSED IS SET
      LWLPRO = WLAST
C     WLAST ADJUSTED FOR SCANNING PROCESS BY SLATER
C     IT PREVIOUSLY INDICATED LAST NODE OF WAITING LIST ACCEPTED BY
C     SLATER
C         THE SLATER HAS ALREADY EXAMINED  WLAST  NODE
C       A ' BOUNDARY CONDITION' IS RESOLVED FOR LIST PROCESSING.
C
      WLAST = WL
   71 IF ( (WLAST .EQ. LWLPRO) .OR. (RQFILE(14,WLAST) .EQ. -188) )
     *GO TO 142
      IF ( (WLAST .EQ. WL) .AND. (IWLTKE .EQ. 0) )CURREQ = WLAST
C       REQUEST HAS BEEN TAKEN FROM THE WAITING LIST
```

```
      IF (IWLTKE .EQ. 1) CURREQ = RQFILE (14,WLAST)
C     SPECIAL CONDITION FOR NO CURRENT WAITING LIST
      IF(IWLTKE.EQ.1 .AND. WLAST.EQ.WL .AND. NSLOT.EQ.0) CURREQ = WL
      IF(DEBUG) WRITE(6,4001) CURREQ
 4001 FORMAT(' ',' REQUEST FROM WL:',I4)
      NNWL = NNWL + 1
      IWLTKE = 1
C
C       REMOVE POSTPONEMENT DECISION FROM PREVIOUS WORK-UP RUN
      IF (DAY.EQ.1.AND.(RQFILE(7,CURREQ).GT.10))RQFILE(7,CURREQ) =
     *RQFILE(7,CURREQ) - 10
C
C       ACCOUNT FOR INCOMING WAITING LIST  IN NO. REQUESTED FOR RUN
      IF(DAY.GT.1) GO TO 4987
      LLD = RQFILE(2,CURREQ)
      LLO = RQFILE(3,CURREQ)
      IF(LLO.GT.100) LLO = LLO - 100
      IF(DAY.EQ.1) FINAL(LLD,LLO) = FINAL(LLD,LLO) + 1
 4987 RFWL = 1
      GO TO 4
C
C       REQUEST IS FROM DEMAND LIST
  142 IF(IDEMD .EQ. -177) GO TO 4708
      IF (ISLTKE .EQ. 0) ISLTKE = 1
      CURREQ = IDEMD
      IDEMD = RQFILE (14,IDEMD)
C       IDENTIFY THE SURGEON
    4 LDOC = RQFILE(2,CURREQ)
      IF(DEBUG) WRITE(6,4002) CURREQ
 4002 FORMAT(' ',' CURRENT REQUEST: ',I4)
      IF(DEBUG) WRITE(6,4003) CENSUS
 4003 FORMAT(' ',' CENSUS: ',I4)
C       LOCAL SURGERY DOES NOT FOLLOW BLOCK SYSTEM
      NS = RQFILE(3,CURREQ)
      IF(NS .GT. 100) NS = NS - 100
      IF (NS .LE. 7) GO TO 143
C       CAN THE SURGEON OPERATE ON THIS WEEKDAY?
      IF (DOCAV(WKDAY,LDOC) .NE. 1) GO TO 20
  143 IF (RQFILE (4,CURREQ) .EQ. 0) GO TO 6
C
C          BED AVAILABILITY FILTER
C
      IF (CENSUS.LT.BEDLIM) GO TO 6
C     NO BED AVAILABLE
      DNOBED = DNOBED + 1
      IF(DEBUG) WRITE(6,4004)
 4004 FORMAT(' ',' NO BED')
      GO TO 20
C
C          CANCELLATION FILTER
C
C       REQUESTING SURGEON IS ALLOWED TO OPERATE TODAY
C     SIGNIFY THAT THIS REQUEST WILL HAVE PASSED THROUGH THE
C     CANCELLATION FILTER
    6 IF ((RQFILE(7,CURREQ) .NE.1) .AND. (RQFILE(7,CURREQ) .NE.11))
     *GO TO 1310
      GO TO 310
 1310 RQFILE(7,CURREQ) = RQFILE(7,CURREQ) + 1
C
      YFL = UNI(0)
      IF (YFL .GE. 0.146) GO TO 10
      IF(DEBUG) WRITE(6,4005)
 4005 FORMAT(' ',' CANC. BY SL. CL.')
```

```
C
C     CANCELLATION BY SLATING CLERK WILL OCCUR
C
      YFL = UNI(0)
      IF (YFL .GE. 0.15) GO TO 11
C
C        NON-REPLACEABLE CANCELLATION WILL OCCUR
C
      IF(DEBUG)WRITE(6,4006)
 4006 FORMAT(' ',' NON-REPL.')
C
C        CREATE GAP SURGERY
C
      RQFILE (3,CURREQ) = RQFILE (3,CURREQ) + 100
      GO TO 310
C
C     THERE IS NO CANCELLATION BY SLATING CLERK
C
   10 YFL = UNI(0)
      IF(DEBUG) WRITE(6,4007)
 4007 FORMAT(' ',' NO CANC. BY SL. CL.')
      IF (YFL .GE.0.169) GO TO 310
C
C     REQUEST WILL HAVE BEEN CANCELLED BY OPERATING ROOM SUPERVISOR
C        SCHEDULE GAP SURGERY
C
      IF(DEBUG) WRITE(6,4008)
 4008 FORMAT(' ',' CANC. BY OR')
      RQFILE (3,CURREQ) = RQFILE (3,CURREQ) + 100
      RQFILE(15,CURREQ) = 1
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C        REQUEST HAS PASSED THROUGH APPROPRIATE FILTERS
C      AN ATTEMPT IS NOW MADE TO SLATE IT
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C      SLATING A NON-CYSTOSCOPIC PROCEDURE WITH A GENERAL ANESTHETIC
C
C      BLOCK THAT REQUEST WAS TAKEN FROM IS NOTED
  310 IBLK = 1
C      DETERMINE THE TYPE OF SURGERY
      NSURG = RQFILE(3,CURREQ)
C    REMOVE GAP EFFECT
      IF (NSURG .GT. 100) NSURG = NSURG - 100
C      IS THE ANESTHETIC LOCAL OR GENERAL?
      IF (NSURG .LE. 7) GO TO 500
C      GENERAL ANESTHETIC
      OPLEN = LENSUR(NSURG)
      IF (TAVLD(LDOC) .EQ.0) GO TO 1002
C      DOES SURGEON HAVE ENOUGH BLOCK TIME LEFT?
  505 IF (DAYBLK(LDOC) .NE. 1) GO TO 1001
      IF (OPLEN .LE. TAVLD(LDOC)) GO TO 502
 1001 IF(DAYBLK(LDOC) .NE. 2) GO TO 1002
      IF(OPLEN .LE. TAVLDA(LDOC)) GO TO 502
      GO TO 506
 1002 IF (TAVLDA (LDOC) .EQ. 0) GO TO 503
      DAYBLK(LDOC) = 2
      GO TO 505
C      SURGERY TAKES LONGER THAN SECOND BLOCK
C      BLOCK TO BE SEARCHED IS BLOCK 1 AGAIN
  506 DAYBLK (LDOC) = 1
C      POSTPONE THE REQUEST
  503 IF(DEBUG) WRITE(6,4009)
```

```
 4009 FORMAT(' ',' NOT ENOUGH BLOCK TIME')
      DNPOST = DNPOST + 1
      IF (RQFILE(7,CURREQ) .GE. 10) GO TO 20
      WNPOST(LDOC) = WNPOST(LDOC) + 1
      WTPOST(LDOC) = WTPOST(LDOC) + OPLEN
C       POSTPONEMENT DECISION INDICATOR
      RQFILE(7,CURREQ) = RQFILE(7,CURREQ) + 10
C      REQUEST WILL BE KEPT OR PLACED  ON WAITING LIST
      GO TO 20
C
C      THERE IS ENOUGH TIME TO SCHEDULE THIS OPERATION
 502  IF (DAYBLK(LDOC) .EQ. 1) TAVLD(LDOC) = TAVLD(LDOC) - OPLEN
      IF (DAYBLK(LDOC) .EQ. 1) GO TO 507
C    TIME IS TAKEN FROM SECOND BLOCK OF DAY
      TAVLDA(LDOC) = TAVLDA(LDOC) - OPLEN
C      BLOCK TO BE SEARCHED ON NEXT ATTEMPT IS BLOCK 1
      DAYBLK(LDOC) = 1
C      BLOCK REQUEST WAS ASSIGNED TO IS BLOCK2
      IBLK = 2
C
C      CHOOSE A ROOM FOR SURGERY
C
  507 CHOICE = DOCLOC(LDOC)
      IF(CHOICE.EQ.3) CHOICE = -1
C      SURGICAL CLASS 19 MAY BE A CYSTOSCOPY
      IF(NSURG .NE. 19) GO TO 2004
C    SURGEONS 9 AND 35 DO NOT DO CYSTOSCOPIES
      IF(LDOC.EQ.9 .OR. LDOC.EQ.35) GO TO 2004
      YFL = UNI(0)
      IF(YFL.LE.0.65) CHOICE = 3
C      SIXTY PERCENT OF GENERAL NFA PROCEDURES ASSIGNED DIRECTLY TO
C     THEATRE 10
 2004 YFL = UNI(0)
      IF(YFL.GT.0.60) GO TO 8506
      IF((NSURG.EQ.14).AND.(RQFILE(4,CURREQ).EQ.0))CHOICE = 10
 8506 IF(CHOICE.EQ.3) GO TO 9007
C      DETERMINE THE POSSIBLE CHOICES FOR THIS REQUEST
      IFIL = 1
      ICL = 1
      DO 9099 J=1,10
 9099 NPOSS(J) = 0
      DO 9001 J=1,12
      IF(OPRM(NSURG,J).NE.1) GO TO 9001
      NPOSS(IFIL) = J
      IFIL = IFIL + 1
 9001 CONTINUE
C    ASSURE SURGEON'S LAST LOCATION IS AMONG THE PRESENT POSSIBILITIES
      LXL = 0
      DO 9098 J=1,10
 9098 IF(CHOICE .EQ. NPOSS(J) ) LXL = 1
      IF (LXL .EQ.0) CHOICE = -1
 9007 IF(CHOICE .EQ.3) GO TO 509
C      THERE IS ASSURANCE OF AVAILABLE BLOCK TIME
C      PROPOSE STARTING TIME
      IF(IBLK.EQ.1)T=MIN(ENDD(LDOC))-(TAVLD(LDOC)+OPLEN)
      IF(IBLK.EQ.2)T=MIN(ENDDA(LDOC))-(TAVLDA(LDOC)+OPLEN)
      IF (CHOICE .EQ. -1) CHOICE = NPOSS(1)
      IF (CHOICE .EQ. 3) GO TO 509
      NVAC = 0
      ITR = 1
 9006 NROW = ((T-800)/30) + 1
C      PROPOSE FINISH TIME
      FT = T + OPLEN
```

```
      IF(DEBUG) WRITE(6,4010) CHOICE
 4010 FORMAT(' ',' CHOICE:  ',I4)
      NHR = IHOURS(T)
      IF(DEBUG) WRITE(6,4011) NHR
 4011 FORMAT(' ',' TIME:  ',I4)
      MROW = (FT-800)/30
      DO 9500 J=NROW,MROW
      IF (XFRAG(J,CHOICE)) GO TO 9003
 9500 CONTINUE
      GO TO 512
C       SEARCH THROUGH ALL POSSIBLE CHOICES
C       EXCEPTION FOR SPECIFIC ASSIGNMENTS
 9003 IF(CHOICE.EQ.3) GO TO 9004
      CHOICE = NPOSS(ICL)
      ICL = ICL + 1
      IF (CHOICE .EQ. 3) GO TO 9003
      IF (CHOICE .EQ. 0) GO TO 9004
      GO TO 9006
 9004 ICL = 1
      IF(ITR.GE.2) GO TO 1004
C       CAN SURGERY START 30 MINUTES LATER THAN ON PREVIOUS ATTEMPT?
      T = T + 30
      NVAC = NVAC + 30
      ITR = ITR + 1
      IF (IBLK .NE. 1) GO TO 9005
      IF((MIN(ENDD(LDOC))-T) .LT. OPLEN) GO TO 1004
      IF(CHOICE.EQ.3) GO TO 9006
      GO TO 9003
 9005 IF((MIN(ENDDA(LDOC))-T) .LT. OPLEN) GO TO 1004
      GO TO 9003
C       REQUEST WILL BE POSTPONED BECAUSE BLOCK TIME WILL HAVE RUN OUT
C     BY THE TIME SURGERY WOULD FINISH
 1004 LACKRM = LACKRM + 1
C       REVERSE AVAILABLE TIME
      IF(IBLK.EQ.1) TAVLD(LDOC) = TAVLD(LDOC) + OPLEN
      IF (IBLK.EQ.2) TAVLDA(LDOC) = TAVLDA(LDOC) + OPLEN
      IF(DEBUG) WRITE(6,4022)
 4022 FORMAT(' ',' LACKRM - PUT ON WL')
      GO TO 20
C
C       T,FT ACCEPTED AS START AND FINISH TIMES IN CHOICE ROOM
C
  512 DO 508 L=NROW,MROW
  508 XFRAG(L,CHOICE) = .TRUE.
 510  DOCLOC (LDOC) = CHOICE
C     ADJUST FOR FRAGMENTED TIME LOSS
      IF((IBLK.EQ.1).AND.(NVAC.GT.0))TAVLD(LDOC)=TAVLD(LDOC)-NVAC
      IF((IBLK.EQ.2).AND.(NVAC.GT.0))TAVLDA(LDOC)=TAVLDA(LDOC)-NVAC
      IF (IAN .NE. 0) GO TO 540
      IAN = -55
      GO TO 1540
C
C       SLATING A CYSTOSCOPY
C     WITH GENERAL ANESTHETIC
C
C       ASSUME SURGEON HAS AT MOST ONE BLOCK
  509 ITR = 1
      NVAC = 0
      IF(DEBUG) WRITE(6,4012)
 4012 FORMAT(' ',' G. CYSTO')
C       PROPOSE START & FINISH TIMES
      T = MIN(ENDD(LDOC)) - (TAVLD(LDOC) + OPLEN)
 2702 FT = T + OPLEN
```

