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A SYSTEMS SIMULATION APPROACH TO INTEGRATE MAINTENANCE OPERATIONS

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ABSTRACT

Maintenance is a major activity in the telecommunications business. This paper describes a systems simulation study to investigate new work load assignment techniques and explore the potential for integrating related maintenance operations. The concept of a "Universal Technician" is introduced to facilitate the integration of tasks of differing complexities. The maintenance operations are modeled as an acyclic network of G|G|M - FCFS queues with Markov routing and non-stationary arrivals. Since such a network is typically intractable even under renewal approximations, a simulation model is employed. The alternatives, namely, the current operations and the proposed integrated operations, are compared in terms of manpower requirements and service levels. An economic analysis of the alternatives reveals significant long term savings in integrating the maintenance operations.

1 INTRODUCTION

The telecommunications market is a competitive one and the industry is striving to find efficient ways of managing their resources. One of the issues of concern is how to allocate, assign, install and maintain network equipment and facilities so as to offer good service, while keeping the operating cost to a reasonable minimum. This has been a significant challenge for the industry as it has traditionally organized the maintenance operations functionally. The existing maintenance environment consists of work centers that are specialized to carry out specific functions or set of functions, for example, switching equipment maintenance, cable maintenance, and network termination maintenance. Such an organization has resulted in considerable redundancy in the operations. It is perceived that the productivity and the economical aspects of the operations can be perhaps improved by eliminating some of the redundancies.

To investigate these potential opportunities a systems simulation study was conducted, which forms the basis of this paper. The study is focused primarily in formulating new work load assignments to minimize redundancies in maintenance operations, and to advance the analysis to investigate the feasibility of integrating such operations. This paper is organized in five sections. Following the introduction, Section 2 outlines the present method of operations and the system. Section 3 describes the development of the simulation models. The analysis is presented in Section 4. The final section offers a summary and conclusions.

2 SYSTEM DESCRIPTION

A typical operating company encompasses several geographically districted areas consisting of hundreds of thousands of communications circuits. Problems associated with these circuits are random, i.e., some circuits may fail several times a year, while others may perform reliably for prolonged periods of time. The maintenance functions that could be undertaken can be categorized as follows:

1. Preventive Maintenance which involves periodic inspections and repair of equipment to preempt unexpected failures;
2. Reactive Maintenance which involves repair activities performed after a failure is reported;
3. Routine Maintenance which includes frequent adjustments, replacements, updates, and the like to minimize the repair efforts; and
4. Corrective Maintenance which involves the upgrading of equipment in addition to repair.

Preventive maintenance is generally regarded as a very difficult task due to a number of reasons such as: the large number of circuits involved, the difficulty of predicting the circuit failures, and the prohibitive cost of routinely checking all the circuits. The routine maintenance activities are not of much interest for the study. The reactive maintenance activities are triggered by failure reports that are generated when a service outage is detected by either a computerized performance monitoring system, a customer, or an affected carrier. The maintenance activities associated with the reactive mode of operations is the scope of the study.

2.1 MAINTENANCE OPERATIONS

Some maintenance operations are predominantly manual and organized along functional lines. The organizational element responsible for a particular function is referred to as a work center. A typical arrangement of an existing maintenance operations process is presented in Figure 1. Several work centers may be involved in the repair activity. For example, once a failure is detected, a set of standardized tests are performed on the line and a failure report is generated, which is then routed to the appropriate work centers. Upon completion of the repair activities, the failure report is updated and forwarded to the originating work center with notification of the actions taken.

