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Computer Applications To An Integrated Maintenance System.

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A computerized system for maintenance management is described in terms of components--inventory control, scheduling of custodial work, preventive maintenance, new work and review and analysis. A flow chart for the system is presented showing the interrelation of the components and the details of each component, for example, 'New Work' includes work order, name of worker, time estimate of job, stock level, re-order, requisition, information feed-in into Review and Analysis Component. The discussion focuses around these components. Specimens of printouts include equipment data, repair data, work performance data, work instruction, accounts, and payout items. Various questions of interest to potential users of the system are posed and answered. Suggestions for developing a system are given based on the experience acquired by the developers of the system described and favorable results of the system are mentioned. (HH)

COMPUTER APPLICATIONS TO AN INTEGRATED MAINTENANCE MANAGEMENT SYSTEM

John A. Berry and Robert Roberson

Integrated Maintenance Management is a term coined at State University of New York at Binghamton. It was born of necessity. This necessity was a huge projected growth of Physical Plant. (See Figures 1 & 2). It seemed apparent that past patterns would be incapable of managing maintenance operation having this rate of growth. We sought a completely new approach.

The amount of significant information about Physical Plant was growing at a staggering rate as new buildings and new utility systems came into operation. How to retrieve this information for management purposes according to some system was a pressing problem.

Plant Management had compelling pressures to save scarce professional time and was forced to seek every measure to economize in the use of available personnel.

In short, what was needed was a management control system to cope with the greatly expanded Physical Plant and physical plant maintenance program, projected for 1970 and 1974.

Which systems? We began investigations into visible index systems. These showed some promise. In 1964 the decision to develop a Computer and Data Processing Center on this campus was taken. It was known that IBM, in neighboring Endicott, New York, was developing third generation computers with projected capacities for handling any management control system for College Maintenance plus the far greater educational research projects conceived for the Computer Center. We decided to seek a computer application for the control system which was taking shape in our minds.

Were this done, it should be done on a big scale. Inventory Control - certainly. Maintenance operations if at all possible. Custodial operations should also be included even though computer applications were vaguely defined in our minds at that time. We developed the concept that total physical plant maintenance operation should be applied to the computer and that the system should be so set up that an extensive Review and Analysis could follow.

This concept was born in the summer of 1965. It is shown on Figures 3 and 4. The core area is shown in the center of Figure 3, Maintenance. Our lay view was that computer technology could help us most by SCHEDULING our Maintenance operations, both Preventative Maintenance and New Work. This was a basic decision and the entire computer application on this campus is centered upon it.

As to P.M., the previous system of control was based upon a set of three cards prepared manually - Figures 5, 6, 7. We sought to INPUT the data on Card #1 to the computer. The tradesmen's entries on Cards #3 and #4 would also be INPUT to the computer. As OUTPUT, the computer would prepare requisitions and supply costs of time and materials campus-wide as for any individual piece of equipment.

Reflecting the emphasis upon SCHEDULING, we expected the computer to OUTPUT weekly schedules for each and all P.M. operations when due. Carrying this concept still further, we designed the system so that with each weekly schedule for P.M., there would be furnished by the computer a print out of a Work Instruction Program for each P.M. task. Figure 8 illustrates this idea and is a copy of what is used at the IBM plant in Poughkeepsie, New York.

On our campus we consider that, as Figure 3 shows, Maintenance consists of both P.M. and New Work generated by Work Orders. We based our Maintenance Management system squarely upon the concept that all work, other than P.M., must be generated by a Work Order devised for computer application.

In Figure 3, consider the sequence entitled New Work. When John Doe originates a Work Order, it goes through whatever approval channels the University Administration directs. Upon receipt at Physical Plant headquarters, the Work Order goes to the Estimators for a dollar price tag, both Time and Materials.

We believed that our system and our computer would be sophisticated enough that, upon query, they would be able to give us a "No Go" or a "Go" signal so far as materials required for each Work Order was concerned.

A "No Go" signal would occur if stocks on hand, less those earmarked for other jobs, were inadequate to complete the job once started. In other words, we hope to eliminate job interruptions for lack of supplies or parts.

In addition, we established a goal of requiring the computer to Print Out requisitions for each part when each bin reaches the Re-Order point. We expect to establish these Re-Order points for each item, initially, based upon a pragmatic knowledge of usage and Order and Shipping time. We also have in mind that these will have to be adjusted on the bin card and in the computer as changes in lead time occur and as contracts change from one supplier to another. Handling both the requisition and a fluctuating re-order point does not appear, even now, to be asking too much of a computer system.

