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ABSTRACT

This paper describes the design, installation, testing, and operation of a computer-based record keeping system for computer terminals and equipment. The system provides all levels of data management for maintenance with instantaneous reports on location of equipment, cost of equipment, cost of repairs, inventory and parts control, as well as a chronological history of both scheduled and emergency repairs of equipment. The management information system is programed in FORTRAN on a CDC-6600/6400 TAURUS time-sharing system. (Author/CH)

AN ON-LINE DATA MANAGEMENT SYSTEM FOR REPAIR AND MAINTENANCE OF COMPUTER TERMINALS

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AN ON-LINE DATA MANAGEMENT SYSTEM FOR REPAIR AND MAINTENANCE OF COMPUTER TERMINALS

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ABSTRACT

This paper describes the design, installation, testing, and operation of a computer-based record keeping system for computer terminals and associated equipment which can provide all levels of management with instantaneous reports on location of equipment, cost of equipment, cost of repairs, inventory and parts control, as well as a chronological history of both scheduled and emergency repairs of equipment. The repair service itself is now operating at The University of Texas at Austin on a self-supporting basis with in-house technical personnel. The management information system is programmed in FORTRAN on a CDC-6600/6400 system.

[1]PROJECT C-BE, Grant GY-9340, National Science Foundation grant to The University of Texas at Austin, Drs. John J. Allan and J.J. Lagowski, Co-Directors.

INTRODUCTION

In November, 1971, the University of Texas installed a CDC-6400 computer and a new operating system which was called the CDC-6600/6400 TAURUS time-sharing system.

TAURUS had provision for 63 low speed computer terminals (teletypes) which are connected to the multiplexor either by commercial dial (telephone) lines or dedicated private leased lines. At the outset some 30 model 33 teletypes were operational on campus, most of which were primarily used for research.

Four or five of these teletypes were used interactively for computer-based education courses in chemistry. Computer-based education (C-BE), was designed to supplement lecture and laboratory instruction by providing each student with individualized instruction.

At that time, little or no consideration was given toward providing for repairing or maintaining the teletypes other than to call the Bell Telephone Company. Units were normally rented from the telephone company for service and on-call repair service was available when the unit was inoperative. Since the machines were on rental (or lease), the telephone company responded with 24 to 28 hours. No one worried about "down time" since there was no urgency with such a limited population of terminals. The problem of "up time" became a major one, however, when some 100 teletypewriters were purchased rather than rented during the next 18 months by various departments and research

projects. No provision for scheduled or emergency repairs was made at that time. Consequently, many departments faced a heavy repair charge by commercial firms when the units required repair. Such repair costs were calculated on a portal to portal mileage basis, plus a $20.00 hourly rate, as well as an added parts charge. At that time, the total teletype density of purchased terminals within the city of Austin was less than 100, and no contractor could economically justify a resident repairman. The result was that no commercial vendors "officed" in Austin, leaving the University to shift for itself. U.T. Departments had to request service from as far away as Dallas or Houston, Texas. After a period of time, such support costs exceeded the operation and maintenance funds allocated within the budgets of the departments. Complaints were many and a solution had to be found. How could an in-house repair service be provided to the entire University? Fast, efficient service must be provided at a cost equal to or below that offered by commercial repair service.

The remainder of this paper then, is a chronological history of how a self-supporting in-house maintenance shop was organized and made operational. This operation was further made more economical and self-sufficient through use of a computerized data management system for maintenance, which is also described. During this period, PROJECT C-BE, a National Science Foundation research project in education was underway. Its purpose was to develop computer-based curriculum matter under the sponsorship of the National Science Foundation, also PROJECT C-BE was the largest user of the system with some twenty teletypewriters in operation. It was by default (since no other agencies desired to)

that PROJECT C-BE personnel volunteered to set up and run the shop on an interim basis until such time as the operation could be transferred to a permanent support facility within the University.

ORGANIZATION OF THE REPAIR SHOP

The alternatives offered for organizing and staffing a teletype repair shop first has to consider personnel recruitment through one of the following:

a. Hiring a person and sending him to the Teletype Corp. factory for a two-week intensive training course (a cost of some $600.00).
b. Recruiting or hiring an experienced teletype repairman from commercial firms engaged in repair services.
c. Hiring an undergraduate student who was formerly a serviceman trained by the military in teletype repair.
d. Training electronic technicians already employed within a university with on-site factory sponsored repair course.

The method we finally selected was to advertise locally for an experienced teletype repairman. We hired a factory trained technician with two years experience who was formerly with a local electronics firm. Thus, we gained a very valuable capability in the way of a fully trained repairman.