```
      NHR = IHOURS(T)
      IF(DEBUG) WRITE(6,4013) NHR
 4013 FORMAT(' ',' G. CYSTO TIME: ',I4)
      NROW =((T-800)/30) + 1
      MROW = (FT-800)/30
      DO 2700 J=NROW,MROW
      IF(XFRAG(J,3)) GO TO 2701
 2700 CONTINUE
      GO TO 2703
C     MOVE DOWN BY 30 MINUTES IF POSSIBLE
 2701 IF (ITR.GE.2) GO TO 1004
      T = T+30
      ITR = ITR+1
      IF((MIN(ENDD(LDOC))-T).GE.OPLEN) GO TO 2702
C      REJECT THE REQUEST
      GO TO 1004
C      ACCEPT REQUEST; NOTE TIME LOSS BECAUSE OF OCCUPIED ROOM
 2703 IF (ITR .EQ. 2) NVAC = 30
      GO TO 512
C
C
C        SCHEDULING LOCAL SURGERY
C
C
  500 OPLEN = LENSUR (NSURG)
      NVAC = 0
      IF(NSURG .EQ.2 .OR. NSURG.EQ.3) GO TO 520
C      SURGERY IS NOT A CYSTOSCOPY
      IF(DEBUG) WRITE(6,530)
  530 FORMAT(' ',' LOCAL ANESTHETIC')
C      SET OPERATING THEATRE AT 11 FOR LOCAL SURGERY
      CHOICE = 11
      GO TO 523
C
  520 CHOICE = 3
      IF(DEBUG) WRITE(6,4014)
 4014 FORMAT(' ',' L. CYSTO')
C      TRY TO SCHEDULE AROUND FIRST BLOCK
  523 IF(STARD(LDOC).EQ.0 .AND. ENDD(LDOC) .EQ. 0) GO TO 2770
C      SCHEDULE DOWN
      T = MIN(ENDD(LDOC))
 2776 FT = T + OPLEN
      IF (FT.GT.1280) GO TO 2772
      NHR = IHOURS(T)
      IF(DEBUG) WRITE(6,4015) NHR
 4015 FORMAT(' ',' LOCAL TIME: ',I4)
      IF(STARDA(LDOC).EQ.0 .AND. ENDDA(LDOC).EQ.0) GO TO 2771
      IF(FT.GT.MIN(STARDA(LDOC))) GO TO 2772
 2771 NROW = ((T-800)/30) + 1
      MROW = (FT - 800)/30
      DO 2773 J=NROW,MROW
      IF(XFRAG(J,CHOICE)) GO TO 2774
 2773 CONTINUE
      GO TO 2775
 2774 T = T+30
      GO TO 2776
C      SCHEDULE UP
 2772 T = MIN(STARD(LDOC)) - OPLEN
 2777 FT = T + OPLEN
      IF(T .LT. 800) GO TO 2778
      NROW = ((T-800)/30) + 1
      MROW = (FT - 800)/30
      DO 2779 J=NROW,MROW
```

```
      IF(XFRAG(J,CHOICE)) GO TO 2780
 2779 CONTINUE
C      CHECK FOR COLLISION WITH OTHER LOCAL SURGERY
 2775 GO TO 525
C      REQUEST SLATED
 9775 IAN = 0
      IF(CHOICE.EQ.11) WDTLOC(LDOC) = WDTLOC(LDOC) + OPLEN
      GO TO 512
C
 2780 T = T-30
      GO TO 2777
 2778 CONTINUE
      IF(DEBUG) WRITE(6,4016)
 4016 FORMAT(' ',' NO TIME FOR LOCAL ')
      GO TO 20
C      SIMPLE DOWNWARD SEARCH
 2770 T=800
 2781 FT = T+OPLEN
      IF(FT.GT.1280) GO TO 2778
      NHR = IHOURS(T)
      IF(DEBUG)WRITE(6,4015)NHR
      NROW = ((T-800)/30) + 1
      MROW = (FT - 800) / 30
      DO 2782 J = NROW , MROW
      IF(XFRAG(J,CHOICE)) GO TO 2783
 2782 CONTINUE
      GO TO 2775
 2783 T = T+30
      GO TO 2781
C      EXAMINE IF THIS SURGEON HAS ALREADY BEEN SCHEDULED
C     FOR A LOCAL CYSTOSCOPY IN THEATRE 3
C      PROPOSED TIME MIGHT CLASH WITH LOCAL CYSTO.
  525 IF(CHOICE.EQ.3) ITHTR = 11
      IF(CHOICE.EQ.11) ITHTR = 3
      ICLASH = CLASPT(ITHTR)
 2349 IF( (ICLASH.EQ.-99)) GO TO 9775
      IISRG = RQFILE(2,ICLASH)
      IF (IISRG .NE. LDOC) GO TO 2348
      ISTCLD = RQFILE(8,ICLASH)
      ISTCLD = MIN(ISTCLD)
      IFNCLD = ISTCLD + RQFILE(9,ICLASH)
      IF((FT.LE.ISTCLD) .OR. (T.GE.IFNCLD)) GO TO 2348
C      A CLASH HAS BEEN NOTICED
      IF (DEBUG) WRITE(6,2347)
 2347 FORMAT(' ',15X,'CLASH OF LOCAL WITH L. CYSTO')
      GO TO 2778
 2348 ICLASH = RQFILE(13,ICLASH)
      GO TO 2349
C
C
C         ATTACH FULL SLATING INFORMATION FOR THIS REQUEST ONTO RQFILE
C
C
C    ANESTHETIST
 540  IF(IBLK.EQ.1) IAN = ANES1(LDOC)
      IF (IBLK .EQ.2) IAN = ANES2(LDOC)
      RQFILE(11,CURREQ) = IAN
C
C    THEATRE
 1540 RQFILE(5,CURREQ) = CHOICE
C      CHAIN BY OPERATING ROOM
      RQFILE(13,CURREQ) = CLASPT(CHOICE)
      CLASPT(CHOICE) = CURREQ
```

```
C     LINK BY SURGEON
       RQFILE(6,CURREQ) = DOCPT (LDOC)
       DOCPT(LDOC) = CURREQ
C     STARTING TIME
       RQFILE(8,CURREQ) = IHOURS(T)
C     DURATION
       RQFILE(9,CURREQ) = OPLEN
C     TYPE OF ANESTHESIA: 1 - LOCAL, 2 - GENERAL
       RQFILE(10,CURREQ) = 1
       IF (NSURG .GT. 7) RQFILE(10,CURREQ) = RQFILE(10,CURREQ) + 1
       IF(IAN .GT. 0) WTUSED(LDOC) = WTUSED(LDOC) + OPLEN
       MOST = WKDAY - 1
       IF(IAN.GT.0 .AND. (RQFILE(7,CURREQ).GT.10) .AND.(RQFILE(12,CURREQ)
     * .LE. MOST) ) WTPOST(LDOC) = WTPOST(LDOC) - OPLEN
C
C       WAS GAP SURGERY SCHEDULED?
       IF(RQFILE(3,CURREQ) .GT. 100) DTGAP = DTGAP + 1
       IF ( (RQFILE(3,CURREQ).GT.100) .AND. (RQFILE(15,CURREQ).EQ.0) )
     *DCANCL = DCANCL + 1
       IF(RQFILE(15,CURREQ) .EQ.1) DCANOR = DCANOR + 1
       GO TO 31
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C
C         ATTACH REQUEST ONTO THE DAY'S SLATE
C
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
 31    ILOS = RQFILE (4,CURREQ)
       IF(ILOS .EQ. 0) GO TO 8888
C       ASSUMPTION: NON-REPLACEABLE CANCELLATIONS DO NOT TIE UP CENSUS
       IF(RQFILE(3,CURREQ).GT.100) GO TO 8888
       IFUT = ILOS + DAY
       IF(IFUT .GT.50) IFUT = IFUT - 50
       LEAVNG(IFUT) = LEAVNG(IFUT) + 1
       CENSUS = CENSUS + 1
C     IS THIS THE FIRST REQUEST TO GO ON SLATE TODAY?
 8888  IF ( (FIRST .EQ.1) .AND. (RFWL .EQ. 1) ) GO TO 91
       GO TO 50
  91   SL = CURREQ
       RQFILE (14,WLAST) = RQFILE(14,CURREQ)
        SLAST = CURREQ
       IF (CURREQ.EQ. WL) WL = RQFILE(14,CURREQ)
       IF (CURREQ .EQ. WLAST) WLAST = WL
       RQFILE (14,CURREQ) = -177
       GO TO 22
C         RFWL = 1,  REQUEST IS NOT FIRST
  50   IF (RFWL .EQ. 0 ) GO TO 12
       RQFILE(14,WLAST) = RQFILE (14,CURREQ)
C          CHAIN PREVIOUS REQUEST ON THE SLATE TO THIS ONE
  21   RQFILE(14,SLAST) = CURREQ
       IF (CURREQ.EQ. WL) WL = RQFILE(14,CURREQ)
       IF (CURREQ .EQ. WLAST) WLAST = WL
       IF(RFWL .EQ.1 .AND. NSLOT .GT.0) RQFILE(14,WLAST) = RQFILE
     *(14,CURREQ)
       RQFILE (14,CURREQ) = -177
       SLAST = CURREQ
       GO TO 2
C       REQUEST IS TAKEN FROM DEMAND LIST
C       IS IT THE FIRST REQUEST TO BE SLATED TODAY?
  12   IF (FIRST .NE. 1) GO TO 21
```

```
      SLAST = CURREQ
C      'BOUNDARY CONDITIONS' TAKEN CARE OF
      IF (SL .LT. 0) SL = CURREQ
   22 FIRST = 0
      GO TO 2
C        REQUEST IS WIPED OUT
 11   DCANCL = DCANCL + 1
      IF(DEBUG) WRITE(6,4019)
 4019 FORMAT(' ',' REPL. CANC. ')
      DO 140 J=1,13
 140  RQFILE (J,CURREQ) = 0
      IF (RFWL .EQ. 1 ) RQFILE(14,WLAST) = RQFILE(14,CURREQ)
      IF(RFWL .EQ.1 .AND. ISLTKE .EQ.0) DWLCAN = DWLCAN + 1
      IF(ISLTKE .EQ.1) DSLCAN = DSLCAN + 1
      IF (CURREQ.EQ. WL) WL = RQFILE(14,CURREQ)
      IF (CURREQ .EQ. WLAST) WLAST = WL
      RQFILE (14,CURREQ) = AVAIL
      IF (SL .EQ. CURREQ) SL = -1
      AVAIL = CURREQ
      GO TO 2
C
C      CHANGE REQUEST TO 'FOR TOMORROW' AND PUT IT
C    ON WAITING LIST IF IT ISNT ALREADY THERE
C
   20 IF(DEBUG) WRITE(6,4020)
 4020 FORMAT(' ',' GOES ON WL')
C        IS THIS REQUEST OFF THE WAITING LIST?
      IF(RQFILE(12,CURREQ) .NE. 0) GO TO 40
      IF (SL .EQ. CURREQ) SL = -1
      IF (WL .EQ. -88) WL = CURREQ
      IF (WLAST .NE. -88) GO TO 42
      WLAST = WL
      GO TO 43
C        CHAIN REQUEST ONTO WAIT LIST
  42  RQFILE (14,WLAST) = CURREQ
      WLAST = CURREQ
C        NO. OF DAYS REQUEST WILL HAVE BEEN ON WL UNTIL NEXT TIME IT
C    IS EXAMINED
  43  RQFILE (12,CURREQ) = RQFILE(12,CURREQ) + 1
C    ADD ONE TO NUMBER OF REQUESTS PLACED ON WAITING LIST
      NREWL = NREWL + 1
      RQFILE (1,CURREQ) = RQFILE (1,CURREQ) + 1
      RQFILE (14,CURREQ) = -188
      GO TO 2
C      REQUEST MUST WAIT AT LEAST ONE MORE DAY ON WAITING LIST.
 40   RQFILE (12,CURREQ) = RQFILE (12,CURREQ) + 1
      RQFILE (1,CURREQ) = RQFILE (1,CURREQ) + 1
      IF(RQFILE(1,CURREQ).EQ.51) RQFILE(1,CURREQ) = 1
      WLAST = CURREQ
C      A REQUEST HAS BEEN PLACED OR LEFT ON WL IN TODAY'S SLATING ATTEMPT
      NSLOT = 1
      GO TO 2
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C
C        RESCAN OF WL
C
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
 4708 IF(DEBUG) WRITE(6,5000)
 5000 FORMAT(' ',' R E S C A N ! ! ! ')
C
C      THE WL IS RESCANNED TO FILL UNUSED BLOCK TIME WITH REQUESTS
```