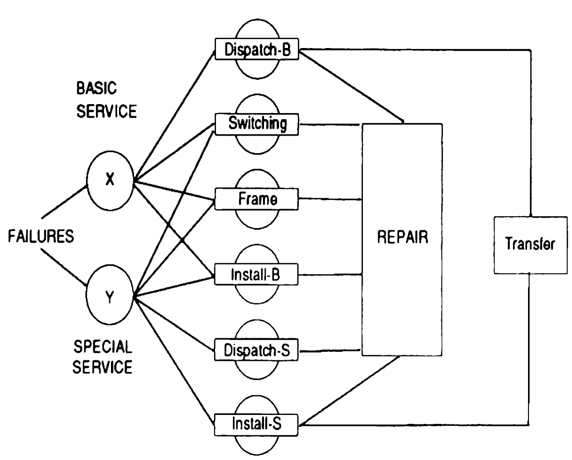

Figure 1: Typical Organization Of Maintenance Centers

The function associated with a work center is described in terms of *tasks*. Tasks are identifiable units of work that are defined in detail by an activity profile. Since the duration of the task time is usually random, conventional work measurement and time-study methods, based on empirical observations, are not directly useful. Instead, an estimation method is used where subject matter experts are asked to estimate the minimum, the most likely, and the maximum task times. A weighted average of the task time is then computed using a weighting ratio of 1:4:1, i.e., the minimum and the maximum task times have unit weights while the most likely task time has a weight of four. (This estimation approach is very similar to that used in the PERT project management technique.) Such task time estimates are obtained from a number of experts and a grand average of the task time is computed. Since more than 20 experts are used in the estimation scheme, it is reasonable to assume that the task times are i.i.d. normal random variables (by virtue of the Central Limit Theorem).

In addition to the task times, their frequency of occurrence also needs to be estimated. A task that is always performed as a part of the maintenance function is said to have a frequency of 1. Therefore, a task has a relative frequency lying between 0 and 1 (see Table 1). The flow diagram of the sequence of tasks, illustrated in Figure 2, completes the definition of the maintenance operations.

Task	Task Name	Time (min)	Frequency
X-1	Receive Failure Report	5.22	1.00
X-2	Call Originator	8.23	0.10
X-3	Search For Records	18.57	0.15
X-4	Screen Failure	6.77	0.90
X-5	Route to Tester	7.67	0.80
X-6	Analyze Failure	5.15	0.40

Table 1: Sample Task Times And Frequencies

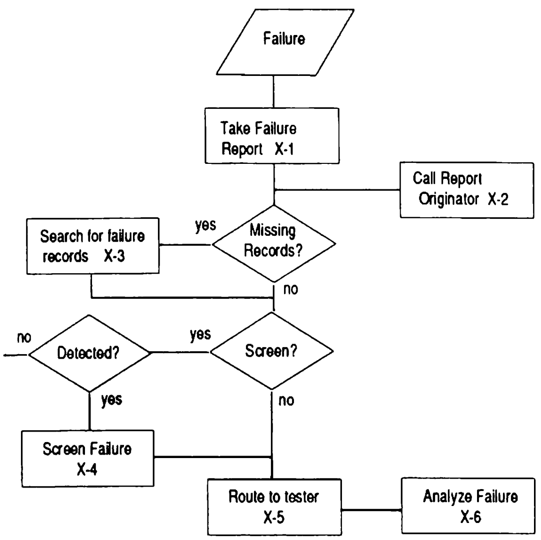

Figure 2: Illustration Of Tasks Sequence

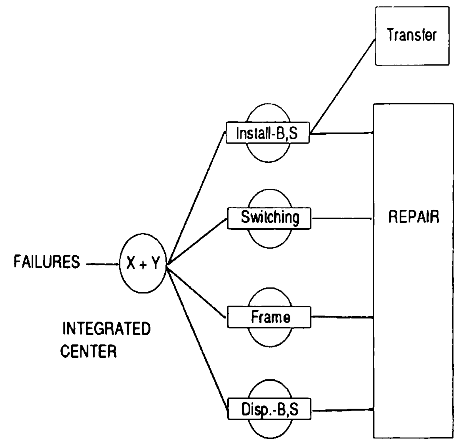

Figure 3: Proposed Work Center Integration

2.2 INTEGRATION ISSUES

The tasks and the associated activity profiles form the basis for the integration of maintenance operations. The tasks and activity profiles of the X and Y maintenance centers (see Figure 1) were compared to identify any task similarities. In some cases, the tasks were found to have either identical activity profiles or minor differences. The integration of these tasks does not pose a problem in terms of the skills of the technicians involved. On the other hand, some tasks were observed to accomplish identical functions but differed in their complexity (and consequently had significantly different activity profiles). To facilitate the integration of such tasks the concept of the Universal Technician (UT) is introduced. A UT is a fully trained technician capable of handling different levels of task complexity. For example, a UT handling failure reports may be capable of working on any type of failure. The notion of UTs alleviates the limitations imposed by the craft requirements and enhances the flexibility in work assignment. It also enables new ways of integrating the maintenance operations with potential savings through reductions in tool equipment, facilities and administrative costs. However, it also incurs costs in training lower level technicians into UTs. The trade-off between these factors is the motivation for the systems simulation study. A diagram of a potential integrated configuration is shown in Figure 3.