As an aside, since we are now discussing Inventory, we are giving Computer Control of Physical Plant Inventory a casual treatment in this paper. There are several reasons. First of all, in a paper delivered at last year's meeting, Harry Hugill presented an excellent analysis of the problem.(1) Next, I know from my query at the Experience Exchange

(1) *Hugill, H. S., "Computer Control of Physical Plant Inventory", Minutes of the 1966 Meeting, Eastern Region, National Association of Physical Plant Administrators.*

during last year, that many of you are engaged in placing your inventory on machines. Those of you who are doing it, realize the advantages which Harry reported and which we can now confirm. Third, the theme of this presentation is the Integration of all Maintenance Management functions, of which inventory control is only one part and we are placing emphasis upon using the computer to Schedule Maintenance operations.

Returning to the chart (Figure 3) and assuming that the arrival of parts or supplies changes the "No Go" signal to a "Go", what then happens? If the work is truly a maintenance task, it goes to the computer for scheduling.

If the work relates to an Academic Program, if it is a "departmental improvement" as George Weber calls it at the University of Maryland, there is a conference between Physical Plant and the Division or Departmental Chairman who approved the Work Order. The basic purpose of this discussion is to establish the source of funds so that the appropriate Program may be charged. The faculty member may, if the backlog of Work Orders is so high as to delay completion of his Work Order beyond his deadline, elect to have the job performed by outside contractors with costs charged to his Program. Similarly the Plant Superintendent has an opportunity to place any job with an outside contractor.

If the job is to be done by College Maintenance, the Work Order with its estimate of hours by trade goes to the computer for scheduling. According to the "Complete Date" assigned, it is scheduled at the proper time on the Weekly Schedule.

Figure 4 shows the machine-prepared schedules we have planned. The Weekly schedule is the heart of our system. It is important to understand how it is built up. Available man hours each day by trade are assigned first to the P.M. tasks due that day as retrieved by the computer. Next seasonal maintenance tasks are scheduled by trade - again by the computer. If any man hours are left over, they may be assigned to the New Work as represented by Work Orders on hand. Repeating, if the man hours per week are insufficient to handle New Work, it is postponed or contracted to off-campus firms.

The Summary Monthly and Six-Months Schedules are planning documents as distinguished from the Weekly Schedule which is a working document. The former two should prove valuable aids to Maintenance Management. Both schedules should identify peak work-load periods, assist in planning vacation time for the Maintenance staff and permit smooth integration of contract work of off-campus firms with the in-house capability. As data is accumulated over the years, these schedules should become increasingly valuable assuming the College Calendar stops changing from two-semester to three-semester and back again.

Obviously, this type of advance planning has been done successfully by visual charts and/or bar graphs. As we have stated, we made the decision to seek an Integrated Maintenance Management System for computer application, so we naturally want these two schedules in computer format. We hope for more sophisticated and complete planning.

The custodial area is at the top of the chart simply because of "layout" requirements. We wanted to show the SCHEDULING OF MAINTENANCE operations in the center. Regardless of order of importance, we do believe that custodial operations belong in an Integrated Maintenance Management System and are capable of full computer application.

One practical application on which we are now embarked, is to INPUT custodial hours spent on

a) regular cleaning tasks

b) non-cleaning tasks such as moving furniture into dormitories which have just been completed (you can tell from the construction program on our campus that this is a recurring annual event), and

c) cleaning tasks in other buildings.

As OUTPUT, we expect an analysis of non-cleaning labor costs by academic department and, as other examples, the labor costs of set-ups such as examinations and Commencement.

As our term "Integrated Maintenance Management" infers, Review and Analysis is the Payout. Before we discuss that aspect, it is most important to understand one principle involved in designing a system, a management information system.(1)

For each system there must be a Data Base or Data Bases. The Data Base can be broken down into two general categories, the bread-and-butter items and the intangibles. The former are those with payout. The latter are non-direct bits of information which can be designated "nice-to-know" items.

Our advice is to build your Data Base as broad as possible. Include as many non-direct bits of information on your maintenance operation as you can pursuade your computer people to include. Doing so will help to provide a system which will be worth the effort and of value which you had not expected.

Hindsight tells us that, had we limited ourselves to the bread-and-butter items, we might have been in business earlier. On the other hand, including the intangibles and thus developing a broad data base should give us a system which will be useful for years. We think we have avoided the pitfall of system turnover.

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(1) Leeseberg, H.S., "Communications News", December 1966. The following two paragraphs lean on Leeseberg's article and succinctly explain what our Computer Center Manager accomplished for us.

Obviously our system had to be coordinated with the College Program Budget and with the Fiscal Laws of New York State. Review and Analysis would be meaningless unless this were done. Figure 9 and Figure 10 show, in abbreviated form, the Functional Accounts and Object Codes of the Program Budget.

The pay out items are shown in Figure 11. Each of the listed items will appear in the categories "a" through "f". The reporting is keyed to the fiscal year.

The management information system portrayed uses the computer to communicate results upward. The Print Out will permit Physical Plant to distribute the information to the Vice-President for Administration and to those responsible for administration of the various functional accounts. Having this information available should expand the effectiveness of the Administration as well as Physical Plant Management.