```
C      FROM ANY SURGEON
C
       FILREQ = WL
       LFINAL =  WLAST
 5444  WLAST = FILREQ
       FILREQ = RQFILE(14,WLAST)
       IF(FILREQ .NE. LFINAL) GO TO 5445
       WLAST = FILREQ
       GO TO 5748
 5445  LDOC = RQFILE(2,FILREQ)
       IF(DEBUG) WRITE(6,4002) FILREQ
       IF(DEBUG) WRITE(6,4003) CENSUS
       NS = RQFILE(3,FILREQ)
       IF(NS.GT.100) NS = NS - 100
       OPLEN = LENSUR(NS)
C       ELIMINATE CYSTOSCOPIES AND LOCALS
       IF(NS .LE. 7) GO TO 5444
       IF(NS.EQ.16 .OR. NS.EQ.17 .OR. NS.EQ.19) GO TO 5444
C
C       EACH REQUEST ENCOUNTERS THE BED AVAILABTLITY AND
C      CANCELLATION FILTER
C
C       BED AVAILABILITY
       IF(CENSUS .LT. BEDLIM) GO TO 5006
       DNOBED = DNOBED + 1
       IF (DEBUG) WRITE(6,4004)
       GO TO 5444
 5006  IF((RQFILE(7,FILREQ).NE.1).AND.(RQFILE(7,FILREQ) .NE. 11))
      *GO TO 5310
       GO TO 5510
C       CANCELLATION
 5310  RQFILE(7,FILREQ) = RQFILE(7,FILREQ) + 1
       YFL = UNI(0)
       IF(YFL.GE.0.146) GO TO 5010
       IF(DEBUG) WRITE(6,4005)
       YFL = UNI(0)
       IF(YFL .GE. 0.15) GO TO 5011
       IF(DEBUG) WRITE(6,4006)
       RQFILE(3,FILREQ) = RQFILE(3,FILREQ) + 100
       GO TO 5510
 5010  YFL = UNI(0)
       IF(DEBUG) WRITE(6,4007)
       IF(YFL.GE.0.169) GO TO 5510
       IF(DEBUG) WRITE(6,4008)
       RQFILE(3,FILREQ) = RQFILE(3,FILREQ) + 100
       RQFILE(15,FILREQ) = 1
       GO TO 5510
 5011  DCANCL = DCANCL + 1
       IF(DEBUG) WRITE(6,4019)
       DO 5140 J=1,13
 5140  RQFILE(J,FILREQ) = 0
       RQFILE(14,WLAST) = RQFILE(14,FILREQ)
       DWLCAN = DWLCAN + 1
       RQFILE(14,FILREQ) = AVAIL
       AVAIL = FILREQ
       FILREQ = WLAST
       GO TO 5444
C   LOOK FOR SURGEON JDOC WHOSE BLOCK TIME CAN BE USED TO SATISFY
C  REQUEST FROM LDOC.
 5510  JDOC = 0
       JJST = 1
 5891  DO 5599 J=JJST,39
       IPLUG = TAVLD(J) - TFIL(J)
```

```
      IF (IPLUG .LT. OPLEN) GO TO 5599
      GO TO 5511
 5599 CONTINUE
C       NOT ENOUGH TIME AVAILABLE
      GO TO 5444
 5511 JDOC = J
C       CHOOSE A ROOM
      CHOICE = DOCLOC(LDOC)
      IF(CHOICE.EQ.3)  CHOICE = -1
      IF(CHOICE.EQ.3)  GO TO 5007
      NFIL = 1
      NCL = 1
      DO 5099 J =1,10
 5099 NPOSS(J)  = 0
      DO 5001 J=1,12
      IF(OPRM(NS,J).NE.1)  GO TO 5001
      NPOSS(NFIL)  = J
      NFIL = NFIL + 1
 5001 CONTINUE
      LXL = 0
      DO 5098 J=1,10
 5098 IF(CHOICE.EQ.NPOSS(J))  LXL = 1
      IF(LXL.EQ.0)  CHOICE = -1
C       PROPOSE START
 5007 IF(CHOICE.EQ.-1)  CHOICE = NPOSS(1)
      T = MIN( ENDD(JDOC)  )  - TAVLD(JDOC)  + TFIL(JDOC)
      NROW =  ((T-800)/30)+1
      FT = T + OPLEN
      MSRCH = DOCPT(LDOC)
 5502 IF(MSRCH.EQ.-99)  GO TO 5890
      MSRCH1 = RQFILE(3,MSRCH)
      IF(MSRCH1 .GT.100)  MSRCH1 = MSRCH1 - 100
      IF(MSRCH1 .GT.7)  GO TO 5501
      MMST = RQFILE(8,MSRCH)
      MMFN = MMST + RQFILE(9,MSRCH)
      IF(FT.LT.MMST .OR. T.GT.MMFN)  GO TO 5501
C       A CLASH WITH LOCAL SURGERY FOR LDOC
      GO TO 5444
 5501 MSRCH = RQFILE(6,MSRCH)
      GO TO 5502
C       WILL A CLASH WITH BLOCK TIME OF LDOC OCCUR?
 5890 IF(T.GE.ENDD(LDOC).OR.  FT.LE.STARD(LDOC))  GO TO 5892
 5893 IF(JDOC.GE.39)  GO TO 5444
      JJST = JDOC + 1
      GO TO 5891
 5892 IF(T.GE.ENDDA(LDOC).OR.FT.LE.STARDA(LDOC) )  GO TO 5503
      GO TO 5893
 5503 IF(DEBUG)  WRITE(6,4010)  CHOICE
      NHR = IHOURS(T)
      IF(DEBUG)  WRITE(6,4011)  NHR
      MROW =  (FT-800)/30
      DO 5900 J=NROW,MROW
      IF(XFRAG(J,CHOICE))  GO TO 5903
 5900 CONTINUE
      GO TO 5912
 5903 IF(CHOICE.EQ.3)  GO TO 5904
      CHOICE = NPOSS(NCL)
      NCL = NCL + 1
      IF(CHOICE.NE.0)  GO TO 5503
 5904 LACKRM = LACKRM + 1
      IF (DEBUG)  WRITE(6,4022)
      GO TO 5920
C
```

```
C       SLATE THE REQUEST
C
 5912 DO 5913 L=NROW,MROW
 5913 XFRAG(L,CHOICE) = .TRUE.
      DOCLOC(LDOC) = CHOICE
      TFIL (JDOC) = TFIL(JDOC) + OPLEN
      IAN = ANES1(JDOC)
      RQFILE(11,FILREQ) = IAN
      IF(IAN.GT.0 .AND. (RQFILE(7,FILREQ).GT.10) .AND. (RQFILE
     *(12,FILREQ).LE.WKDAY) ) WTPOST(LDOC)=WTPOST(LDOC)-OPLEN
      WTAKEN(LDOC) = WTAKEN(LDOC) + OPLEN
      NFILL = NFILL + 1
C
C       ATTACH SLATING INFORMATION
      RQFILE(5,FILREQ) = CHOICE
      RQFILE(13,FILREQ) = CLASPT(CHOICE)
      CLASPT(CHOICE) = FILREQ
      RQFILE(6,FILREQ) = DOCPT(LDOC)
      DOCPT(LDOC) = FILREQ
      RQFILE(8,FILREQ) = IHOURS(T)
      RQFILE(9,FILREQ) = OPLEN
      RQFILE(10,FILREQ) = 2
      IF (RQFILE(3,FILREQ).GT.100) DTGAP = DTGAP + 1
      IF((RQFILE(3,FILREQ).GT.100).AND.(RQFILE(15,FILREQ).EQ.0))
     *DCANCL = DCANCL + 1
      IF(RQFILE(15,FILREQ).EQ.1) DCANOR = DCANOR + 1
C
C       CHAIN FILREQ ONTO SLATE
C
      ILOS = RQFILE(4,FILREQ)
      IF(ILOS.EQ.0) GO TO 5888
      IF(RQFILE(3,FILREQ).GT.100) GO TO 5888
      IFUT = ILOS + DAY
      IF(IFUT.GT.50) IFUT = IFUT - 50
      LEAVNG(IFUT) = LEAVNG(IFUT) + 1
      CENSUS = CENSUS + 1
 5888 RQFILE(14,WLAST) = RQFILE(14,FILREQ)
      RQFILE(14,SLAST) = FILREQ
      RQFILE(14,FILPEQ) = -177
      SLAST = FILREQ
      FILREQ = WLAST
      GO TO 5444
C       KEEP REQUEST ON WL
 5920 RQFILE(12,FILREQ) = RQFILE(12,FILREQ) + 1
      RQFILE(1,FILREQ) = RQFILE(1,FILREQ) + 1
      GO TO 5444
C
C++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
C
C         OUTPUT THE DESIRED INFORMATION ON THE SIMULATED PROCESS
C
C
C++++++++++++++++++++++++++++:+++++++++++++++++++++++++++++++++++++++++++++++++++++++++
C
 5748 IF(DEBUG) GO TO 700
      GO TO 4707
 700  WRITE(6,7)
  7   FORMAT('1',20X,'CONTENTS OF THE REQUEST FILE',//)
      IF (FIRST .NE. 1) WRITE(6,2431) DAY
 2431 FORMAT(' ',10X,'AFTER SLATING DAY:  ',I4)
      WRITE (6,708) (J,J=1,40)
 708  FORMAT (' ',//,40I3,//)
```

```
      DO 702 K=1,14
 702  WRITE(6,703) (RQFILE (K,J) ,J=1,40)
 703  FORMAT (' ',40I3)
      WRITE (6,708) (J,J=41,80)
      DO 704 K=1,14
 704  WRITE(6,703) (RQFILE(K,J),J=41,80)
      WRITE(6,708) (J,J=81,120)
      DO 705 K=1,14
 705  WRITE (6,703) (RQFILE(K,J), J=81,120)
      WRITE(6,708) (J,J=121,160)
      DO 706 K=1,14
 706  WRITE (6,703)(RQFILE(K,J),J=121,160)
      IF(DEBUG) WRITE(6,4021)WL,SL,IDEMD,WLAST,SLAST,LAST,AVAIL
 4021 FORMAT(' ',' WL: ',I4,' SL: ',I4,' IDEMD: ',I4,' WLAST: ',I4,' SLA
     *ST: ',I4,' LAST: ',I4,' AVAIL: ',I4)
      IF (FIRST .EQ. 1) GO TO 2
C
C        PRINT OUT THE EFFECTIVE DAILY SLATE ...
C
 4707 IF(COVER1) GO TO 4533
      WRITE(6,707) DAY
  707 FORMAT ('1',//,15X,' EFFECTIVE SURGICAL SLATE FOR SIMULATED DAY: '
     *,I4,///)
      WRITE(6,709)
  709 FORMAT(' ',5X,'ROOM',8X,'TIME',8X,'SURGERY CLASS',15X,'SURGEON',
     *11X,'ANESTHETIST',6X,'SCHEDULED DURATION',7X,'DAYS ON WL',//)
 4533 ITAVL = 1
      I = 1
 715  IN = CLASPT(I)
      IF(IN.EQ.-99) GO TO 717
 716  TEMP(ITAVL,1) = RQFILE(5,IN)
      TEMP(ITAVL,2) = RQFILE(8,IN)
      TEMP(ITAVL,3) = RQFILE(3,IN)
      TEMP(ITAVL,4) = RQFILE(2,IN)
      TEMP(ITAVL,5) = RQFILE(11,IN)
      TEMP(ITAVL,6) = RQFILE(9,IN)
      TEMP(ITAVL,7) = RQFILE(12,IN)
      ITAVL = ITAVL + 1
      IF(RQFILE(12,IN) .GT. 0) NREMWL = NREMWL + 1
      DSLAT = DSLAT + 1
      NWAIT = NWAIT + RQFILE(12,IN)
      NWAIT2 = NWAIT2 + (RQFILE(12,IN)*RQFILE(12,IN))
      IF( RQFILE(3,IN) .LT.100)
     *OPUT(RQFILE(5,IN)) = OPUT(RQFILE(5,IN)) + RQFILE(9,IN)
      IN = RQFILE(13,IN)
      IF (IN.NE.-99) GO TO 716
C      SORT & PRINT
      IF (ITAVL .EQ. 2) GO TO 8864
      LATEST = ITAVL - 1
 6662 LAST = LATEST
      DO 6664 J=2,LAST
      K = J-1
      IF(TEMP(K,2) .LE. TEMP(J,2) ) GO TO 6664
C    INTERCHANGE
      LATEST = K
      DO 6616 L =1,7
      BUFFER(L) = TEMP(K,L)
      TEMP(K,L) = TEMP(J,L)
 6616 TEMP(J,L) = BUFFER(L)
 6664 CONTINUE
C    ARE FURTHER PASSES NECESSARY?
      IF(LATEST .LT. LAST .AND. LATEST .GT.1) GO TO 6662
C
```