3 SYSTEM SIMULATION MODEL

A simulation based modeling approach is adopted for a number of reasons: the flexibility it affords in conducting sensitivity analysis and modifying the model, the opportunity to model the operations in considerable detail, and the intractability of analytical models faced with non-stationary distributions. The use of simulation as a modeling tool to study maintenance processes is not new. Martinson (1981) has used a network simulation approach to study maintenance planning and scheduling. Roar et al. (1984) use simulation to evaluate different maintenance alternatives for avionics equipment. Wang (1980) has used simulation models to evaluate maintenance strategies for large networks before introducing them to the field. It must be noted that although simulation has been used widely in manufacturing, there are few applications of simulation in the area of maintenance.

The simulation study was conducted in two phases. In phase I simulation models were constructed for the X and Y centers (shown in Figure 1). Following this, the activity profiles of the tasks corresponding to centers X and Y were compared as outlined in section 2 in order to develop an integrated center. Phase 2 consists of constructing a simulation model of the integrated center and comparing the alternatives, i.e., the X and Y centers on one hand and the integrated center on the other. The objective of the two phased approach is to build a reasonable model of the actual operations and to validate it so that it forms the basis for interpreting the results of the integrated model.

3.1 Modeling Assumptions

The assumptions listed below largely pertain to the operations of the centers X and Y. To protect the business interests of the operations no actual data is reported; all numbers may be seen to be representative of the operations.

1. The centers X and Y are assumed to serve a total of 250,000 and 60,000 lines respectively. On average these lines have a failure rate of 0.47 failures per line per year. This represents an average daily volume of approximately 560 trouble reports per day.

2. The trouble reports address any one of four failure types. Type 1 failures are associated with the end user equipment. Type 2 failures are those that are reported by the customer and upon checking turned out to be false. Type 3 failures represent failed cross connections mainly due to switching problems. Type 4 failures occur due to deterioration of the transmission properties of the line. It may be caused by an open circuit, shorts etc. The distribution of these failures are shown in Figure 4.

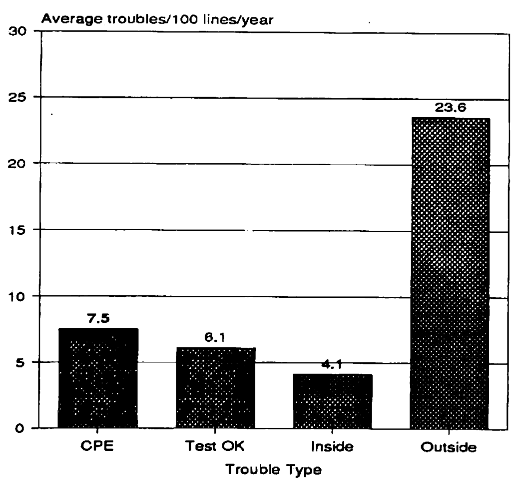

Figure 4: Distribution Of Failure Types

3. A normal day of operation is assumed to be 8 hours long. The arrival process of the failures during the course of the day is shown in Figure 5; the mid-morning and the mid-afternoon hours see relatively higher rates of failure.

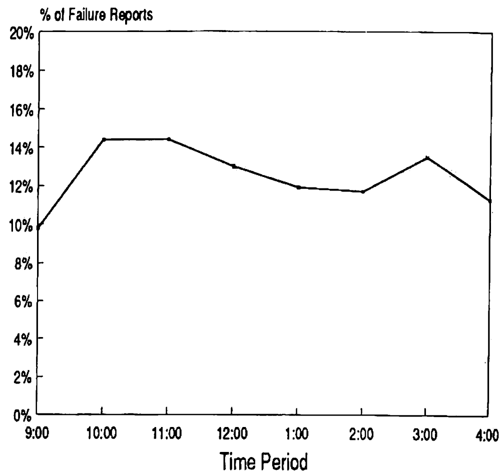

Figure 5: Failure Arrival Process

4. The tasks executed in a center are grouped into three major processes: failure receipt, testing, and close-out. A queue is associated with each of these processes. A number of technicians are assigned to each of these processes to process the failures. Each failure is processed without interruptions, i.e., there is no preemption of failures.