INTEGRATED MAINTENANCE MANAGEMENT SYSTEM

COMPUTER APPLICATIONS/SYSTEMS DESIGN

The first discussions by the people in the Computer Center and the Maintenance area of SUNY Binghamton revealed a situation where work orders were virtually uncontrolled because of a lack of knowledge of priorities, backlogs and status, and limited information on which to make judgements, such as the amount of time estimated to complete outstanding work orders as they were known, versus the amount of available hours to expend on such jobs. Neither were there any inventory control procedures, and part numbers were unknown, classes of material unidentified, unit cost unassigned. This led to the obvious inventory control and work order problems.

When a job was processed, until such time as inventory was physically checked at the time the job was to be released to laborers, there was no knowledge as to the availability of material. Neither was there any way to attempt to determine how much material was used on a job or the cost of that job for labor or material, ordering the product only as required and then on demand or without regard to actual known requirement. These discussions further portrayed the fact that labor reporting was at best marginal and required a great deal of clerical effort in the Business Office area to reconcile actual time to reported time. The same time, of course, would be assigned to specific work orders which we were considering controlling.

Another large area was tool control. Because of the necessity of certain tools to be permanently assigned to some employees and the necessity of other types of tools being checked in and out of the warehouse, and because of a lack of a system to control such inventory and tools, we found ourselves in a position where we neither knew our tool inventory or the location or assignment of such tools to individuals on campus.

At the same time these discussions were proceeding, it was quite clear that SUNY Binghamton, along with other State Institutions, was going to be expected to report substantially more data, both internally and externally, to Administrations representing this institution and the State. At best, any such information supplied under the old system would have been estimates and subject to much questioning and error. With these problems confronting us, we designed a system as follows:

1. Identifiable material through the assignment of part numbers which could be related not only to work orders but which would allow automatic ordering, based upon minimum balances and reorder points established by Maintenance and control by the computer.

2. The development of routines which would permit the association of part numbers as well as labor reporting to work order numbers, which would allow us to accumulate costs of projects, work orders and individual times.

3. A tool system which would identify a distribution of tools which were permanently assigned to individuals and permit the automatic reorder of tools when inventory balances reached a minimum on-hand balance.

4. Based on fixed criteria, to actually computer schedule work orders for the Maintenance area, based on priorities, commitments, available material and available personnel.

Our first step in this direction was to have the Maintenance Departments begin immediately reporting to us all the work orders which came into their shop, both scheduled and unscheduled, including whether or not the material was on hand, a moderate estimated time required to complete the jobs, the estimated start date, the building to which the job was charged and the date the job was received. We immediately began establishing a file of these jobs and providing on a weekly basis for Maintenance a report that showed by work order number sequence all jobs in house and the status of those jobs. We provided a second report which showed, by building, the jobs that were either in process or waiting to be completed.

Once this basic routine was established, it gave the Maintenance Department the ability to identify their work load, based upon work orders in process or backlogged. It was a relatively simple matter to begin reporting completion dates and actual time against jobs. This was accomplished by re-routing all labor reports which were already previously computed by the Maintenance people to the Computer Center. At that time the reports began taking on more significance to the extent that we were able to compare estimated hours to actual hours by labor group. We were further able to indicate the total number of actual hours expended by the multitude of labor groups existent and identifiable on this campus. It further is able and does show the backlog of hours by labor group, by estimate, as well as by building. With this information available, we

began also providing management analysis data. For example, how many jobs were on the schedule which were awaiting the arrival of material, or how many jobs were not completed by their scheduled complete date. We also began running a listing of all jobs completed, on a weekly basis, and as a management report, those categories of unmatched labor, i.e., labor reported which was charged to a non-existent work order number. Built into this was also a category of labor for non-standard work orders; for example, personnel who did work around the shop or where the work would not be the result of a work order generated by someone on the campus, but standard type maintenance. We have special work order numbers for this category and we charge to it as required.

This system just described was developed as a card (Unit Record) routine, and required some manipulation of data beyond what we would like to have expended on this effort. At the present time we are transferring this to the tape system in conjunction with a disk, and the basic configuration of our system will be as follows:

On magnetic tape we will place all work orders in house, or as reported to us by Maintenance. These would be in work order sequence. Our system also calls for all inventory items to be placed on a random accessible disk in part number sequence. On a weekly basis, what this would allow us to do is to match all outstanding work order numbers with their material requirements against our inventory disk file randomly accessible. We will reserve and assign material to work orders based upon priority, where material is available. Where material is not available and it must be ordered, this will affect the scheduling of an even higher priority job and allow for its displacement on the work schedule by a job which otherwise would have had to wait, since our disk file inventory material will contain on-hand balances, issue quantities, minimum order balances, received quantities and part number, as well as unit of measure and classification of material. At that time of checking work order requirements against inventory balances, we will check all part numbers to determine if any order should be processed because issuances have occurred which have reduced the on-hand balance below the minimum on-hand quantity. This processing will then result in the establishment of inventory requirements for outstanding work orders, as well as generating material requirements by requisition to be processed in the Maintenance Department for approval prior to ordering by the Business Office.