```
 8864 LMT = ITAVL - 1
      DO 8865 J=1,LMT
      NTYPE = TEMP(J,3)
      NANS = TEMP(J,5)
      IF(NTYPE.LT.100 .AND. NANS.NE.0) WANOCC(NANS) = WANOCC(NANS)+
     * TEMP(J,6)
C        ACCUMULATE NO. OF OPERATIONS TO BE ACTUALLY PERFORMED
      LDOC = TEMP(J,4)
      IF (NTYPE.LT.100) PERFOR(LDOC,NTYPE) = PERFOR(LDOC,NTYPE) + 1
      IF(WKDAY.EQ.1) IWLSRT = NNWL
      IF(DAY.EQ.1) IRLSRT = IWLSRT
      IF(COVER1) GO TO 8865
      CHAR = BLANK
      IF ( NTYPE .LT. 100) GO TO 6865
      NTYPE = NTYPE - 100
      CHAR = GAP
 6865 WRITE(6,710) TEMP(J,1),TEMP(J,2),(CLCODE(NTYPE,LL),LL=1,4),CHAR,
     *TEMP(J,4),TEMP(J,5),TEMP(J,6),TEMP(J,7)
 8865 CONTINUE
      IF(COVER1) GO TO 4534
      WRITE(6,8710)
 8710 FORMAT(' ',  ' ')
 4534 DO 8866 J=1,LMT
      DO 8866K=1,7
 8866 TEMP(J,K) = 0
      DO 8867 K=1,7
 8867 BUFFER(K) = 0
 717  I = I+1
      ITAVL = 1
      IF (I .LE. 12) GO TO 715
  710 FORMAT (' ',3X,I4,9X,I5,9X,4A4,A4,4X,I8,12X,I7,12X,I9,12X,I7,/)
 720  FORMAT('1', '    ',/)
      IF(DEBUG) GO TO 4747
      GO TO 4748
 4747 WRITE(6,720)
      DO 747 M=1,16
 747  WRITE(6,721) (XFRAG(M,N),N=1,12)
 721  FORMAT(' ',25X,12L5)
C
C        PRODUCE DAILY SUMMARY
C
 4748 IDCAN = DSLAT - NREMWL
      IF(COVER2) GO TO 4541
      WRITE(6,780) DAY
  780 FORMAT('1',25X,' SUMMARY FROM SIMULATED SLATE ON DAY  ',I5,/)
      WRITE(6,781)
  781 FORMAT(' ',10X,' SLATING:')
      WRITE(6,8710)
      WRITE(6,782) NNWL
  782 FORMAT(' ',15X,' NO. OF REQUESTS ON WL FROM YESTERDAY: ',I4,/)
      NRR1 = NREMWL - NFILL
      WRITE(6,783) NRR1
  783 FORMAT(' ',15X,' NO. OF REQUESTS SLATED FROM WL: ',I4,/)
      WRITE(6,1784) DWLCAN
 1784 FORMAT(' ',15X,' NO. OF REQUESTS CANCELLED FROM WL: ',I4,/)
      WRITE(6,5784) NFILL
 5784 FORMAT(' ',15X,' NO. OF REQUESTS SLATED ON RESCAN OF WL: ',I4,/)
      WRITE(6,784) NREQ
  784 FORMAT(' ',15X,' EXOGENOUS DAILY DEMAND: ',I4,/)
      WRITE(6,1785) DSLCAN
 1785 FORMAT(' ',15X,' NO. OF DEMAND REQUESTS CANCELLED (REPLACEABLE): '
     *,I4,/)
      NRR2 = NREWL - NFILL
```

```
      WRITE(6,785) NRR2
      WRITE(6,1786) IDCAN
 1786 FORMAT(' ',15X,' NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND
     *: ',I4,/)
      WRITE(6,786) DSLAT
  785 FORMAT(' ',15X,' NO. OF REQUESTS ADDED TO WL: ',I4,/)
  786 FORMAT(' ',15X,' TOTAL NO. OF DAILY REQUESTS SLATED: ',I4,//)
      WRITE(6,787)
  787 FORMAT(' ',10X,' CANCELLATION AND POSTPONEMENT:')
      WRITE(6,8710)
      WRITE(6,788) DCANCL
  788 FORMAT(' ',15X,' NO. OF REQUESTS CANCELLED BY SLATING CLERK: ',I4,
     */)
      WRITE(6,789) DCANOR
  789 FORMAT(' ',15X,' NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: ',
     *I4,/)
      WRITE(6,790) DTGAP
  790 FORMAT(' ',15X,' NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLA
     *TION: ',I4,/)
      WRITE(6,791) DNPOST
  791 FORMAT(' ',15X,' NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INS
     *UFFICIENT BLOCK TIME: ',I4,/)
      WRITE(6,792) BEDLIM
  792 FORMAT(' ',15X,' NO. OF AVAILABLE SURGICAL BEDS: ',I4,/)
      WRITE(6,793) DNOBED
  793 FORMAT(' ',15X,' NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE
     *BED: ',I4,/)
      WRITE(6,794) LACKRM
  794 FORMAT(' ',15X,' NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FR
     *EE OPERATING ROOM: ',I4,//)
      WRITE(6,795)
  795 FORMAT(' ',10X,' EVALUATION:')
      WRITE(6,8710)
      DENOM = NNWL + NREQ
      RBT = FLOAT (DNPOST) / DENOM
      WRITE(6,796) RBT
  796 FORMAT(' ',15X,' FRACTION OF EXAMINED REQUESTS WITH INSUFFICIENT (
     *EXISTING) BLOCK TIME: ',F5.3,/)
      RET = FLOAT(DSLAT) / DENOM
      WRITE(6,797) RET
  797 FORMAT(' ',15X,' FRACTION OF EXAMINED REQUESTS SLATED: ',F5.3,/)
      IF(NREMWL .NE. 0) GO TO 4974
      RWT = 0.
      RWTD = 0.
      GO TO 4975
 4974 RWT = FLOAT(NWAIT)/FLOAT(NREMWL)
      ISLT1 = NREMWL - 1
      RWTD = SQRT( (NWAIT2 -(NWAIT*NWAIT)/FLOAT(NREMWL))/FLOAT(ISLT1) )
 4975 WRITE(6,798) RWT,RWTD
  798 FORMAT(' ',15X,' AVERAGE NO. OF DAYS ON WL FOR A SLATED REQUEST: '
     *,F6.3,6X,'ST. DEV.: ',F6.3,///)
      WRITE(6,799)
  799 FORMAT(' ',10X,' OPERATING ROOM UTILIZATION (SLATED): ')
      WRITE(6,8710)
      WRITE(6,850) (J,J=1,12)
  850 FORMAT(' ',15X,' OPERATING ROOM: ',13X,12I6,/)
      DO 851 J = 1,12
      SLUR(J) = FLOAT(OPUT(J))/4.80
  851 PERCID(J) = 100. - SLUR(J)
      WRITE(6,852) (SLUR(J), J=1,12)
  852 FORMAT(' ',15X,' SLATED UTILIZATION PERCENTAGE ',12F6.1,/)
      WRITE(6,853) (PERCID(J),J=1,12)
  853 FORMAT(' ',15X,' PERCENTAGE SLATED IDLE TIME    ',12F6.1,//)
```

```
      WRITE(6,854)
  854 FORMAT(' ',10X,' OVERALL PERFORMANCE: ')
      WRITE(6,8710)
      OPSM = 0.
      PERSM = 0.
      DO 855 J=1,12
      OPSM = SLUR(J) + OPSM
  855 PERSM = PERCID(J) + PERSM
      OPSM = OPSM/9.
      PERSM =(PERSM -300 ) / 9.
      WRITE(6,856) OPSM
  856 FORMAT(' ',20X,' SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERA
     *TING ROOMS AVAILABLE: ',F7.2,/)
      WRITE(6,857) PERSM
  857 FORMAT(' ',20X,' PERCENTAGE SLATED IDLE TIME OVER ALL OPERATING RO
     *OMS AVAILABLE: ',F7.2)
C         ADD TO WEEKLY ACCUMULATORS
 4541 WSLAT = WSLAT + DSLAT
      IWNWL = NNWL + IWNWL
      IWNWL2 = IWNWL2 + (NNWL*NNWL)
      DO 858 J=1,12
  858 WOPUT(J) = WOPUT(J) + OPUT(J)
      WNREQ = WNREQ + NREQ
      WNFILL = WNFILL + NFILL
      WLDAY = FLOAT(NWAIT) + WLDAY
      WLDAY2 = WLDAY2 + NWAIT*NWAIT
      WCANCL = WCANCL + DCANCL
      WCANOR = WCANOR + DCANOR
      WNOROM = WNOROM + LACKRM
      WTGAP = WTGAP + DTGAP
      WNOBED = WNOBED + DNOBED
      WNREWL = WNREWL + NREWL
      WNREML = WNREML + NREMWL
      WIDCAN = WIDCAN + IDCAN
      DO 5860 J=1,39
 5860 WTFIL(J) = TFIL(J) + WTFIL(J)
      IF (WKDAY .NE.5) GO TO 9790
      IF(COVER3) GO TO 4551
C
C         PRINT OUT WEEKLY SUMMARY
C
      IWEEK = DAY/5
      WRITE(6,600) IWEEK
  600 FORMAT('1',25X,' WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FO
     *R WEEK # ',I4,/)
      WRITE(6,781)
      WRITE(6,1870)IWLSRT
 1870 FORMAT(' ',/,16X,' NO. OF REQUESTS ON WL AT START OF WEEK: ',I4,/)
      WRITE(6,870) WNREQ
  870 FORMAT(' ',15X,' NO. OF REQUESTS GENERATED DURING WEEK: ',I4,/)
      WRITE(6,871) WSLAT
  871 FORMAT(' ',15X,' NO. OF REQUESTS SLATED: ',I4,/)
      WRITE(6,1786) WIDCAN
      WRITE(6,5784) WNFILL
      DEN = FLOAT(WNREQ) + FLOAT(IWLSRT)
      FRSL = FLOAT(WSLAT)/DEN
      WRITE(6,872) FRSL
  872 FORMAT(' ',15X,' FRACTION OF REQUESTS SLATED: ',F5.2,/)
      AVWT = WLDAY/FLOAT(WNREML)
      AVWTD = SQRT((WLDAY2-(WLDAY*WLDAY)/FLOAT(WNREML))/(WNREML-1))
      WRITE(6,873) AVWT,AVWTD
  873 FORMAT(' ',15X,' AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: ',
     *F5.2,6X,'ST. DEV.: ',F5.2,/)
```

```
      AVSZWL = FLOAT(IWNWL) / 5.
      AVSZW2 = SQRT( (IWNWL2 - (IWNWL*IWNWL)/5.)/4. )
      WRITE(6,874) AVSZWL,AVSZW2
  874 FORMAT(' ',15X,' AVERAGE NO. OF REQUESTS ON DAILY WL: ',F6.2,6X,
     *'ST. DEV.: ',F6.2,//)
      WRITE(6,4720)
      WRITE(6,787)
      WRITE(6,8710)
      WRITE(6,788) WCANCL
      WRITE(6,789) WCANOR
      WRITE(6,790) WTGAP
      DO 5989 J=1,39
 5989 NWPST = WNPOST(J) + NWPST
      WRITE(6,791) NWPST
      WRITE(6,793) WNOBED
      WRITE(6,794) WNOROM
      WRITE(6,799)
      WRITE(6,8710)
      WRITE(6,850) (J,J=1,12)
      DO 860 J=1,12
      SLUR(J) = FLOAT(WOPUT(J))/24.
  860 PERCID(J) = 100. - SLUR(J)
      WRITE(6,852) (SLUR(J),J=1,12)
      WRITE(6,853) (PERCID(J),J=1,12)
      OPSM = 0.
      DO 5855 J=1,12
 5855 OPSM = SLUR(J) + OPSM
      OPSM = OPSM/9.
      WRITE(6,856) OPSM
      WRITE(6,4720)
      WRITE(6,880)
  880 FORMAT(' ',10X,' ANESTHETIST UTILIZATION (SLATED): ')
      WRITE(6,8710)
      WRITE(6,881) (J,J=1,7)
  881 FORMAT(' ',15X,' ANESTHETIST: ',25X,7I8,/)
      DO 7654 J=1,7
 7654 PERCAN(J) = FLOAT(WANOCC(J))/24.
      WRITE(6,882) (PERCAN(J), J=1,7)
  882 FORMAT(' ',15X,' PERCENTAGE OF TIME OCCUPIED: ',10X,7F8.1,/)
      OPSM = 0.
      DO 5856 J=1,7
 5856 OPSM = PERCAN(J) + OPSM
      OPSM = OPSM/5.
      WRITE(6,5870) OPSM
 5870 FORMAT(' ',20X,' AVERAGE OCCUPANCY PERCENTAGE: ',F7.2,/)
      WRITE(6,601)
      WRITE(6,605)
      WRITE(6,606)
      WRITE(6,5607)
      WRITE(6,5606)
      WRITE(6,602)
      WRITE(6,609)
      WRITE(6,607)
      WRITE(6,608)
      DO 2266 J=1,39
      IF(WTAVLD(J) .NE. 0) GO TO 2265
      UTRAT(J) = 0.
      FRIND(J) = 0.
      BLUT(J) = 0.
      GO TO 2266
 2265 UTRAT(J) =(WTPOST(J) + WTAKEN(J) + WTUSED(J) )/FLOAT(WTAVLD(J))
      FRIND(J) = (WTAVLD(J) - (WTUSED(J)+WTFIL(J)) )/FLOAT(WTAVLD(J))
      BLUT(J) = (WTUSED(J) + WTFIL(J))/FLOAT(WTAVLD(J))
```