5. Failures of type 1 involve the equipment which is owned by the customer and hence it is resolved during the receipt process. Failures of type 2 are resolved after the testing process. These two failures leave the system after the receipt and the testing process respectively. Failures of type 3 and 4 go through all the three processes.

3.2 MODEL DESCRIPTION

Based on the assumptions listed above a SIMAN simulation model is developed for the X and Y maintenance centers and the integrated center. A sample model listing is provided in Appendix A.

The failures represent the entities that flow through the system in the simulation model. The models consist of three main segments. The first segment simulates the work cycle and maintains the simulation clock. The second segment models the failure arrival process. Finally, the third segment models the operations within a center.

The models, for centers X and Y, begin with the initialization of the work cycle which involves activating the number of technicians in the center. Depending on the time of the day, i.e., the simulation clock, segment 2 picks the mean interarrival times from the distribution shown in Figure 5. The failures then arrive at the center based on a Poisson process. Each failure, i.e., entity in the model, carries with it five attributes: the time of arrival, the type of failure which is set based on the distribution shown in Figure 4, and the process times for the receipt, the test, and the close-out processes. The process times are estimated from the task times whose distribution is ascertained as described in Section 2. The processes themselves are modeled as queues with First-In-First-Out discipline. As soon as a technician responsible for a process is free the next failure in the queue is processed. The dispatch and referral times of failures between the respective centers are assumed to be normally distributed. Statistics are collected on queue lengths, utilization of the technicians, average time in the system for each failure type, and the overall time spent by any failure in the system. It must be noted that the models for X and Y centers differ in their task time assignments used to compute the process times of the failures.

The integrated center model also has three segments of which the first two are identical in structure to that of X and Y center models. In the third segment the major difference in how the queues with respect to the three processes are organized. Although, each failure still goes through the sequence of receipt, test, and close-out, from the perspective of the technicians the queues are parallel (recall the versatility of the UTs).

3.3 MODEL VALIDATION

The models of the current operations, i.e., the X and Y center models, are validated using the Delphi and Turing Methods. In this approach the results of the model are presented to the domain experts who estimate the performance measures for each failure type. The model is adjusted based on the difference of the model's performance to that estimated. This "negotiation" process is repeated until there is a convergence. The input data used in the modeling was validated previously by the operating company and therefore was sufficiently reliable.

4 ANALYSIS

In order to evaluate the benefits of integration vis-a-vis the current operations, two performance measures are considered: the minimum number of technicians that are required to process the failures, and the average time spent by a failure in the system. The former is a surrogate measure of the cost of operations while the latter measures the level of service.

To determine the minimum number of technicians required for handling the specified failure volumes, the model is initially run with a large number of technicians assigned to the receipt, the test, and the close-out processes. This number is then gradually reduced in subsequent runs until an overflow condition is detected, i.e., when the number of technicians is insufficient to handle the failures. For example, Figure 6 shows the test queue for the X center with 20 technicians assigned to the testing process. The "plateaus" in the figure represent the overnight failure backlogs. The maximum queue length in this instance is observed to be 29. However, when the technicians are reduced to 19 an overflow condition is noticed (see Figure 7). The queue length increases drastically. This procedure is repeated to determine the overall "minimum" configuration for the centers, i.e., the minimum number of technicians required in the receipt, the test, and the close-out processes.

For each minimum configuration, detailed simulation output analysis is performed to obtain long run averages of the time in the system and the queue lengths. This includes determining the sample size necessary to obtain a 95 level of precision, using variance reduction techniques and batching the observations, and two-tailed hypothesis tests to establish if there is any difference in the mean performance measures for the different configurations. The results for centers X and Y are presented in Table 2.

The mean and standard deviation of the time in the system for each failure type is reported for each configuration. The last column in Table 2. indicates whether the configuration is valid or not; if an overflow condition results, then it is considered an invalid configuration.