The logic of our scheduling routine is straight forward based upon criteria agreed upon by the Computer Center and the Maintenance Department. Jobs will either be priority or non-priority. If on the transmittal supplied to us by Maintenance there is a scheduled completion date, to us that represents a priority and would take prerogative over any other work order which we receive knowledge of where no completion schedule date appears. Our program would result in all items with completion schedule dates indicated being analyzed first. Since these would contain labor group requirements as the result of estimating, we would match the required hours by labor group against all the established priority jobs or jobs in process and unscheduled jobs to determine what available hours exist by labor group for the earliest possible scheduling. We will

analyze these available hours against the lead time and the scheduled completion date and determine if the job can be completed in the time span requested. If it can, the job will be so scheduled. If it cannot, we will indicate this exception to the Maintenance Department and at the same time indicate it will stretch beyond the requested completed schedule date, unless action on their part is taken, such as the assignment of more people to that department. Once all priority jobs are scheduled and exceptions noted, all jobs without a scheduled completion date will then be assigned to the master schedule. The only priority here will be based upon the date that the Maintenance Department receives the work order and they will be scheduled in that sequence with the only factor affecting this being available hours. In other words, if we have ten hours of plumbing time available and we have a job which was received two weeks in advance of another job which requires fifty hours, but the second job only requires ten, we would assign the lower number hour job since it can be accomplished with the available hours that are existent.

This schedule will be provided weekly and projected monthly and for a six-month period. It will include, in addition to the normal work order jobs, preventative maintenance applications. These will be carried permanently on the record and anticipated based upon predetermined requirements of Maintenance. It will become a part of the schedule. We will be able to project on that basis where we will stand six months from now. Initially, this will be based on known requirements, but as history occurs, we should be able to anticipate based on previous experience and on criteria fed to us, from which we can anticipate reasonably, without knowledge of the specific jobs.

The Maintenance people will continue to report labor to the Computer Center. The labor will be assigned by work order number and dollar value applied based upon the actual salary of the individual involved. This, plus the material cost which will be part of the inventory record and any overhead factor which we may apply, will determine the cost of the work order for a project. It will be so reported by the Computer Center to Maintenance at the time jobs are completed. We will take this same labor information and use it as the basis for developing our payroll reports to the Business Office which will be mailed to our State Offices.

A third file we will have in addition to the work order file and the inventory file will be the tool file, which by tool number will record all tools which have been permanently assigned to the individuals on campus, as well as the minimum on-hand balance for a given tool. As tools are charged out to and returned by the trade groups, it will be so indicated on our file. If the tools are lost or destroyed, this, too, will be indicated, and when minimum on-hand balance is reached, we will prepare a requisition for reorder. All tools which are issued to and from the tool room on the basis of a specific work order would be controlled by Maintenance. However, even in this regard it would be in the ordering process if such a tool is lost or destroyed, affecting on-hand balances. With this total information available we will be in a position to provide virtually any analysis by building, by program, by work order, by labor group, by material cost that the Maintenance people should elect to request.

We intend, as a part of this system, to show how many work orders were processed on a given week, on a given month, or since a year ago on the same time period. We intend to reflect an analysis of percentages of jobs where material is available versus non-available, over a period of time. The same thing will apply to such experiences as failure to meet with required complete dates, invalid estimating and other typical production or inventory reporting.

The file capacity which we are discussing is as follows: with the preventative maintenance information as well as our non-repetitive work orders, we anticipate on the order of an estimated 1,000 jobs in some status at all times. The amount of information which we will maintain on each job will vary, particularly because of the nature of the daily requirement on preventative maintenance. However, it is currently estimated that we will need one million characters for storage to adequately support the data requirements for the work orders only. Based upon our inventory at the present time and its anticipated growth, we expect to have somewhere between 7 and 10 thousand different part numbers in our system. We have established a record length or data requirement for each part number of approximately 200 characters, meaning that we require the utilization of two million characters of disk storage.

The tool control file will require only approximately 200,000 characters of storage and will be a part of the same disk which houses the inventory material. The total commitment, therefore, for storage devices is a part of one tape and approximately one-third of one disk. We currently project an estimated running time for all facets of the integrated management system to be no more than two hours a week.

Our programming effort is currently in process and has been scheduled in phases. Phase 1 will be completed as of April 1, 1967. This is primarily a conversion from the card system to the mass file program we are discussing. By June 1, we expect Phase 2 to be completed which will represent the scheduling routines for maintenance jobs exclusive of P.M. effort. Phase 3 will be the establishment of the inventory file, the addition of P.M. to the master work order file and the tool control file. This we have scheduled for October 1, 1967. By January 1, 1968, we expect to add to this the labor reporting and the ability to completely analyze and compute the cost of a given order or program.