```
 2266 CONTINUE
C
  601 FORMAT('1',//,10X,'SURGEON STATISTICS (WEEKLY):  ',/)
 4720 FORMAT(' ',///)
  602 FORMAT(' ',20X,' BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME
     * GIVEN) / BLOCK TIME ALLOTTED' )
  607 FORMAT(' ',20X,' REQUEST UTILIZATION - ((TIME USED + TIME TAKEN +
     *UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM ',/)
  608 FORMAT(' ',10X,'SURGEON',5X,'ALLOTTED',7X,'USED',10X,'TAKEN', 8X,
     *'GIVEN',8X,'BLOCK UT.',8X,'FR. IND.',8X,'REQUEST UT.')
  605 FORMAT(' ',20X,' ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM')
 5606 FORMAT(' ',20X,' GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEON
     *S')
 5607 FORMAT(' ',20X,' TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS')
 606  FORMAT(' ',20X,' USED - BLOCK TIME USED')
  609 FORMAT(' ',20X,' FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENT
     *ATION/TIME ALLOTTED) FOR BLOCK SYSTEM' )
C
      DO 650 J=1,39
      WRITE(6,651)J,WTAVLD(J),WTUSED(J),WTAKEN(J),WTFIL(J),BLUT(J),FRIND
     *(J),UTRAT(J)
  651 FORMAT(' ',10X,I5,8X,I5,8X,I5,8X,I5,8X,I5,12X,F4.2,12X,F4.2,12X,F
     *6.2)
 650  CONTINUE
      CALL USTAT(BLUT,BMN,BDEV)
      CALL USTAT(FRIND,FMN,FDEV)
      CALL USTAT(UTRAT,UTMN,UTDEV)
      WRITE(6,652) BMN,BDEV
      WRITE(6,653) FMN,FDEV
      WRITE(6,654) UTMN,UTDEV
  652 FORMAT(' ',29X,'BLOCK UTILIZATION',16X,'MEAN:  ',F5.2,9X,'STANDARD
     * DEVIATION:  ',F5.2,//)
  653 FORMAT(' ',29X,'FRAGMENTATION INDICATORS',9X,'MEAN:  ',F5.2,9X,
     *'STANDARD DEVIATION:  ',F5.2,//)
  654 FORMAT(' ',29X,'REQUEST UTILIZATION',14X,'MEAN:  ',F5.2,9X,
     *'STANDARD DEVIATION:  ',F5.2,//)
      WRITE(6,655)
  655 FORMAT(' ',60X,'************')
      WRITE(6,720)
C
C       ADD WEEKLY ACCUMULATORS TO THOSE FOR ONE RUN.
C
 4551 RNREQ = RNREQ + WNREQ
      RIDCAN = RIDCAN + WIDCAN
      RNREML = RNREML + WNREML
      RSLAT = RSLAT + WSLAT
      RNFILL = RNFILL + WNFILL
      RWLDAY = RWLDAY + WLDAY
      RWLDA2 = RWLDA2 + WLDAY2
      RCANCL = RCANCL + WCANCL
      RCANOR = RCANOR + WCANOR
      RTGAP = RTGAP + WTGAP
      RNOBED = RNOBED + WNOBED
      RNORCM = RNOROM + WNOROM
      IRNWL = IRNWL + IWNWL
      IRNWL2 = IRNWL2 + IWNWL2
      DO 660 J=1,12
  660 ROPUT(J) = ROPUT(J) + WOPUT(J)
      DO 661 J=1,7
  661 RANOCC(J) = RANOCC(J) + WANOCC(J)
      DO 662 J=1,39
      RTAKEN(J) = RTAKEN(J) + WTAKEN(J)
      RNPOST(J) = RNPOST(J) + WNPOST(J)
```

```
      RTAVLD(J) = RTAVLD(J) + WTAVLD(J)
      RTPOST(J) = RTPOST(J) + WTPOST(J)
      RTFIL(J) = RTFIL(J) + WTFIL(J)
  662 RTUSED(J) = RTUSED(J) + WTUSED(J)
      DO 7766 J=1,39
      IF(RTAVLD(J).NE.0) GO TO 7765
      RUTRAT(J) = 0.
      RFRIND(J) = 0.
      RBLUT(J) = 0.
      GO TO 7766
 7765 RUTRAT(J) =(RTPOST(J) + RTAKEN(J) + RTUSED(J))/FLOAT(RTAVLD(J))
      RFRIND(J) = (RTAVLD(J)-(RTUSED(J)+RTFIL(J)) )/FLOAT(RTAVLD(J))
      RBLUT(J) = (RTUSED(J) + RTFIL(J)) / FLOAT(RTAVLD(J))
 7766 CONTINUE
      IF (DAY.NE. FINDAY) GO TO 9790
C
C         LAST DAY OF RUN WAS JUST SIMULATED
C
C
      WRITE(6,665) FINDAY,DSTAB
  665 FORMAT('1',20X,'SUMMARY FROM ENTIRE RUN OF',I5,'  SIMULATED DAYS A
     *FTER A ',I5,'  DAY STABILIZATION PERIOD')
      WRITE(6,666)
  666 FORMAT(' ',18X,'*****************************************************
     ****************************************',/)
      WRITE(6,781)
      WRITE(6,1667) IRLSRT
 1667 FORMAT(' ',/,16X,' NO. OF REQUESTS ON WL AT START OF RUN: ',I4,/)
      WRITE(6,667) RNREQ
  667 FORMAT( ' ',15X,' NO. OF REQUESTS GENERATED DURING RUN: ',I4,/)
      WRITE(6,871) RSLAT
      WRITE(6,1786) RIDCAN
      WRITE(6,5784) RNFILL
      DEN = FLOAT(RNREQ) + FLOAT(IRLSRT)
      FRSL = FLOAT(RSLAT) / DEN
      WRITE(6,872) FRSL
      AVWT = RWLDAY/FLOAT(RNREML)
      RRSLAT = RNREML - 1
      AVWTD=SQRT((RWLDA2-(RWLDAY*RWLDAY/FLOAT(RNREML)))/RRSLAT)
      WRITE(6,873) AVWT,AVWTD
      AVSZWL = FLOAT(IRNWL)/FINDAY
      FNDAY = FINDAY - 1
      IFNDY = FINDAY
      AVSZW2 = SQRT((IRNWL2-(IRNWL*IRNWL/FLOAT(IFNDY)))/FNDAY)
      WRITE(6,874) AVSZWL,AVSZW2
      WRITE(6,4720)
      WRITE(6,787)
      WRITE(6,8710)
      WRITE(6,788) RCANCL
      WRITE(6,789) RCANOR
      WRITE(6,790) RTGAP
      NRPST = 0
      DO 5968 J=1,39
 5968 NRPST = RNPOST(J) + NRPST
      WRITE(6,791) NRPST
      WRITE(6,793) RNOBED
      WRITE(6,794) RNOROM
      WRITE(6,799)
      WRITE(6,8710)
      WRITE(6,850) (J,J=1,12)
      DO 670 J=1,12
      SLUR(J) = FLOAT(ROPUT(J))/(24.*(FINDAY/5.))
  670 PERCID(J) = 100. - SLUR(J)
```

```
      WRITE(6,852)  (SLUR(J),J=1,12)
      WRITE(6,853)  (PERCID(J),J=1,12)
      OPSM = 0.
      DO 5969 J=1,12
 5969 OPSM = SLUR(J)  + OPSM
      OPSM = OPSM/9.
      WRITE(6,856)OPSM
      WRITE(6,4720)
      WRITE(6,880)
      WRITE(6,8710)
      WRITE(6,881)  (J,J=1,7)
      DO 671 J=1,7
  671 PERCAN(J)  = FLOAT(RANOCC(J))/(24. *(FINDAY/5.))
      WRITE(6,882)  (PERCAN(J), J=1,7)
      OPSM = 0.
      DO 5970 J=1,7
 5970 OPSM = PERCAN(J)  + OPSM
      CPSM = OPSM/5.
      WRITE(6,5870)  OPSM
      WRITE(6,672)
  672 FORMAT('1',//,10X,'SURGEON STATISTICS  (OVER  ENTIRE  SIMULATION RUN)
     *:  ',/)
      WRITE(6,605)
      WRITE(6,606)
      WRITE(6,602)
      WRITE(6,609)
      WRITE(6,607)
      WRITE(6,608)
      DO 673 J=1,39
  673 WRITE(6,651)  J,RTAVLD(J),RTUSED(J),RTAKEN(J),RTFIL(J),RBLUT(J),
     *RFRIND(J),RUTRAT(J)
      CALL USTAT(RBLUT,BMN,BDEV)
      CALL USTAT(RFRIND,FMN,FDEV)
      CALL USTAT (RUTRAT,UTMN,UTDEV)
      WRITE(6,652)  BMN,BDEV
      WRITE(6,653)  FMN,FDEV
      WRITE(6,654)  UTMN,UTDEV
      WRITE(6,655)
 9790 RETURN
      END
```