ECONOMICS OF OPERATION

In organizing a maintenance support facility, we realized we had to develop a valid yardstick for repair costs. The best indicator we found for monthly costs for maintaining teletype terminals was to compare commercial vendor contract rates with proposed in-house costs. The contract rates selected for use in-house were based upon repair statistics for a large number of machines (100), in a non-academic environment. Although commercial contractor monthly rates varied according to geographic region, the cost spread from high to low range was fairly narrow ($25.00 to $45.00 per unit). For example, we found that all vendors required a minimum of a one-year signed contract for a Model ASR-33 teletype. The rates were $25.00 per month plus parts per terminal. This cost estimate was based upon repair costs for a large urban area where there were at least 100 or more units in service. Without this density of terminals, commercial repair services could not make a profit and remain in business. Another factor was the prohibitive costs required for repairman travel to and from geographically remote units. For one-time calls (where a terminal was not under contract), labor rates charged were as high as $15.00 to $20.00 per hour plus 10¢ a mile for travel by commercial services. This charge was calculated on a portal to portal basis!

Armed with the above information, we organized an in-house repair service concentrating solely on model 33 plus a few additional model 35 teletypes. A minimum population of 50 machines was required before the service could start. In order to assure continuity of service, the

purchase of at least one teletype and data set to be used as a spare was considered essential. A one-time charge of $30.00 per terminal provided $1500.00 for this spare equipment. A basic monthly repair rate was then set at $19.00 per unit. Our first year contracts provided a total of $11,240 for an operating budget (personnel, spare parts, tools, test equipment, and expendables such as teletype ribbons, etc.).

The first year's budget did not allow for the purchasing of all the required equipment, etc. The "austere shoestring" budget was as follows:

Teletype repairman salary $630.00/Mo. x 11 Mos.[1]	$ 7,560
Teletype tools, gauges, etc., cart	200
Teletype spare parts and expendables	2,500
Test equipment, digital voltmeter	385
Pocket data transmission test set	99
O.A.S.I. matching funds for personnel	468
Telephone and expendable administrative supplies, transportation costs, etc.	208
TOTAL	$11,240

Still lacking was the following additional test equipment[2]: A Tektronix dual trace oscilloscope ($3,100), a professional digital data transmission measuring set and test message generator ($2,600), a data logic test set, special tools for working with logic circuit boards ($400), etc. Such equipment was required to repair not only data sets (MODEMS), but also cathode ray tube and graphics terminals. This new equipment was programmed for acquisition in 1973-1974.

[1] One month had gone by when the budget was activated.

[2] All of the above required test equipment has been purchased and is now in use.

STANDARDS ESTABLISHED

By referring to the manufacturer's technical specifications and spare parts listings we were able to formulate some yardsticks such as the time required for scheduled maintenance for each terminal. We found the best time to program repairs, overhauls to be the end of each semester during exam week. The rest of the time there was heavy student usage, etc. Unfortunately, the present model 33 teletype was designed only for moderate usage, i.e., four hours a day on-line. Using this standard, the manufacturer recommended a major equipment overhaul every 1000 hours (every semester) of operation. Since some of our units were operating as much as 14 hours per day six days a week, this standard had to be reduced by 50% or more and a closer examination of the units for scheduled maintenance was required. Normally, each terminal was given preventive maintenance (cleaning, lubrication and adjustment) every four weeks.

The $19.00 per month contract provided for two emergency calls per terminal per month (during normal working hours Monday through Friday), in addition to scheduled maintenance. This service charge included all parts and labor (except the motor). Calls in excess of two per month were billed at $8.00 per hour. Appendix A shows a copy of the maintenance contract.

The formulation of preventive maintenance schedules; compilation of trouble calls; and preparation of spare parts requisitions required an inordinate amount of administrative time. It was quickly apparent

that a more efficient method or system was required to handle the essential information in the large volume of paperwork. With the thought in mind of making for a more efficient administrative system, an on-line management information system for teletype repair was conceived. A description of the concept, method of implementation, and experience to date follows in the next section.

THE ON-LINE MANAGEMENT INFORMATION SYSTEM

The concept of our on-line self updating management information system was actually built around the University of Texas TAURUS operating system using interactive FORTRAN IV. The program was constructed by James C. Nash, Computer Programmer of the Computation Center Programming Staff. This software is now resident on the University of Texas Computation Center CDC-6600 time sharing computer. In summary, some 22 data elements of information for each terminal are contained in the basic file of the data base. The specifics included model, serial number, location, fiscal data, date of contract, funds, etc. A sample printout is shown in Appendices B and C. The files were designated as Inventory File and Work File and were stored on a magnetic tape. The second file ("Daily Work") was provided for the repairman's use in inputting information on repairs for both scheduled maintenance data and emergency trouble repairs to be merged into the management information system. This is actually done in the field by the repairman using the teletype he just serviced for input to the management system. The data elements that were transmitted to the file included terminal serial number, type of trouble(s), parts used (stock number and quantity), time required for repairs, date serviced, and other bits of miscellaneous information which became an integral part of the life history of each terminal or device.