PERSPECTIVES

This presentation has attempted to complement the paper of Mr. Virgil B. Clark, Director of Physical Plant at the University of West Virginia, and printed in the Minutes of the 1965 National Association meeting. It has also tried to complement the paper presented by Harry Hugill, University of Massachusetts, at last year's Eastern Region meeting. Clark gave Data Processing a general treatment with penetrating wit. Hugill gave a thorough analysis of his Inventory Control System. The following comments select points from each and attempt to add perspective for this group of people.

Hugill said, "A word of caution - before you start, - be sure you have a large supply of patience to draw on - you will need it." To this I can add a loud "Amen".

Hugill started in September 1961, and got his miscellaneous material picked up in January, 1965. We started in September, 1965. To us amateurs it appeared that we were making progress. After an exchange of correspondence last January with Donald Whiston of MIT, in which he gave us substantial help, we invited him to visit us in May of 1966, "at which time we expect we will have made substantial progress". Fortunately for us, he did not accept our offer. Last May we had, indeed, made little real progress.

Clark told, under a section entitled "What it takes to Initiate Data Processing in Maintenance" the story of two frogs who fell into a bucket of cream. You know it. The moral is, "Keep churning!"

At the University of Massachusetts the type of computer chosen was based on university-wide requirements and is not particularly adapted to processing data for inventory and work control. With us the decision as to hardware was taken from the same base. As a matter of fact, we are at this stage still using punch card systems. But Bob Roberson has been careful to design a system which can be transferred to our 360/Model 40 Computer.

Harry Hugill reports that the Physical Plant Department could "expect little support from the Computer Department or from the Administration in the developing of computer programs". I would like to put this statement in a little finer focus. We have had fine support from our Computer Center people. However, they have been bothered by personnel shortages, though when you look into a Center you often wonder where all the people came from. In addition, the matter of priorities has conditioned Bob Roberson's support of our efforts. Research projects are on a high priority on our campus; developing a regional computer system, and developing computer-assisted instruction are also on high priorities. Perhaps our slow progress shows that we haven't advocated strongly enough the urgency of our own needs. You may wish to fight for high priority.

I would also like to point out that the Input, i.e., the data base, will never be handled by Computer Center personnel. The Physical Plant force, the individual researcher or whoever else, must always be prepared to generate this data. I am referring to such items as short parts description, unit cost, stock numbers, codes, etc. Whether you use your own clerks, your Maintenance Foreman as we had to do, or temporary hire, you'll have to do this job yourself. As we began our experiment, we took on a Head Maintenance Supervisor, Ralph L. Howell, who at Endicott-Johnson had several years' experience with Data Processing Systems in a business context. I suspect he did a lot of this detailed work himself, and I know that he supervised the work of the others who contributed to the Data Base.

You will have to make a substantial effort if you go into computer applications. As Hugill points out, it becomes a major project particularly if you must continuously provide retail service from your warehouse and conduct your regular business as usual.

You can tell from this discussion that we are not yet able to point with pride to solid benefits and demonstrate these with hard facts. We have had enough experience with our system to be confident that several are just around the corner. Our experience has also taught us to be cautious in making statements as to when we will turn that corner.

We have already noticed overall improvement in operating efficiency just as the University of Massachusetts has reported.

We would like to claim improvement in customer relations. It is too early in our program to make these claims, but we expect that this will follow.

Already we can claim reduction of delays in starting work due to non-availability of materials. We expect greater benefits in the future.

Regarding delays in the middle of a job awaiting procurement of materials, we can only say that our system forsees this problem and is capable of reducing it to manageable proportions.

In the past, we too have been plagued by morale problems involved in pulling workmen off a job when someone pushed the panic button. There is a hopeful gleam in our eye that our system, when in operation, will provide for continuous job progress. Of course, we are not so naive as to expect that, when the President wants his Christmas tree relocated for tomorrow's party for our Trustees, we will not have to drop everything to get it done.

The greatest benefits we foresee will be in the area of Review and Analysis.

From the start, we worked with our computer people on a system which would incorporate all the data about Physical Plant which we could think of. In other words, we were not limited to the "bread-and butter items" in our data base. We were able to incorporate many intangibles.

Now perhaps I'm getting out on a limb when I tell you that my personal conviction is, "It's not a question IF you put Maintenance Management on machine. It's a question of WHEN and HOW." I say this to large and small colleges. For most, it is one of those GRAY AREA decisions which Mr. Partridge mentioned. If you have to take a small first step, be sure the system you adopt can be expanded in scope and to a bigger, faster computer.

SUMMARY

SUNY AT BINGHAMTON
Gross Sq. Ft.