A similar analysis is performed for the integrated center and the results are presented in Table 3. It may be noted that the average time in the system statistics are computed separately for activities that were originally part of centers X and Y.

The following observations can be made comparing the performance of X and Y centers with the integrated center:

- The "minimum" configurations of 14:20:12 for center X and 5:7:5 for center Y jointly represents the least number of technicians needed (63). In contrast the integrated center has a minimum requirement of 59 technicians, a staff reduction of 6.

- For the 14:20:12 X configuration the average time in the system for a failure is 385 minutes. In comparison the integrated center has an average of 388 minutes. However for the Y center failures there is a drastic reduction in the average time in the system, 1065 minutes for the 5:7:5 configuration versus 455 minutes for the integrated center.

- No significant difference in the technician utilizations are observed between the X and Y centers compared to the integrated center.

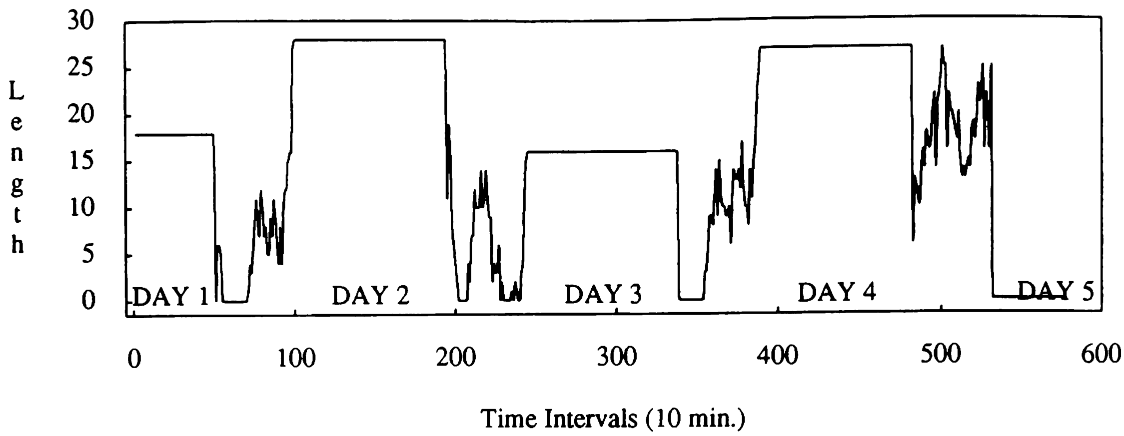

Figure 6: Test Queue With 20 Technicians In Center X

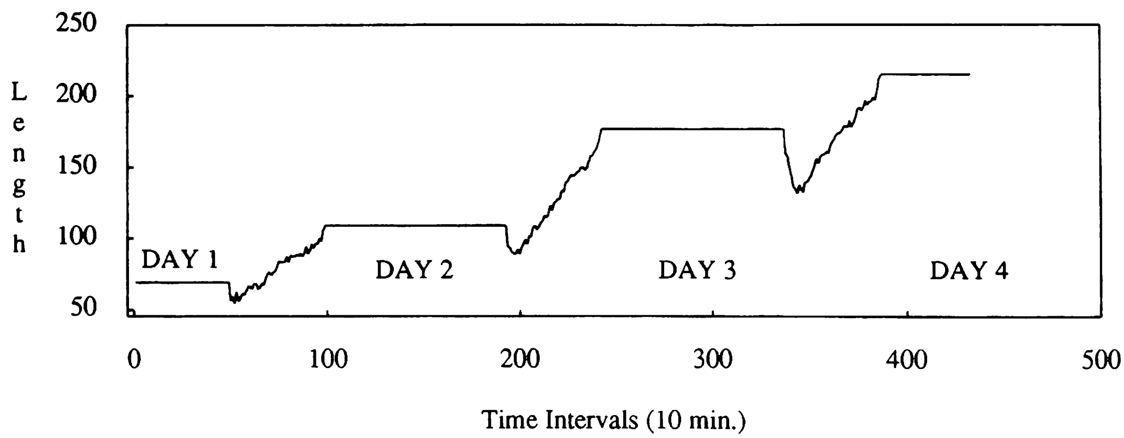

Figure 7: Test Queue In Center X Showing Overflow Condition

Work	No. Technicians	Time in System										Average Queue Length			Overload
Center	[R : T : C]	Type 1		Type 2		Type 3		Type 4		Overall		R	T	C	
		σ	μ	σ	μ	σ	μ	σ	μ	σ	μ				
X	20 : 30: 30	64.4	24.2	157.1	55.8	320.6	224.9	398.1	337.8	360.3	231.6	1.6	6.2	35.7	
X	15 : 25 : 25	91.9	25.5	211.3	95.7	351.0	268.1	396.1	347.8	364.6	253.4	3.3	7.7	35.6	
X	14 : 20 : 20	166.0	47.1	354.1	137.3	419.7	303.4	440.2	436.0	419.0	308.7	8.3	19.5	37.2	
X	13 : 20 : 20	260.4	146.1	302.2	231.4	392.2	375.1	440.2	463.3	419.0	390.8	38.5	13.9	36.5	X
X	14 : 19 : 20	143.0	49.2	411.4	318.6	464.1	458.9	480.0	525.8	476.4	442.4	10.2	59.7	36.0	X