Each week the "work" (repairman's record file) is updated and merged into a master file containing all individual device records. We found it to be more economical to do this as a means of keeping computer costs down and also for meeting the criteria of efficient system information needs. A sample of a typical summary report output is attached as Appendix C.

One point worth mentioning is that the master file also contains information on spare parts inventory listed by stock number, description, cost and quantity (on hand). As the updating of records occurs by inputs from the repairman's files, the inventories are automatically reduced in quantity and in dollar value. As new parts were received this information was also fed into the master files for dollar value and resource summaries.

The advantage in using this type of system is that only one search needs to be made for any type of information on repairs, costs, location, type, and fiscal data in tabular form. This can be accomplished rapidly for management purposes without the traumatic back-breaking report request and the ensuing mountain of paper work. A back-up of the system in the form of written contracts, purchase orders, etc., for fiscal audit; however, to prevent the loss of vital data, the central files had two additional back-up magnetic tapes plus the weekly record of repairs on a magnetic tape file.

ACKNOWLEDGEMENT

The writer wishes to acknowledge the assistance and advice given by Mr. Mack Rowell and Mr. Dave Creek, both Technical Staff Assistant IV's. Mr. Rowell and Mr. Creek were teletype repairmen for PROJECT C-BE during the turbulent period of the growth of this service. The University of Texas Computation Center assumed the responsibility for university wide terminal repair service in November, 1973.

APPENDIX A

University of Texas
Teletypewriter Maintenance Agreement

I. Customer Name _____

Address _____

Department _____

(hereinafter referred to as Customer) hereby contracts for with University Teletype Equipment Repair Service (hereinafter referred to as UNITERS) by its acceptance agrees to furnish the services set forth in this agreement.

II. Equipment

Serial Number	Model and Type	Exact Location of Terminal

III. Terms of Coverage

A. The equipment identified above shall be subject to inspection by UNITERS to determine if it is in good operating condition. Any repairs or adjustments then deemed necessary by UNITERS to bring the equipment up to good operating condition shall be made prior to commencement of maintenance service. Charges for bringing equipment up to good operating condition will be billed at $8 per hour plus parts.

B. UNITERS will provide one scheduled, preventive maintenance call every six weeks. During this preventive maintenance period, UNITERS will perform visual inspections, external and internal, proper lubrication of all necessary parts, replace any worn parts (excluding motor), clean externally and internally and perform the necessary operating tests to insure the equipment is in proper working order. If replacement of the motor is required, UNITERS will make such replacement and bill customer for the motor at UNITERS' cost.

C. UNITERS will provide two emergency maintenance calls per month between the hours of 8 A.M. and 5 P.M., Monday through Friday, excluding official University holidays, without additional charge (excluding motor failure). Additional emergency maintenance calls will be billed at $8 per hour, with a one-hour minimum charge per call. Emergency maintenance calls will be made on a first-call, first-service basis.

D. If a teletype terminal cannot be repaired within a reasonable amount of time, it will be temporarily replaced with a UNITERS terminal while Customer's unit is being repaired.

E. If the data set (modem) is inoperative, UNITERS will verify this to the Customer with: (1) Test equipment which provides appropriate signals directly to the teletype; (2) A spare modem connected to indicate proper teletype operation. UNITERS will at Customer's request arrange for the repair of a defective modem.

F. UNITERS will have modems available for loan to the Customer (at no charge) for the period of time Customer's modem is being repaired. The cost to repair the modem is not included in this service agreement. Costs of repairs made to the modem will be billed to the Customer at rates billed to UNITERS.

IV. Period of Coverage

A. This agreement will be in effect from the date it is signed by both the Customer and UNITERS to the end of the current fiscal year, with renewal at the end of the fiscal year at the option of both UNITERS and the contracting party.

V. Cost and Payment

A. The monthly maintenance charge is $19.00 per month per terminal. In addition, a one-time start-up charge of $30.00* per terminal is required for the purchase of a minimal stock of spare parts.

B. Basic maintenance charges for the first fiscal year are payable in lump sum in advance. Additional charges will be billed monthly. Payment will be made through an Interdepartmental Transfer Voucher.

* For continuing contracts this charge is not necessary.