	1962	1966	1970	1974
Existing	657,697			
Added		558,043		
Under Construction or Programmed for 1970			784,600	
Estimated for 1974 (non-residential)				646,225
Estimated for 1974 (residential)				537,380
Cumulative	657,697	1,215,740	2,000,340	3,183,945

FIGURE 1

SUNY AT BINGHAMTON

Maintenance Staffing

SUMMARY

	'62	'66
Buildings & Grounds Headquarters	1	7
Heating Plant	24	24
Maintenance	12	32
Grounds	5	10
Garage	1	3
Security	5	9
Custodial	37	102
	75	187

	1962	1966
Gross Sq. Ft.	657,697	1,215,740

FIGURE 2

INTEGRATED MAINTENANCE MANAGEMENT

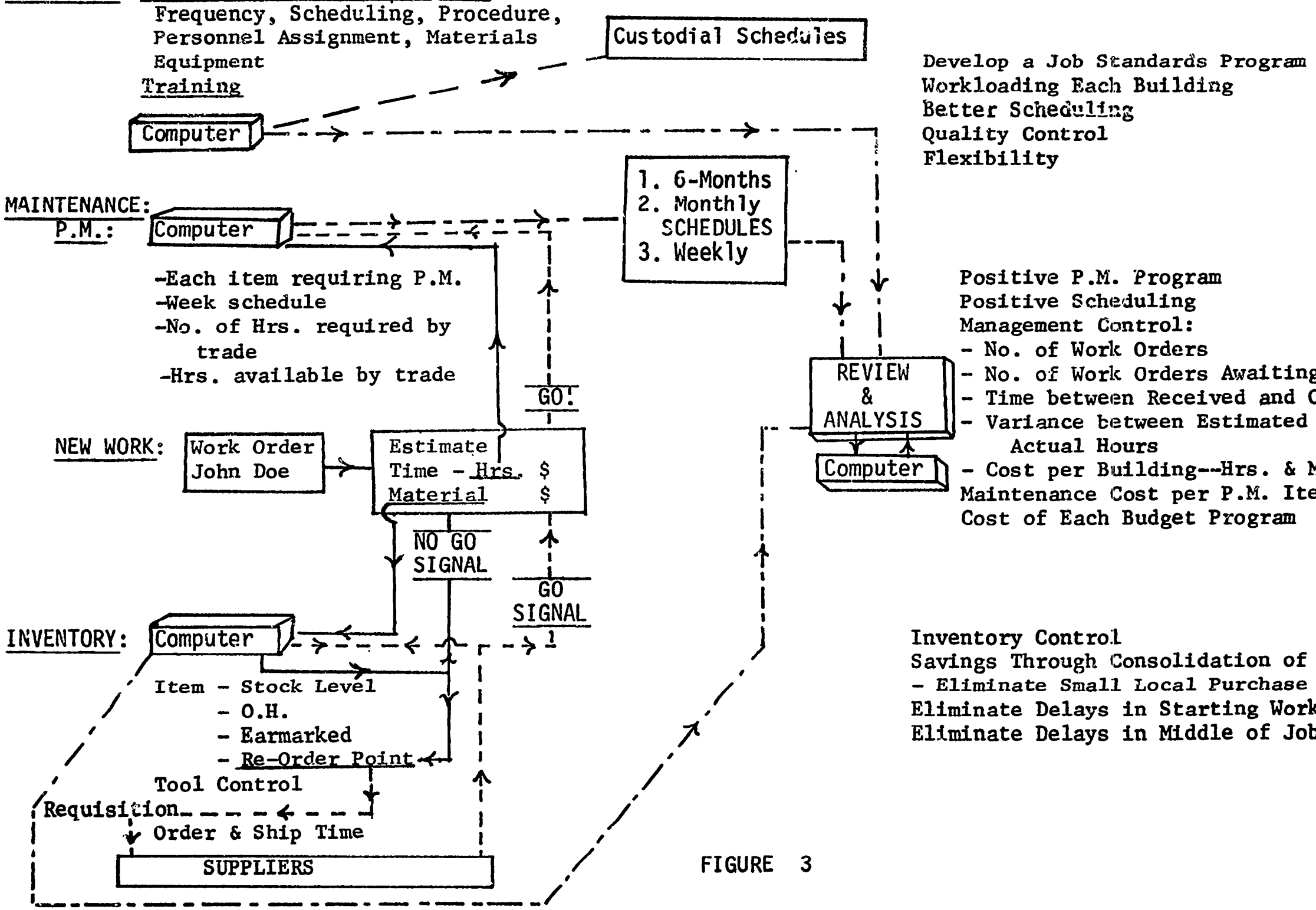


FIGURE 3

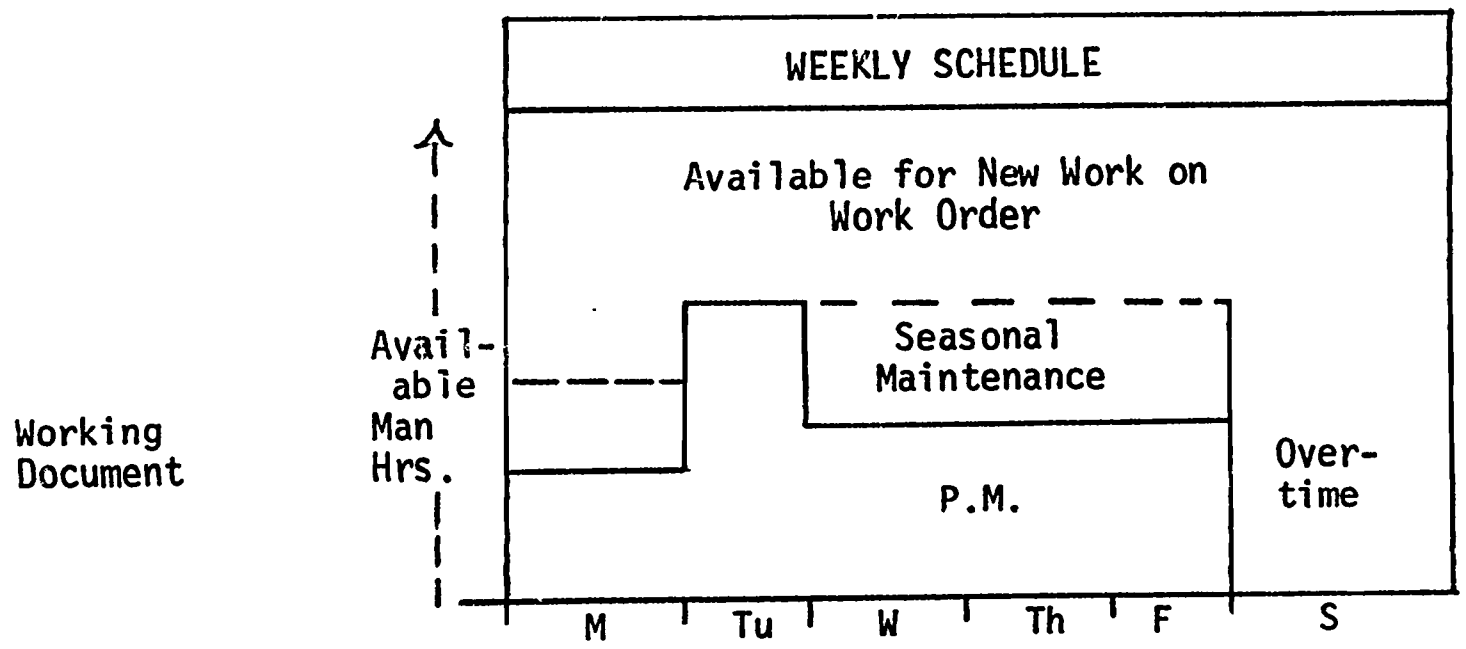
SUNY AT BINGHAMTON

COMPUTER SCHEDULE PRINT OUTS

Planning Documents

Summary 6-Months Schedule

Summary Monthly Schedule



Working Document

Notes: Priorities are (1) Emergency Work which overrides any Schedule, (2) P.M., (3) Maintenance and (4) New Work on Work Order