X	14 : 20 : 17	166.5	39.8	357.8	150.8	420.3	304.1	462.1	435.0	445.6	320.7	8.7	22.5	37.6	
X	14 : 20 : 15	168.0	51.1	353.8	168.7	423.2	355.1	464.0	440.0	447.8	351.9	9.1	32.1	36.9	
X	14 : 20 : 12	163.4	50.7	345.7	188.7	446.4	396.4	479.2	526.1	468.5	384.9	9.6	30.4	46.9	
X	14 : 20 : 11	172.8	49.5	410.3	173.0	551.0	717.3	550.8	778.2	620.4	625.8	9.5	32.8	123.2	X
Y	14 : 20 : 11	122.4	38.3	209.5	109.8	376.5	314.5	422.6	437.0	395.0	311.5	1.6	2.1	10.0	
Y	10 : 10 : 10	130.7	40.1	230.0	131.8	415.1	376.0	438.7	481.8	420.2	357.1	1.9	4.3	10.9	
Y	5 : 5 : 5	282.5	138.0	2175.5	3840.0	1987.6	4438.0	2040.5	4467.0	2533.6	3428.2	8.8	238.3	6.4	X
Y	4 : 8 : 5	1503.9	2857.5	1588.3	2864.3	1502.0	2981.8	1503.5	3214.4	1522.3	3088.0	209.4	2.5	10.0	X
Y	5 : 7 : 5	381.1	261.2	597.5	892.9	642.3	1181.5	606.3	1301.2	690.9	1065.1	17.0	37.9	15.6	
Y	5 : 6 : 5	409.1	412.2	600.8	3667.9	892.7	3519.5	1010.7	3797.6	1531.8	3121.5	28.8	197.3	8.84	X
Y	5 : 7 : 4	407.2	261.2	622.2	892.3	2038.3	3938.9	1976.8	4101.1	2346.7	2861.3	10.8	29.4	159.3	X

Table 2: Long Run Performance Measures For X And Y Centers

# UT	Average Time in System - Activities that belonged to Center X									
	Type 1		Type 2		Type 3		Type 4		OVERALL	
	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ
65	110.4	28.1	221.7	90.2	353.8	271.2	407.2	361.6	376.2	262.1
60	336.3	60.7	427.6	168.0	477.7	371.5	487.4	496.8	487.7	371.9
59	362.6	60.1	438.4	173.1	473.9	395.2	499.8	522.0	495.4	388.3
58	456.6	176.9	513.7	386.6	521.4	747.8	511.5	885.4	535.3	686.1

# UT	Average Time in System - Activities that belonged to Center Y									
	Type 1		Type 2		Type 3		Type 4		OVERALL	
	σ	μ	σ	μ	σ	μ	σ	μ	σ	μ
65	139.8	34.4	220.9	139.6	394.4	344.0	435.0	463.1	413.7	337.2
60	300.7	78.3	419.9	185.3	483.7	484.5	492.0	569.6	504.7	427.3
59	333.0	75.4	462.7	227.8	505.5	479.5	503.1	601.2	513.0	455.2
58	449.4	178.1	515.3	479.6	517.8	794.0	522.2	982.3	543.1	760.7