Account to be Billed

Date

Authorized Signature

Department

Date

for UNITERS

APPENDIX B

INVENTORY FILE OF EQUIPMENT AND MAINTENANCE

SERIAL NUMBER* TTY023781
MODEL NUMBER* ASR33
UNIVERSITY NUMBER* 205923
BUILDING* COM
ROOM* 17
PHONE NUMBER* PAX-3318
DEPARTMENT OWNING* CC
WHO'S RESPONSIBLE* SHAW
ON CONTRACT* YES
DATE OF CONTRACT* 09/01/72
DATE CONTRACT EXPIRES* 08/31/73
ACCOUNT CODE CITED* 18-2300-0078
ACCOUNT CODE CREDITED* 18-0017-0520
I D T NUMBER* 43
AMOUNT OF CONTRACT* $228.00
DATE LAST SCHEDULED MAINT* 06/20/1974
WHO DID MAINT* CMR
REMARKS LAST P M* NONE
TOTAL NO OF P M* 0
TOTAL P M TIME* .00
WEEKS BETWEEN P M* 6
DATE NEXT SCHEDULED MAINT* 8/01/1972

APPENDIX C

WEEKLY REPORT OF WORK FILE

26 JUL 73

TYPE UNIT	SERIAL NO	RESPONSIBLE INDIVIDUAL	BLDG	ROOM	DATE LAST MAINT	LAST MAINT BY	REMARKS
ASR 33	TTY202663	CUSHING	BEB	303S	06/25/1973	LNS	NONE
ASR 33	TTY202654	DEAKIN	BEB	325	06/25/1973	LNS	NONE
ASR 33	TTY222980	BRUCE	BEB	727 OR 706	06/26/1973	LNS	NONE
ASR 33	TTY182794	CLARK	CHE	101	06/21/1973	LNS	NONE
ASR 33	TTY210170	LAGOWSKI	CHE	216W	07/06/1973	LNS	NONE
ASR 33	TTY122023	LAMB	ENL	215	06/28/1973		NONE
ASR 33	TTY20054	SCHECHTER	EPS	201	07/02/1973	LNS	NONE
ASR 33	TTY081281	TATOM	EPS	405	06/25/1973	LNS	REPLACED MOTOR FUSE & STARTER
ASR 33	TTY184089	BRADLEY	PAT	630	06/27/1973	LNS	NONE
ASR 33	TTY149291	BRADLEY	PAT	647	06/27/1973	LNS	NONE
ASR 33	TTY149292	BRADLEY	PAT	647	06/27/1973	LNS	NONE
ASR 33	UT205924	WISSLER	TAY	104	01/25/1973	CMR	NONE
ASR 33	UT207559	LAMB	THY	125	01/28/1973	CMR	NONE
ASR 33	UT230693	BRADLEY	100E	106	03/10/1973	LNS	NONE

COMPUTER-BASED EDUCATION COURSES

AEROSPACE ENGINEERING

Aircraft Design—Drs. W. T. Fowler and D. G. Hull
Structural Analysis—Dr. Eric Becker

ARCHITECTURE

Survey of Environmental Control Systems—Dr. F. N. Arumi

CHEMICAL ENGINEERING

Process Analysis and Simulation—Dr. D. M. Himmelblau
Optimal Control—Drs. T. F. Edgar, E. H. Wissler and J. O. Hougen

CHEMISTRY

Vector Space Theory of Matter—Dr. F. A. Matsen
Physical Chemistry Laboratory—Dr. John M. White
Organic Chemistry—Drs. J. C. Gilbert and G. H. Culp
Introductory Chemistry—Dr. J. J. Lagowski
Principles of Chemistry—Dr. J. J. Lagowski
Introduction to Chemical Practice—Dr. J. J. Lagowski

CIVIL ENGINEERING

Computer Methods for Civil Engineering Laboratory—Dr. C. Philip Johnson et. al.

ECONOMICS

Theory of Income and Employment—Dr. James L. Weatherby

ENGLISH

English Composition—Dr. Susan Wittig

HOME ECONOMICS

Child Development—Dr. Mary Ellen Durrett

LINGUISTICS

Language and Society—Dr. W. P. Lehmann

MATHEMATICS

Calculus I, II—Dr. John P. Alexander

MECHANICAL ENGINEERING

Dynamic Systems-Synthesis—Dr. L. L. Hoberock
Probability and Statistics for Engineers—Dr. G. R. Wagner
Energy Systems Laboratory—Dr. G. C. Vliet
Element Design—Dr. John J. Allan III
Nuclear Reactor Engineering—Dr. B. V. Koen
Kinematics and Dynamic Mechanical Systems—Dr. W. S. Reed

PSYCHOLOGY

Introduction to Psychology—Self Paced—Dr. Jan H. Bruell
Statistical Methods in Psychology—Dr. James M. Swanson

PHYSICS

Computer Introduction to Physics—Dr. J. D. Gavenda

ZOOLOGY

Genetics—Dr. Richard Richardson
Experimental Genetics—Dr. Richard Richardson
Biophysical Analysis—Dr. J. L. Fox