FIGURE 4

INTEGRATED MAINTENANCE MANAGEMENT

S.U.N.Y. at BINGHAMTON

CARD #1

ELECTRIC MOTOR DATA
LOCATION: 4th Floor East PURPOSE: Interior Zone A.C. Unit #3
MAKE OF MOTOR: Westinghouse DATE INSTALLED: 5-52
TYPE: CPS FRAME: 225 MODEL: Lifeline SERIAL NO.: 1442038
PHASE: 3 CYCLE: 60 VOLTS: 208/440 AMP.: 8.4/4.3 RPM: 1740 H.P.: 3
KIND BEARINGS: Norma S-3506
KIND DRIVE: Texrope Adj., 7.4" Min., 7.9" Max.
NO. OF BELTS: 2 SIZE BELTS NO.: Gates A-85
MAKE CONTROLLER: Allen Bradley - Size 1 - Form 2F - Type 1 Bulletin 712
NO.: Holding Coil #1A06 - 208 Volts - Heater #N30 (2)
Fuses 10 Amps. (3)
NAME OF DRIVEN A.C.: Unit #3 - Sturdevant Air Handling Unit
SIZE: AV-1250 SERIAL NO.: DV SPEC. NO.: 2RT
RPM: 522 SIZE SHAFT: 1-15/16" KIND BEARING: Fafnir - Pillowblock S-1115K
Filters - Farr - 8 - Size 16' x 20' x 2
C.W. Valve - 2" - Honeywell Motor Valve #V581B - Motor No. 950A-6
Return Air Thermostat - Honeywell T0900BX14