# UT	Average Queue Length			O F
	R	T	C	
65	4.7	12.2	49.5	
60	17.3	24.7	63.6	
59	19.1	26.0	64.0	
58	58.3	65.7	101.7	X

Table 3: Long Run Performance Measures For The Integrated Center

Integrating the centers therefore seems to be attractive. To pursue the analysis further, the economic aspects of the move need to be studied. Let the *Present Mode of Operations* (PMO) refer to the current configuration of X and Y centers with dedicated technicians, and the *Future Mode of Operations* (FMO) refer to the integrated center alternative with the implementation of Universal Technicians. Recall that a universal technician is trained to perform work on any process and on any failure type. Therefore, their level of expertise is comparable to a dedicated technician responsible for the most complex activities among the two centers X and Y. It is hence assumed that the wage rate of a universal technician is as high as that of the highest paid dedicated technician. On the other hand the implementation of a universal technician will allow for a conservative staff reduction of at least 5. To compare the PMO and the FMO alternatives a 10 year time frame is used. The cost drivers for the comparison are presented in Table 4.

Wage Rate ($/hour):	$42.50 (X Center) $35.00 (Y Center) $42.50 (Integrated Center)
Training Cost per Technician ($):	$2,500
Labor Inflation Rate (%):	6.0%
Net Present Value Discount Rate (%):	13.5%
Work Days/month:	22

Table 4: Cost Drivers For Comparing PMO And FMO

In the yearly labor costs computations it is assumed that no work force changes will take place during the study period. Further, the training cost to upgrade a low level technician to a universal technical is included as a one time cost. The net present value analysis for the PMO and the FMO alternatives are shown in Table 5.

PRESENT MODE OF OPERATIONS [PMO]			
Year	X Center	Y Center	Total
1	$20.6	$6.2	$26.8
2	$21.8	$6.6	$28.4
3	$23.1	$7.0	$30.1
4	$24.5	$7.4	$31.9
5	$26.0	$7.9	$33.9
6	$27.6	$8.4	$36.0
7	$29.2	$8.9	$38.1
8	$31.0	$9.4	$40.4
9	$32.9	$10.0	$42.9
10	$34.8	$10.6	$45.4
Net Present Value $201.8			
FUTURE MODE OF OPERATIONS [FMO]			
Year	Integrated Center	Training	Total
1	$26.4	$0.2	$26.6
2	$28.0		$28.0
3	$29.7		$29.7
4	$31.5		$31.5
5	$33.4		$33.4
6	$35.4		$35.4
7	$37.5		$37.5
8	$39.8		$39.8
9	$42.2		$42.2
10	$44.7		$44.7
Net Present Value $198.5			
Savings $3.2			

Table 5: Operations Costs For A 10 Year PMO vs FMO Study (in millions)

The comparison reveals substantial savings in the long term. It must be noted that only two centers are considered here. Typically a telecommunications operation has several such centers with potential for new work assignments and integration of maintenance functions.

5 SUMMARY AND CONCLUSIONS

A systems simulation approach is used to study new work assignment techniques in maintenance operations of a telecommunication business. It has been shown that the current operations can be made more efficient by integrating tasks that previously engaged dedicated technicians. In this context the concept of a universal technician is introduced who is versatile to handle all types of failures. An economic analysis shows the integrated approach to be attractive in the longer term. The systems simulation model can be extended to encompass wider set of issues such as maintenance operations under contingencies, the impact of seasonal traffic volumes, etc.