```
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      SUBROUTINE USTAT(ARRAY,RMEAN,RDEV)
C
C        UTILITY ROUTINE TO CALCULATE
C     SAMPLE MEAN AND STANDARD DEVIATION
C     OF A 39 COMPONENT ARRAY
C
      REAL ARRAY(39)
      ACC = 0.
      SACC = 0.
      DO 10 J=1,39
      ACC = ACC + ARRAY(J)
   10 SACC = SACC + ARRAY(J)  * ARRAY(J)
      RMEAN = ACC/39.
      RDEV = SQRT((SACC -  ((ACC*ACC)/39.))/38.)
      RETURN
      END
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
      FUNCTION MIN(N)
C      CONVERTS A TIME IN HOURS
C     TO MINUTES PAST 8:00
      MIN = N - 800
      NMIN = MIN
      MIN = MIN/100.
      NMIN = NMIN - MIN*100
      MIN = (MIN*60 + NMIN) + 800
      RETURN
      END
C
C$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
C      CONVERTS TIME IN MINUTES
C     TO TIME IN HOURS
C     ON A 24 HOUR CLOCK
      FUNCTION IHOURS (M)
      INTEGER*2 M
      MTS = M-800
      IHOURS = MTS / 60
      MTS = MTS - (IHOURS*60)
      IHOURS = IHOURS*100 + MTS + 800
      RETURN
      END
```

APPENDIX 4

DETAILED OUTPUT FOR DAY 49

*** EXOGENOUS DEMAND FOR SURGICAL REQUESTS ***

DAY: 49

NO. OF REQUESTS: 48

SURGEON	SURGERY CLASS	LENGTH OF STAY (DAYS)
1	GYNECOLOGY-1	2
18	GENERAL-4	12
34	LOCAL-2	0
34	UROLOGY-3	0
2	GENERAL-3	8
18	GENERAL-3	8
4	ORTHOPEDICS-3	14
37	GENERAL-3	4
23	GENERAL-1	6
35	GYNECOLOGY-1	0
7	E-N-T-3	4
38	LOCAL-1	0
27	DENTAL-1	0
23	LOCAL-1	0
37	GYNECOLOGY-1	0
12	UROLOGY-1	5
32	LOCAL-5	0
9	GYNECOLOGY-1	0
10	E-N-T-2	4
16	LOCAL-6	0
24	GYNECOLOGY-1	0
38	LOCAL-2	0
21	GENERAL-3	8
11	E-N-T-1	2
26	GYNECOLOGY-2	8
1	GYNECOLOGY-1	0
9	GYNECOLOGY-1	2
21	GENERAL-3	8
17	DENTAL-1	0
23	GENERAL-1	6
37	E-N-T-1	2
31	GYNECOLOGY-2	8
38	GENERAL-1	6
37	GYNECOLOGY-1	7
8	GYNECOLOGY-1	3
37	GYNECOLOGY-1	3
9	GYNECOLOGY-2	8
1	LOCAL-1	0
4	ORTHOPEDICS-2	2
37	GYNECOLOGY-1	2
10	E-N-T-3	4
12	LOCAL-2	0
2	GENERAL-1	1
12	UROLOGY-4	10
14	GYNECOLOGY-1	7
31	GENERAL-3	6
37	E-N-T-1	2
19	GYNECOLOGY-1	2

GENERAL SURGERY BLOCK-TIME ARRANGEMENT

	ANESTHETISTS						
	1	2	3	4	5	6	7
TIME	SURGEON-CODES						
800	1	22	30	23	37	0	0
900	1	22	30	23	37	0	0
1000	32	8	30	23	37	0	0
1100	32	8	9	23	37	0	0
1200	16	12	9	23	25	0	0
1300	16	12	9	31	3	0	0
1400	16	12	9	31	3	0	0
1500	16	12	9	31	3	0	0

SURGICAL BED CENSUS INFORMATION

BEFORE SIMULATION OF SLATING ON DAY: 49

CENSUS AT START OF DAY 48 BEFORE DEPARTURES WAS: 122

NO. SCHEDULED TO DEPART ON DAY 48 WAS: 23

EFFECTIVE SURGICAL SLATE FOR SIMULATED DAY: 49

ROOM	TIME	SURGERY CLASS		SURGEON	ANESTHETIST	SCHEDULED DURATION	DAYS ON WL
1	1030	ORTHOPEDICS-3	(G)	37	5	90	18
2	800	GYNECOLOGY-2		37	5	90	19
2	930	GENERAL-1		37	5	60	19
2	1100	GYNECOLOGY-1	(G)	8	2	60	15
2	1200	DENTAL-1		16	1	60	15
2	1300	E-N-T-3		16	1	90	15
2	1430	PLASTIC-1		16	1	60	13
3	800	LOCAL-2	(G)	34	0	60	0
3	900	LOCAL-2		38	0	60	0
3	1100	LOCAL-2		12	0	60	0
3	1230	UROLOGY-4	(G)	12	2	90	15
4	800	GENERAL-1		22	2	60	12
4	900	GENERAL-1		22	2	60	5
4	1000	E-N-T-2		11	1	90	20
4	1200	GYNECOLOGY-1		25	5	60	8
4	1300	GYNECOLOGY-1		3	5	60	15
4	1400	GENERAL-3		3	5	90	15
5	800	E-N-T-3	(G)	30	3	90	8
5	930	E-N-T-3		30	3	90	8
5	1400	GENERAL-3		12	2	90	14

6	800	GENERAL-3	(G)	23	4	90	7
6	930	GYNECOLOGY-2	(G)	23	4	90	5
6	1100	GENERAL-3		23	4	90	5
6	1300	GYNECOLOGY-2		31	4	90	0
6	1430	GENERAL-3		31	4	90	0
10	800	GENERAL-4		1	1	120	3
10	1000	GYNECOLOGY-1		8	2	60	16
10	1100	GYNECOLOGY-1		9	3	60	17
10	1200	GYNECOLOGY-1		9	3	60	16
10	1300	GYNECOLOGY-2		9	3	90	15
10	1430	GYNECOLOGY-2		9	3	90	14
11	800	LOCAL-1		38	0	60	0
11	1100	LOCAL-6		16	0	60	0
11	1200	LOCAL-5	(G)	32	0	30	0
11	1300	LOCAL-1		23	0	60	0

SUMMARY FROM SIMULATED SLATE ON DAY 49

SLATING:

NO. OF REQUESTS ON WL FROM YESTERDAY: 395

NO. OF REQUESTS SLATED FROM WL: 25

NO. OF REQUESTS CANCELLED FROM WL: 4

NO. OF REQUESTS SLATED ON RESCAN OF WL: 1

EXOGENOUS DAILY DEMAND: 48

NO. OF DEMAND REQUESTS CANCELLED (REPLACEABLE): 1

NO. OF REQUESTS ADDED TO WL: 37

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 9

TOTAL NO. OF DAILY REQUESTS SLATED: 35

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 6

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 7

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 8

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 266

NO. OF AVAILABLE SURGICAL BEDS: 140

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 1

EVALUATION:

FRACTION OF EXAMINED REQUESTS WITH INSUFFICIENT (EXISTING) BLOCK TIME: 0.600

FRACTION OF EXAMINED REQUESTS SLATED: 0.079

AVERAGE NO. OF DAYS ON WL FOR A SLATED REQUEST: 12.769 ST. DEV.: 4.950

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	0.0	75.0	25.0	87.5	37.5	56.3	0.0	0.0	0.0	100.0	37.5	0.0
PERCENTAGE SLATED IDLE TIME	100.0	25.0	75.0	12.5	62.5	43.8	100.0	100.0	100.0	-0.0	62.5	100.0

OVERALL PERFORMANCE:

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 46.53

PERCENTAGE SLATED IDLE TIME OVER ALL OPERATING ROOMS AVAILABLE: 53.47

APPENDIX 5

WEEKLY REPORTS FOR SIMULATED WEEKS 5 to 10

WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FOR WEEK # 5

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 232

NO. OF REQUESTS GENERATED DURING WEEK: 202

NO. OF REQUESTS SLATED: 169

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 21

NO. OF REQUESTS SLATED ON RESCAN OF WL: 16

FRACTION OF REQUESTS SLATED: 0.39

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 6.90 ST. DEV.: 37.09

AVERAGE NO. OF REQUESTS ON DAILY WL: 237.60 ST. DEV.: 4.83

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 30

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 31

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 34

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 133

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 14

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	35.0	77.5	43.8	62.5	68.8	47.5	0.0	0.0	0.0	33.8	28.8	0.0
PERCENTAGE SLATED IDLE TIME	65.0	22.5	56.3	37.5	31.3	52.5	100.0	100.0	100.0	66.3	71.3	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 44.17

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	77.5	75.0	63.8	73.8	72.5	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 72.50

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	510	0	150	0.92	0.08	0.71
2	180	60	90	90	0.83	0.17	0.83
3	180	180	0	0	1.00	0.0	1.33
4	180	0	0	180	1.00	0.0	0.0
5	0	0	0	0	0.0	0.0	0.0
6	240	210	0	0	0.88	0.13	1.38
7	180	150	0	0	0.83	0.17	2.00
8	480	450	120	0	0.94	0.06	2.69
9	780	750	0	0	0.96	0.04	2.15
10	180	90	0	60	0.83	0.17	0.50
11	120	90	90	0	0.75	0.25	3.75
12	660	630	0	0	0.95	0.05	2.05
13	120	0	0	90	0.75	0.25	0.0
14	60	0	0	60	1.00	0.0	0.0
15	240	210	0	0	0.88	0.13	1.25
16	480	450	0	0	0.94	0.06	1.81
17	360	180	0	150	0.92	0.08	0.50
18	480	390	0	60	0.94	0.06	1.00
19	840	780	0	0	0.93	0.07	1.04
20	60	60	0	0	1.00	0.0	2.00
21	300	270	0	0	0.90	0.10	2.00
22	120	60	0	60	1.00	0.0	1.25
23	420	390	0	0	0.93	0.07	1.93
24	60	60	0	0	1.00	0.0	2.00
25	180	150	0	0	0.83	0.17	1.17
26	300	270	0	0	0.90	0.10	2.20
27	180	180	0	0	1.00	0.0	3.67
28	180	150	0	0	0.83	0.17	1.33
29	180	180	0	0	1.00	0.0	1.33
30	180	180	0	0	1.00	0.0	1.83
31	360	270	0	60	0.92	0.08	0.75
32	120	0	0	120	1.00	0.0	0.0
33	60	0	0	60	1.00	0.0	0.0
34	240	210	0	0	0.88	0.13	1.63
35	480	420	0	0	0.88	0.13	1.06
36	480	480	300	0	1.00	0.0	2.56
37	1080	1050	540	0	0.97	0.03	3.19
38	180	150	0	0	0.83	0.17	2.83
39	60	60	0	0	1.00	0.0	1.00

BLOCK UTILIZATION	MEAN:	0.90	STANDARD DEVIATION:	0.16
FRAGMENTATION INDICATORS	MEAN:	0.07	STANDARD DEVIATION:	0.07
REQUEST UTILIZATION	MEAN:	1.45	STANDARD DEVIATION:	1.00

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WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FOR WEEK # 6

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 238

NO. OF REQUESTS GENERATED DURING WEEK: 225

NO. OF REQUESTS SLATED: 172

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 29

NO. OF REQUESTS SLATED ON RESCAN OF WL: 18

FRACTION OF REQUESTS SLATED: 0.37

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 8.08 ST. DEV.: 42.95

AVERAGE NO. OF REQUESTS ON DAILY WL: 248.80 ST. DEV.: 11.99

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 31

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 30

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 33

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 138

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 2

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	35.0	72.5	50.0	61.3	63.8	52.5	0.0	0.0	0.0	48.8	23.8	0.0
PERCENTAGE SLATED IDLE TIME	65.0	27.5	50.0	38.8	36.3	47.5	100.0	100.0	100.0	51.3	76.3	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 45.28

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	72.5	76.3	68.8	82.5	70.0	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 74.00

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	510	0	120	0.88	0.13	0.71
2	180	180	0	0	1.00	0.0	2.67
3	180	120	0	60	1.00	0.0	1.67
4	180	180	0	0	1.00	0.0	2.83
5	0	0	0	0	0.0	0.0	0.0
6	240	210	0	0	0.88	0.13	1.25
7	180	180	0	0	1.00	0.0	1.50
8	480	450	0	0	0.94	0.06	1.94
9	780	780	0	0	1.00	0.0	2.50
10	180	0	0	150	0.83	0.17	0.0
11	120	90	90	0	0.75	0.25	3.00
12	660	600	0	0	0.91	0.09	1.86
13	120	90	0	0	0.75	0.25	1.50
14	60	0	0	60	1.00	0.0	0.0
15	240	240	0	0	1.00	0.0	2.38
16	480	480	0	0	1.00	0.0	1.50
17	360	300	0	60	1.00	0.0	0.83
18	480	480	0	0	1.00	0.0	1.75
19	840	360	0	420	0.93	0.07	0.54
20	60	60	0	0	1.00	0.0	1.00
21	300	270	240	0	0.90	0.10	3.50
22	120	90	0	0	0.75	0.25	3.00
23	420	360	0	0	0.86	0.14	1.50
24	60	60	0	0	1.00	0.0	2.00
25	180	150	60	0	0.83	0.17	2.00
26	300	300	0	0	1.00	0.0	2.30
27	180	180	120	0	1.00	0.0	3.33
28	180	180	0	0	1.00	0.0	1.00
29	180	180	0	0	1.00	0.0	3.00
30	180	150	0	0	0.83	0.17	2.33
31	360	60	0	240	0.83	0.17	0.17
32	120	0	0	120	1.00	0.0	0.0
33	60	0	0	60	1.00	0.0	0.0
34	240	240	60	0	1.00	0.0	2.38
35	480	450	0	0	0.94	0.06	1.63
36	480	450	120	0	0.94	0.06	1.75
37	1080	1020	540	0	0.94	0.06	3.14
38	180	150	60	0	0.83	0.17	1.50
39	60	60	0	0	1.00	0.0	1.00

BLOCK UTILIZATION	MEAN:	0.91	STANDARD DEVIATION:	0.17
FRAGMENTATION INDICATORS	MEAN:	0.06	STANDARD DEVIATION:	0.08
REQUEST UTILIZATION	MEAN:	1.67	STANDARD DEVIATION:	1.02

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WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FOR WEEK # 7

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 263

NO. OF REQUESTS GENERATED DURING WEEK: 232

NO. OF REQUESTS SLATED: 168

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 27

NO. OF REQUESTS SLATED ON RESCAN OF WL: 8

FRACTION OF REQUESTS SLATED: 0.34

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 7.92 ST. DEV.: 41.56

AVERAGE NO. OF REQUESTS ON DAILY WL: 277.20 ST. DEV.: 12.28

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 35

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 30

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 36

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 157

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 2

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	37.5	68.8	46.3	65.0	55.0	47.5	0.0	0.0	0.0	55.0	22.5	0.0