APPENDIX A: SAMPLE SOURCE CODE

```
BEGIN,1,1,YES,POTS,NO;
;
;    Center X Model
;
;    Shift Submodel
;
          CREATE,1;                               SHIFT SUBMODEL
NEWDAY    DELAY:480;                              12:00 AM TO 8:00 AM
          ALTER:TECH1,14;                         ATTENDANTS
          ALTER:TECH2,20;                         TESTERS
          ALTER:TECH3,12;                         TESTERS - B
          DELAY:480;                              8:00 AM TO 4:00 PM
          ALTER:TECH1,-14;                        TIME TO GO HOME
          ALTER:TECH2,-20;
          ALTER:TECH3,-12;
          DELAY:480;                              4:00 PM TO 12:00 AM
          ASSIGN:X(1)=X(1)+1440:NEXT(NEWDAY);UPDATE DAY INDICATOR
;
;    Timer Update Submodel
;
          CREATE,1;                               PARAMETER ADJUSTMENT
HOUR      DELAY:60;
          ASSIGN:X(2)=TNOW-X(1);                  COMPUTE TIME OF DAY
          ASSIGN:P(1,1)=TF(1,X(2)):
            NEXT(HOUR);                           UPDATE ARRIVAL RATE
;
;    Main Submodel - Operations
;
;    [Attribute assignment section]
;
          CREATE,1:EX(1,1):MARK(1);               TROUBLE REPORT ARRIVAL
          BRANCH,1:
            IF,X(2).LT.480.OR.X(2).GT.960,
            NO_REACH:
            ELSE,START;                           IGNORE NON REACH TRS
START     ASSIGN:A(2)=DP(2,1);                    SET TROUBLE TYPE
          ASSIGN:A(3)=RN(3,1)+RN(4,1)*DP(5,
            1)+RN(6,1)*DP(7,1)+RN(8,1)
            *DP(9,1);                             SET TR RECEIPT TIME
          ASSIGN:A(4)=RN(10,1)+RN(11,1)
            *DP(12,1)+RN(13,1)*DP(14,1)
            +RN(15,1)*DP(16,1);                   SET SECTIONALIZATION TIME
          ASSIGN:A(4)=A(4)+RN(17,1)*DP(18,1);continued
          ASSIGN:A(5)=RN(19,1)*DP(20,1)
            +RN(21,1)*DP(22,1)+RN(23,1)
            +RN(24,1)*DP(25,1);                   SET VERIFY & CLOSEOUT TIME
;
;    [Processing section]
;
          QUEUE,1;                                TROUBLE RECEIPT PROCESS
          SEIZE:TECH1;
          DELAY:A(3);
          RELEASE:TECH1;
          BRANCH,1:
            IF,A(2).EQ.1,CPE:
            ELSE,GOON;                            REMOVE CPE TROUBLES
GOON      QUEUE,2;                                SECTIONALIZATION PROCESS
          SEIZE:TECH2;
          DELAY:A(4);
```

```
          RELEASE:TECH2;
          BRANCH,1:
            IF,A(2).EQ.2,TOK:
            ELSE,REFER;                              REMOVE TEST OKS
REFER     BRANCH,1:
            IF,A(2).EQ.4,DISPATCH:
            WITH,.50,SCC:
            WITH,.50,FCC;                            REFERRAL PROCESS
VERIFY    QUEUE,3;                                   CLOSEOUT PROCESS
          SEIZE:TECH3;
          DELAY:A(5);
          RELEASE:TECH3;
;
;   [Statistics collection section]
;
          TALLY:5,INT(1);                            COLLECT OVERALL TIME IN SYS.
          TALLY:A(2),INT(1);                         COLLECT INSIDE/OUTSIDE T I S
          COUNT:5;                                   TOTAL NUMBER OF TRS PROCESSED
          COUNT:A(2):DISPOSE;                        NUMBER OF INSIDE/OUTSIDE TRS
CPE       TALLY:5,INT(1);                            same as above
          TALLY:1,INT(1);                            COLLECT CPE T I S
          COUNT:5;
          COUNT:1:DISPOSE;                           NUMBER OF CPE TRS
TOK       TALLY:5,INT(1);
          TALLY:2,INT(1);                            COLLECT TOK T I S
          COUNT:5;
          COUNT:2:DISPOSE;                           NUMBER OF TOK TRS
;
;   [Referral times]
;
DISPATCH  DELAY:RN(26,1):NEXT(VERIFY);               OUTSIDE PLANT WORK
SCC       DELAY:RN(27,1):NEXT(VERIFY);               SWITCHING CONTROL CENTER
FCC       DELAY:RN(28,1):NEXT(VERIFY);               FRAME CONTROL CENTER
NO_REACH  COUNT:6:DISPOSE;                           NUMBER OF IGNORED TRS
END;
```

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