PERCENTAGE SLATED IDLE TIME	62.5	31.3	53.8	35.0	45.0	52.5	100.0	100.0	100.0	45.0	77.5	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 44.17

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	63.8	80.0	68.8	81.3	67.5	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 72.25

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	600	0	60	0.92	0.08	1.13
2	180	180	0	0	1.00	0.0	1.33
3	180	180	0	0	1.00	0.0	1.33
4	180	180	0	0	1.00	0.0	1.50
5	0	0	0	0	0.0	0.0	0.0
6	240	240	0	0	1.00	0.0	2.75
7	180	180	0	0	1.00	0.0	1.00
8	480	480	0	0	1.00	0.0	2.31
9	780	720	0	0	0.92	0.08	2.27
10	180	180	0	0	1.00	0.0	1.00
11	120	90	90	0	0.75	0.25	2.75
12	660	600	0	0	0.91	0.09	1.82
13	120	90	0	0	0.75	0.25	3.25
14	60	60	0	0	1.00	0.0	3.00
15	240	240	0	0	1.00	0.0	3.00
16	480	480	0	0	1.00	0.0	1.88
17	360	240	0	90	0.92	0.08	0.67
18	480	450	0	0	0.94	0.06	1.06
19	840	600	0	180	0.93	0.07	1.18
20	60	60	0	0	1.00	0.0	3.00
21	300	270	0	0	0.90	0.10	1.40
22	120	90	0	0	0.75	0.25	2.75
23	420	420	0	0	1.00	0.0	2.21
24	60	60	0	0	1.00	0.0	2.00
25	180	150	0	0	0.83	0.17	2.83
26	300	270	0	0	0.90	0.10	2.10
27	180	180	0	0	1.00	0.0	2.33
28	180	0	0	150	0.83	0.17	0.0
29	180	180	0	0	1.00	0.0	1.50
30	180	180	0	0	1.00	0.0	1.50
31	360	360	0	0	1.00	0.0	1.50
32	120	90	0	0	0.75	0.25	1.50
33	60	0	0	60	1.00	0.0	0.0
34	240	180	90	0	0.75	0.25	1.38
35	480	450	0	0	0.94	0.06	2.38
36	480	450	0	0	0.94	0.06	1.88
37	1080	1080	420	0	1.00	0.0	2.78
38	180	180	0	0	1.00	0.0	2.67
39	60	0	0	60	1.00	0.0	0.0

BLOCK UTILIZATION	MEAN:	0.91	STANDARD DEVIATION:	0.17
FRAGMENTATION INDICATORS	MEAN:	0.06	STANDARD DEVIATION:	0.09
REQUEST UTILIZATION	MEAN:	1.77	STANDARD DEVIATION:	0.91

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WEEKLY SUMMARY STATISTICS CN SIMULATED SLATING FOR WEEK # 8

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 298

NO. OF REQUESTS GENERATED DURING WEEK: 258

NO. OF REQUESTS SLATED: 167

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 21

NO. OF REQUESTS SLATED ON RESCAN OF WL: 7

FRACTION OF REQUESTS SLATED: 0.30

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 8.32 ST. DEV.: 44.50

AVERAGE NO. OF REQUESTS ON DAILY WL: 322.80 ST. DEV.: 23.44

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 31

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 24

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 27

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 176

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 11

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	26.3	68.8	55.0	75.0	55.0	60.0	0.0	0.0	0.0	60.0	18.8	0.0
PERCENTAGE SLATED IDLE TIME	73.8	31.3	45.0	25.0	45.0	40.0	100.0	100.0	100.0	40.0	81.3	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 46.53

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	68.8	67.5	81.3	78.8	86.3	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 76.50

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	660	0	0	0.92	0.08	1.46
2	180	180	0	0	1.00	0.0	1.83
3	180	150	0	0	0.83	0.17	2.00
4	180	120	0	60	1.00	0.0	2.17
5	0	0	0	0	0.0	0.0	0.0
6	240	210	0	0	0.88	0.13	0.88
7	180	150	0	0	0.83	0.17	1.83
8	480	420	0	0	0.88	0.13	2.63
9	780	720	0	0	0.92	0.08	2.38
10	180	180	0	0	1.00	0.0	2.00
11	120	90	0	0	0.75	0.25	2.00
12	660	600	0	0	0.91	0.09	2.55
13	120	90	0	0	0.75	0.25	1.25
14	60	60	0	0	1.00	0.0	3.00
15	240	240	0	0	1.00	0.0	1.50
16	480	420	0	0	0.88	0.13	1.63
17	360	300	0	60	1.00	0.0	0.83
18	480	300	0	180	1.00	0.0	0.63
19	840	780	0	60	1.00	0.0	1.36
20	60	60	0	0	1.00	0.0	2.00
21	300	300	0	0	1.00	0.0	2.60
22	120	90	0	0	0.75	0.25	0.75
23	420	420	0	0	1.00	0.0	2.57
24	60	60	0	0	1.00	0.0	1.00
25	180	150	0	0	0.83	0.17	1.67
26	300	270	0	0	0.90	0.10	1.80
27	180	180	300	0	1.00	0.0	4.67
28	180	180	0	0	1.00	0.0	1.00
29	180	180	0	0	1.00	0.0	2.00
30	180	180	0	0	1.00	0.0	2.00
31	360	330	0	0	0.92	0.08	0.92
32	120	90	0	0	0.75	0.25	1.50
33	60	0	0	60	1.00	0.0	0.0
34	240	240	0	0	1.00	0.0	2.25
35	480	450	0	0	0.94	0.06	2.25
36	480	450	0	0	0.94	0.06	1.56
37	1080	1050	120	0	0.97	0.03	3.39
38	180	180	0	0	1.00	0.0	1.67
39	60	60	0	0	1.00	0.0	1.00

BLOCK UTILIZATION MEAN: 0.91 STANDARD DEVIATION: 0.17

FRAGMENTATION INDICATORS MEAN: 0.06 STANDARD DEVIATION: 0.08

REQUEST UTILIZATION MEAN: 1.76 STANDARD DEVIATION: 0.89

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WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FOR WEEK # 9

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 361

NO. OF REQUESTS GENERATED DURING WEEK: 205

NO. OF REQUESTS SLATED: 173

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 29

NO. OF REQUESTS SLATED ON RESCAN OF WL: 17

FRACTION OF REQUESTS SLATED: 0.31

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 10.36 ST. DEV.: 55.15

AVERAGE NO. OF REQUESTS ON DAILY WL: 360.60 ST. DEV.: 4.83

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 30

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 29

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 32

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 161

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 11

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	52.5	68.8	38.8	68.8	46.3	65.0	0.0	0.0	0.0	38.8	28.8	0.0
PERCENTAGE SLATED IDLE TIME	47.5	31.3	61.3	31.3	53.8	35.0	100.0	100.0	100.0	61.3	71.3	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 45.28

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	63.8	78.8	70.0	70.0	80.0	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 72.50

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FRCM CTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIMF ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLCTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	660	0	0	0.92	0.08	1.33
2	180	150	0	0	0.83	0.17	1.17
3	180	180	0	0	1.00	0.0	2.17
4	180	120	90	60	1.00	0.0	3.83
5	0	0	0	0	0.0	0.0	0.0
6	240	240	270	0	1.00	0.0	2.63
7	180	180	0	0	1.00	0.0	1.00
8	480	480	0	0	1.00	0.0	1.75
9	780	750	0	0	0.96	0.04	2.27
10	180	180	0	0	1.00	0.0	1.50
11	120	90	90	0	0.75	0.25	2.75
12	660	540	0	0	0.82	0.18	2.27
13	120	120	0	0	1.00	0.0	2.25
14	60	60	0	0	1.00	0.0	2.00
15	240	210	0	0	0.88	0.13	0.88
16	480	480	0	0	1.00	0.0	1.69
17	360	240	0	90	0.92	0.08	0.67
18	480	360	0	90	0.94	0.06	0.75
19	840	600	0	240	1.00	0.0	0.71
20	60	60	0	0	1.00	0.0	2.00
21	300	300	0	0	1.00	0.0	2.70
22	120	90	0	0	0.75	0.25	5.25
23	420	390	0	0	0.93	0.07	2.50
24	60	0	0	60	1.00	0.0	0.0
25	180	180	0	0	1.00	0.0	2.83
26	300	270	0	0	0.90	0.10	3.90
27	130	180	60	0	1.00	0.0	2.33
28	180	90	0	60	0.83	0.17	0.50
29	180	180	0	0	1.00	0.0	2.00
30	180	180	0	0	1.00	0.0	2.50
31	360	60	0	300	1.00	0.0	0.17
32	120	90	0	0	0.75	0.25	2.25
33	60	0	0	60	1.00	0.0	0.0
34	240	210	0	0	0.88	0.13	2.00
35	480	480	0	0	1.00	0.0	2.88
36	480	270	0	180	0.94	0.06	0.75
37	1080	1050	690	0	0.97	0.03	3.25
38	180	180	0	0	1.00	0.0	2.67
39	60	0	0	60	1.00	0.0	0.0

BLOCK UTILIZATION MEAN: 0.92 STANDARD DEVIATION: 0.17

FRAGMENTATION INDICATCRS MEAN: 0.05 STANDARD DEVIATION: 0.08

REQUEST UTILIZATICN MEAN: 1.85 STANDARD DEVIATION: 1.20

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WEEKLY SUMMARY STATISTICS ON SIMULATED SLATING FOR WEEK # 10

SLATING:

NO. OF REQUESTS ON WL AT START OF WEEK: 366

NO. OF REQUESTS GENERATED DURING WEEK: 193

NO. OF REQUESTS SLATED: 159

NO. OF REQUESTS SLATED DIRECTLY FROM DAILY DEMAND: 15

NO. OF REQUESTS SLATED ON RESCAN OF WL: 11

FRACTION OF REQUESTS SLATED: 0.28

AVERAGE NO. OF DAYS A REQUEST REMAINS ON WL: 10.23 ST. DEV.: 54.90

AVERAGE NO. OF REQUESTS ON DAILY WL: 365.20 ST. DEV.: 6.98

CANCELLATION AND POSTPONEMENT:

NO. OF REQUESTS CANCELLED BY SLATING CLERK: 30

NO. OF REQUESTS CANCELLED BY O.R. SUPERVISOR: 21

NO. OF REQUESTS GAPPED BECAUSE OF ABRUPT CANCELLATION: 25

NO. OF EXAMINED REQUESTS POSTPONED BECAUSE OF INSUFFICIENT BLOCK TIME: 116

NO. OF REQUESTS POSTPONED BECAUSE OF UNAVAILABLE BED: 0

NO. OF REQUESTS POSTPONED BECAUSE OF LACK OF A FREE OPERATING ROOM: 5

OPERATING ROOM UTILIZATION (SLATED):

OPERATING ROOM:	1	2	3	4	5	6	7	8	9	10	11	12
SLATED UTILIZATION PERCENTAGE	35.0	75.0	40.0	81.3	70.0	48.8	0.0	0.0	0.0	45.0	11.3	0.0
PERCENTAGE SLATED IDLE TIME	65.0	25.0	60.0	18.8	30.0	51.3	100.0	100.0	100.0	55.0	88.8	100.0

SLATED-TIME UTILIZATION PERCENTAGE OVER ALL OPERATING ROOMS AVAILABLE: 45.14

ANESTHETIST UTILIZATION (SLATED):

ANESTHETIST:	1	2	3	4	5	6	7
PERCENTAGE OF TIME OCCUPIED:	65.0	81.3	81.3	82.5	75.0	0.0	0.0

AVERAGE OCCUPANCY PERCENTAGE: 77.00

SURGEON STATISTICS (WEEKLY):

ALLOTTED - TIME ALLOTTED BY BLOCK SYSTEM
USED - BLOCK TIME USED
TAKEN - BLOCK TIME TAKEN FROM OTHER SURGEONS
GIVEN - TIME GIVEN TO REQUESTS FROM OTHER SURGEONS
BLOCK UTILIZATION - (BLOCK TIME USED + BLOCK TIME GIVEN) / BLOCK TIME ALLOTTED
FR. IND. - (BLOCK TIME UNUSED BECAUSE OF FRAGMENTATION/TIME ALLOTTED) FOR BLOCK SYSTEM
REQUEST UTILIZATION - ((TIME USED + TIME TAKEN + UNSLATED TIME POSTPONED) / TIME ALLOTTED) FOR BLOCK SYSTEM

SURGEON	ALLOTTED	USED	TAKEN	GIVEN	BLOCK UT.	FR. IND.	REQUEST UT.
1	720	570	0	120	0.96	0.04	0.92
2	180	150	0	0	0.83	0.17	0.83
3	180	150	0	0	0.83	0.17	1.17
4	180	180	0	0	1.00	0.0	2.17
5	0	0	0	0	0.0	0.0	0.0
6	240	240	0	0	1.00	0.0	1.00
7	180	0	0	150	0.83	0.17	0.0
8	480	480	0	0	1.00	0.0	1.75
9	780	780	0	0	1.00	0.0	2.23
10	180	180	0	0	1.00	0.0	2.00
11	120	120	90	0	1.00	0.0	2.50
12	660	630	0	0	0.95	0.05	2.00
13	120	90	0	0	0.75	0.25	1.50
14	60	60	0	0	1.00	0.0	1.00
15	240	180	0	60	1.00	0.0	1.50
16	480	450	0	0	0.94	0.06	1.63
17	360	360	0	0	1.00	0.0	1.00
18	480	480	0	0	1.00	0.0	1.44
19	840	600	0	180	0.93	0.07	1.21
20	60	60	0	0	1.00	0.0	1.00
21	300	270	90	0	0.90	0.10	1.70
22	120	90	150	0	0.75	0.25	3.25
23	420	390	0	0	0.93	0.07	1.71
24	60	60	0	0	1.00	0.0	2.00
25	180	150	0	0	0.83	0.17	1.17
26	300	300	0	0	1.00	0.0	1.60
27	180	180	180	0	1.00	0.0	4.67
28	180	180	0	0	1.00	0.0	1.00
29	180	180	0	0	1.00	0.0	1.00
30	180	180	0	0	1.00	0.0	1.00
31	360	120	0	210	0.92	0.08	0.33
32	120	90	0	0	0.75	0.25	1.50
33	60	0	0	60	1.00	0.0	0.0
34	240	210	0	0	0.88	0.13	2.00
35	480	450	0	0	0.94	0.06	1.63
36	480	450	0	0	0.94	0.06	1.31
37	1080	1020	210	0	0.94	0.06	3.00
38	180	150	60	0	0.83	0.17	1.50
39	60	60	0	0	1.00	0.0	1.00

BLOCK UTILIZATION MEAN: 0.91 STANDARD DEVIATION: 0.17

FRAGMENTATION INDICATORS MEAN: 0.06 STANDARD DEVIATION: 0.08

REQUEST UTILIZATION MEAN: 1.49 STANDARD DEVIATION: 0.88

****

APPENDIX 6

SUMMARY REPORTS

SURGERY PERFORMANCE RATIOS BY SURGEON

SURGEON	# REQUESTED	# PERFORMED	RATIO
1	100	68	0.680
2	18	11	0.611
3	41	22	0.537
4	17	7	0.412
5	0	0	0.0
6	38	24	0.632
7	25	18	0.720
8	119	64	0.538
9	194	113	0.582
10	23	14	0.609
11	31	15	0.484
12	177	103	0.582
13	15	10	0.667
14	8	4	0.500
15	36	23	0.639
16	154	90	0.584
17	47	32	0.681
18	54	35	0.648
19	80	50	0.625
20	22	8	0.364
21	45	29	0.644
22	23	13	0.565
23	87	61	0.701
24	17	9	0.529
25	36	21	0.583
26	70	33	0.471
27	66	35	0.530
28	16	11	0.688
29	16	8	0.500
30	28	16	0.571
31	40	32	0.800
32	13	9	0.692
33	40	22	0.550
34	54	35	0.648
35	86	48	0.558
36	57	41	0.719
37	396	213	0.538
38	95	52	0.547
39	5	4	0.800

RATIO MEAN: 0.583 ST. DEV.: 0.134

SURGERY PERFORMANCE RATIOS BY SURGERY-CLASS

CLASS	# REQUESTED	# PERFORMED	RATIO
LOCAL-1	41	29	0.707
LOCAL-2	70	46	0.657
LOCAL-3	23	16	0.696
LOCAL-4	15	11	0.733
LOCAL-5	42	31	0.738
LOCAL-6	27	18	0.667
LOCAL-7	47	27	0.574
GENERAL-1	145	88	0.607
GENERAL-2	2	2	1.000
GENERAL-3	297	196	0.660
GENERAL-4	55	34	0.618
GENERAL-5	1	0	0.0
GENERAL-6	0	0	0.0
GYNECOLOGY-1	643	353	0.549
GYNECOLOGY-2	153	84	0.549
UROLOGY-1	105	53	0.505
UROLOGY-2	28	15	0.536
UROLOGY-3	27	17	0.630
UROLOGY-4	68	39	0.574
OBSTETRICS-1	15	5	0.333
ORTHOPEDICS-1	5	5	1.000
ORTHOPEDICS-2	82	43	0.524
ORTHOPEDICS-3	25	18	0.720
ORTHOPEDICS-4	6	4	0.667
PLASTIC-1	20	13	0.650
PLASTIC-2	8	6	0.750
PLASTIC-3	0	0	0.0
THORACIC-1	2	0	0.0
THORACIC-2	6	3	0.500
E-N-T-1	127	70	0.551
E-N-T-2	39	23	0.590
E-N-T-3	41	27	0.659
NEUROLOGICAL	10	7	0.700
DENTAL-1	214	120	0.561
DENTAL-2	0	0	0.0
OPHTHALMOLOGY-1	0	0	0.0
OPHTHALMOLOGY-2	0	0	0.0
XXX	0	0	0.0
XXX	0	0	0.0

RATIO MEAN: 0.492 ST. DEV.: 0.297

REPORT ON REQUESTS AND PERFORMANCE OF INDIVIDUAL SURGEONS

	SURGERY CLASS	NO. REQUESTED	NO. PERFORMED
SURGEON:	1		
	LOCAL-1	1	0
	LOCAL-4	1	0
	LOCAL-5	3	2
	GENERAL-1	20	16
	GENERAL-3	26	18
	GENERAL-4	9	6
	GYNECOLOGY-1	31	18
	GYNECOLOGY-2	1	1
	ORTHOPEDICS-1	2	2
	ORTHOPEDICS-2	3	2
	ORTHOPEDICS-3	1	1
	PLASTIC-1	2	2
		TOTAL: 100	TOTAL: 68
SURGEON:	2		
	GENERAL-1	1	0
	GENERAL-3	3	2
	GENERAL-4	1	1
	GYNECOLOGY-1	6	4
	GYNECOLOGY-2	6	4
	ORTHOPEDICS-2	1	0
		TOTAL: 18	TOTAL: 11
SURGEON:	3		
	LOCAL-5	6	6
	GENERAL-1	5	4
	GENERAL-3	6	3
	GYNECOLOGY-1	16	5
	ORTHOPEDICS-2	1	0
	PLASTIC-1	1	1
	E-N-T-1	6	3
		TOTAL: 41	TOTAL: 22
SURGEON:	4		
	LOCAL-4	2	2
	ORTHOPEDICS-2	10	2
	ORTHOPEDICS-3	3	2
	ORTHOPEDICS-4	2	1
		TOTAL: 17	TOTAL: 7
SURGEON:	5		
		TOTAL: 0	TOTAL: 0
SURGEON:	6		
	GENERAL-1	3	1
	GENERAL-3	7	4
	GENERAL-4	8	7
	GENERAL-5	1	0
	GYNECOLOGY-1	8	5
	ORTHOPEDICS-2	4	3
	PLASTIC-1	1	1
	E-N-T-1	6	3
		TOTAL: 38	TOTAL: 24

SURGEON:	7		
	LOCAL-4	6	4
	LOCAL-5	4	3
	GENERAL-1	2	1
	ORTHOPEDICS-2	2	2
	PLASTIC-1	7	5
	PLASTIC-2	2	2
	E-N-T-3	2	1
		TOTAL: 25	TOTAL: 18

SURGEON:	8		
	GENERAL-3	3	3
	GYNECOLOGY-1	93	52
	GYNECOLOGY-2	23	9
		TOTAL: 119	TOTAL: 64

SURGEON:	9		
	GENERAL-1	4	3
	GENERAL-3	1	0
	GYNECOLOGY-1	131	75
	GYNECOLOGY-2	49	31
	UROLOGY-4	1	1
	OBSTETRICS-1	8	3
		TOTAL: 194	TOTAL: 113

SURGEON:	10		
	GENERAL-3	1	1
	E-N-T-1	1	1
	E-N-T-2	7	3
	E-N-T-3	13	8
	DENTAL-1	1	1
		TOTAL: 23	TOTAL: 14

SURGEON:	11		
	E-N-T-1	11	3
	E-N-T-2	16	10
	E-N-T-3	4	2
		TOTAL: 31	TOTAL: 15

SURGEON:	12		
	LOCAL-1	7	4
	LOCAL-2	23	17
	LOCAL-3	9	7
	GENERAL-1	7	2
	GENERAL-3	8	5
	GYNECOLOGY-2	1	0
	UROLOGY-1	62	33
	UROLOGY-2	6	3
	UROLOGY-3	19	13
	UROLOGY-4	35	19
		TOTAL: 177	TOTAL: 103

SURGEON:	13		
	LOCAL-5	2	1
	GENERAL-3	4	3
	GYNECOLOGY-1	1	1
	GYNECOLOGY-2	2	2
	E-N-T-1	3	2
	DENTAL-1	3	1
		TOTAL: 15	TOTAL: 10

SURGEON:	14		
	LOCAL-5	2	2
	GYNECOLOGY-1	4	2
	E-N-T-1	2	0
		TOTAL: 8	TOTAL: 4
SURGEON:	15		
	GENERAL-3	11	8
	GENERAL-4	8	5
	UROLOGY-4	2	1
	THORACIC-1	2	0
	THORACIC-2	6	3
	NEUROLOGICAL	7	6
		TOTAL: 36	TOTAL: 23
SURGEON:	16		
	LOCAL-5	12	9
	LOCAL-6	27	18
	LOCAL-7	5	3
	GENERAL-1	2	1
	GENERAL-3	3	2
	GYNECOLOGY-1	2	1
	UROLOGY-2	1	0
	PLASTIC-1	9	4
	PLASTIC-2	1	0
	E-N-T-1	5	3
	E-N-T-3	8	6
	DENTAL-1	79	43
		TOTAL: 154	TOTAL: 90
SURGEON:	17		
	DENTAL-1	47	32
		TOTAL: 47	TOTAL: 32
SURGEON:	18		
	LOCAL-5	2	1
	GENERAL-1	5	3
	GENERAL-3	32	22
	GENERAL-4	5	2
	GYNECOLOGY-1	2	1
	GYNECOLOGY-2	2	2
	UROLOGY-3	2	1
	UROLOGY-4	1	1
	ORTHOPEDICS-2	1	1
	ORTHOPEDICS-3	2	1
		TOTAL: 54	TOTAL: 35

SURGEON:	19			
	GENERAL-1	7		4
	GENERAL-3	38		25
	GENERAL-4	3		1
	GYNECOLOGY-1	9		6
	GYNECOLOGY-2	10		6
	OBSTETRICS-1	3		2
	ORTHOPEDICS-2	4		2
	E-N-T-1	6		4
		TOTAL: 80		TOTAL: 50
SURGEON:	20			
	UROLOGY-1	8		1
	UROLOGY-2	14		7
		TOTAL: 22		TOTAL: 8
SURGEON:	21			
	LOCAL-5	1		1
	GENERAL-1	20		15
	GENERAL-3	14		8
	GENERAL-4	3		1
	UROLOGY-3	2		1
	E-N-T-1	5		3
		TOTAL: 45		TOTAL: 29
SURGEON:	22			
	GENERAL-1	9		7
	GENERAL-3	4		1
	GYNECOLOGY-1	6		3
	ORTHOPEDICS-2	1		0
	ORTHOPEDICS-3	1		1
	E-N-T-1	2		1
		TOTAL: 23		TOTAL: 13
SURGEON:	23			
	LOCAL-1	15		12
	GENERAL-1	17		11
	GENERAL-2	1		1
	GENERAL-3	27		22
	GENERAL-4	1		1
	GYNECOLOGY-1	11		6
	GYNECOLOGY-2	6		3
	ORTHOPEDICS-2	2		0
	E-N-T-1	7		5
		TOTAL: 87		TOTAL: 61
SURGEON:	24			
	GYNECOLOGY-1	17		9
		TOTAL: 17		TOTAL: 9

SURGEON: 25			
GYNECOLOGY-1	25		15
GYNECOLOGY-2	9		5
UROLOGY-4	2		1
	TOTAL: 36		TOTAL: 21
SURGEON: 26			
GENERAL-3	2		1
GYNECOLOGY-1	53		26
GYNECOLOGY-2	13		5
UROLOGY-4	2		1
	TOTAL: 70		TOTAL: 33
SURGEON: 27			
DENTAL-1	66		35
	TOTAL: 66		TOTAL: 35
SURGEON: 28			
E-N-T-1	8		4
E-N-T-2	7		6
E-N-T-3	1		1
	TOTAL: 16		TOTAL: 11
SURGEON: 29			
ORTHOPEDICS-1	1		1
ORTHOPEDICS-2	12		4
ORTHOPEDICS-3	1		1
E-N-T-1	2		2
	TOTAL: 16		TOTAL: 8
SURGEON: 30			
LOCAL-5	2		1
E-N-T-1	4		2
E-N-T-2	9		4
E-N-T-3	13		9
	TOTAL: 28		TOTAL: 16
SURGEON: 31			
LOCAL-1	1		1
GENERAL-1	2		1
GENERAL-2	1		1
GENERAL-3	19		17
GENERAL-4	2		1
GYNECOLOGY-1	6		4
GYNECOLOGY-2	3		1
ORTHOPEDICS-1	2		2
PLASTIC-2	3		3
E-N-T-1	1		1
	TOTAL: 40		TOTAL: 32

SURGEON: 32			
LOCAL-5	5		3
GENERAL-3	8		6
TOTAL:	13	TOTAL:	9
SURGEON: 33			
LOCAL-7	40		22
TOTAL:	40	TOTAL:	22
SURGEON: 34			
LOCAL-1	8		4
LOCAL-2	6		4
LOCAL-3	6		6
GENERAL-1	1		0
UROLOGY-1	12		6
UROLOGY-2	3		3
UROLOGY-3	4		2
UROLOGY-4	14		10
TOTAL:	54	TOTAL:	35
SURGEON: 35			
GYNECOLOGY-1	60		36
GYNECOLOGY-2	19		11
UROLOGY-4	3		1
OBSTETRICS-1	4		0
TOTAL:	86	TOTAL:	48
SURGEON: 36			
LOCAL-4	5		4
UROLOGY-1	1		1
ORTHOPEDICS-2	31		21
ORTHOPEDICS-3	13		10
ORTHOPEDICS-4	4		3
E-N-T-1	3		2
TOTAL:	57	TOTAL:	41

SURGEON: 37

LOCAL-1	6	5
LOCAL-4	1	1
LOCAL-5	3	2
LOCAL-7	2	2
GENERAL-1	31	15
GENERAL-3	79	44
GENERAL-4	15	9
GYNECOLOGY-1	160	83
GYNECOLOGY-2	9	4
ORTHOPEDICS-2	10	6
ORTHOPEDICS-3	4	2
PLASTIC-2	2	1.
E-N-T-1	53	30
NEUROLOGICAL	3	1
DENTAL-1	18	8
	TOTAL: 396	TOTAL: 213

SURGEON: 38

LOCAL-1	3	3
LOCAL-2	41	25
LOCAL-3	8	3
GENERAL-1	6	1
GENERAL-3	1	1
GYNECOLOGY-1	2	1
UROLOGY-1	22	12
UROLOGY-2	4	2
UROLOGY-4	8	4
	TOTAL: 95	TOTAL: 52

SURGEON: 39

GENERAL-1	3	3
E-N-T-1	2	1
	TOTAL: 5	TOTAL: 4

SUMMARY: SURGEON-CLASS REQUEST FREQUENCIES

SURGEON / SURGERY CLASS

SURGEON	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	1	0	0	1	3	0	0	20	0	26	9	0	0	31	1	0	0	0	0	0	2	3	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	1	0	3	1	0	0	6	6	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	6	0	0	5	0	6	0	0	0	16	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0
4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	3	0	7	8	1	0	8	0	0	0	0	0	0	0	4	0	0	1	0	0	0	0	6	0	0	0	0	0	0	0	0	0
7	0	0	0	6	4	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	7	2	0	0	0	0	0	2	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	3	0	0	0	93	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	4	0	1	0	0	0	131	49	0	0	0	1	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	13	0	1	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	16	4	0	0	0	0	0	0	0
12	7	23	9	0	0	0	0	7	0	8	0	0	0	0	1	62	6	19	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	2	0	0	0	0	4	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0
14	0	0	0	0	2	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	11	8	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	2	6	0	0	0	7	0	0	0	0	0	0
16	0	0	0	0	12	27	5	2	0	3	0	0	0	2	0	0	1	0	0	0	0	0	0	0	9	1	0	0	0	5	0	8	0	79	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	47	0	0	0	0	0
18	0	0	0	0	2	0	0	5	0	32	5	0	0	2	2	0	0	2	1	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	7	0	38	3	0	0	9	10	0	0	0	0	3	0	4	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	1	0	0	20	0	14	3	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	9	0	4	0	0	0	6	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
23	15	0	0	0	0	0	0	17	1	27	1	0	0	11	6	0	0	0	0	0	0	2	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	25	9	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	2	0	0	0	53	13	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	7	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	12	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
30	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	9	13	0	0	0	0	0	0	0
31	1	0	0	0	0	0	0	2	1	19	2	0	0	6	3	0	0	0	0	0	2	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0
32	0	0	0	0	5	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	8	6	6	0	0	0	0	1	0	0	0	0	0	0	0	12	3	4	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	60	19	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	31	13	4	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
37	6	0	0	1	3	0	2	31	0	79	15	0	0	160	9	0	0	0	0	0	0	10	4	0	0	2	0	0	0	53	0	0	3	18	0	0	0	0	0
38	3	41	8	0	0	0	0	6	0	1	0	0	0	2	0	22	4	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0

SUMMARY: SURGEON-CLASS PERFORMANCE FREQUENCIES

SURGEON	SURGERY CLASS 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39
1	0	0	0	0	2	0	0	16	0	18	6	0	0	18	1	0	0	0	0	0	2	2	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	2	1	0	0	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	6	0	0	4	0	3	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0
4	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	1	0	4	7	0	0	5	0	0	0	0	0	0	0	3	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0
7	0	0	0	4	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	2	0	0	0	0	0	1	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	3	0	0	0	52	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	3	0	0	0	0	0	75	31	0	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	3	8	0	1	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	10	2	0	0	0	0	0	0	0
12	4	17	7	0	0	0	0	2	0	5	0	0	0	0	0	33	3	13	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	1	0	0	0	0	3	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	1	0	0	0	0	0
14	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	8	5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	6	0	0	0	0	0	0
16	0	0	0	0	9	18	3	1	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	3	0	6	0	43	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0	0	0
18	0	0	0	0	1	0	0	3	0	22	2	0	0	1	2	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	4	0	25	1	0	0	6	6	0	0	0	0	2	0	2	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	1	0	0	15	0	8	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	7	0	1	0	0	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
23	12	0	0	0	0	0	0	11	1	22	1	0	0	6	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	15	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	1	0	0	0	26	5	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	35	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6	1	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	1	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
30	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	9	0	0	0	0	0	0	0
31	1	0	0	0	0	0	0	1	1	17	1	0	0	4	1	0	0	0	0	0	2	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0
32	0	0	0	0	3	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	4	4	6	0	0	0	0	0	0	0	0	0	0	0	0	6	3	2	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	36	11	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	21	10	3	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
37	5	0	0	1	2	0	2	15	0	44	9	0	0	83	4	0	0	0	0	0	0	6	2	0	0	1	0	0	0	30	0	0	1	8	0	0	0	0	0
38	3	25	3	0	0	0	0	1	0	1	0	0	0	1	0	12	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0