FIGURE 5

MAINTENANCE DATA

CARD #2

MOTOR CARD

4th Floor, East A.C. Unit #3
Annual - Clean - Inspect Bearings - Check Windings

DATE	DESCRIPTION OR REPAIRS	COST
9/28/65	Replaced belts	$9.85

FIGURE 6

CARD #3

A.C. UNIT NO. 3 EAST 4TH FLOOR SERVES EAST INTERIOR ZONE, 4TH FLOOR

DATE	WORK PERFORMED	HOURS LABOR	MATERIALS USED	REMARKS
7/6/65	Cleaned motor Adjusted controls Inspected C.W. valve	3 hrs	1/4 pt. oil	No rust in coil
7/6/65	Greased fan bearings	1/4 hr.	1 shot grease	Temp & Sound OK
8/10/65	" " "	1/4 hr.	"	Temp & Sound OK
9/7/65	" " "	1/4 hr.	"	Temp & Sound OK
9/28/65	Replaced both belts Adjusted Motor Pulley	3/4 hr.	2 Gates A-85 belts	Oil OK

FIGURE 7

WORK INSTRUCTION PROGRAM

	001	AHU W CW BLDG 001 INSIDE COL.B-9
514	010	INSPECT COILS FOR DIRT - RECORD CONDITION
514	011	CLEAN CHILLED WATER COIL - AIR SIDE
514	014	INSPECT INTERNAL INSULATION FOR TEARS
514	016	CLEAN AROUND BELTS
514	021	SECURE VALVES ON EACH SIDE OF UNIT
514	022	INSPECT AND CLEAN DRIP TRAP
514	023	CLEAN STRAINER ON TRAP LINE
514	024	REPLACE COVER - PLACE INTO SERVICE
514	030	CHECK CONNECTIONS IN STARTER BOX
514	032	CLEAN EXTERNAL CASING OF ALL DIRT AND GREASE
514	036	TAKE SPEED OF UNIT AND RECORD
757	100	FAN
757	101	REMOVE BELTS
757	102	CHECK BLOWER BEARINGS FOR END PLAY AND WEAR
757	103	REMOVE HATCH - INSPECT BLOWER WHEELS
757	104	RECORD CONDITION
757	110	STEAM TRAP
757	111	SECURE STEAM VALVES ON EACH SIDE OF STEAM TRAP
757	112	REMOVE COVER. INSPECT AND CLEAN
757	113	REPLACE COVER AND PLACE INTO SERVICE
757	120	INSPECT ALL PACKING BOXES ON CONDENSATE AND STEAM LINES
75	121	AND TIGHTEN
757	130	CLEAN ALL AIR VENTS ON CHILLED WATER SYSTEM
880	153	VACUUM OUT DAMPERS
880	154	CHECK CONDITION OF FILTER BANK
880	155	TAPE ALL AIR LEAKS AROUND AIR BANK
880	156	FLUSH OUT DRAIN LINE WITH HOSE
880	157	SAFETY PRECAUTIONS
880	158	BE SURE TO TURN OFF UNIT ELECTRICALLY AND
880	159	SECURE MAIN STEAM LINE BEFORE PROCEEDING WITH
880	160	ANY PHASE OF MAINTENANCE
880	161	DO NOT TURN ON UNTIL MAINTENANCE IS COMPLETED

FIGURE 8

FUNCTIONAL ACCOUNTS

INSTRUCTION AND DEPARTMENTAL RESEARCH

55000	Graduate Division
55001	Director's Office (430)
56000	Health and Physical Education, Division of
56001	Director's Office (700)
56045	Physical Education
59000	Humanities, Division of
59001	Director's Office (630, 639)
59009	Art and Art History (634)
59018	Classical, Semitic, and Slavic Studies (632)
59031	English, General Literature, and Rhetoric (637)
59042	German (638)
59066	Music (635)
59073	Philosophy (633)
59083	Romance Languages and Literature
59091	Theater
66000	Mathematics and Science, Division of
80000	Social Sciences, Division of
86000	Other

ORGANIZED ACTIVITIES	(Has similar sub-accounts)
ORGANIZED RESEARCH	"
PUBLIC SERVICE	"
LIBRARY	"
STUDENT SERVICES	"

MAINTENANCE AND OPERATION

86601	Administration and Supervision
86605	Alterations-Physical Plant
86601	Custodial Service
86615	Maintenance: Buildings (948)
86620	Maintenance: Equipment
86625	Maintenance: Grounds (905)
86628	Maintenance: Pres. Res.
86630	Motor Pool
86640	Power Plant
86660	Security (906,908)
86675	Utilities (904)

FIGURE 9

OBJECT CODES

0000-2999	SALARIES AND WAGES
0000-1999	Regular
0001-0399	Administrative
0400-0599	Instructional: regular
0600-0699	Instructional: auxiliary
0700-0899	Supporting academic
0900-1099	Professional, technical
1100-1299	Maintenance, security, transportation
1300-1599	Clerical
1600-1999	Other
2000-2999	Temporary
3000-5999	SUPPLIES AND EXPENSE
3000-3999	Supplies and Materials
4000-4999	Travel
5000-5999	Other Contractural Services
6000-6999	EQUIPMENT
6000-6299	Noninventoriable
6300-6499	Inventoriable: library acquisitions
6500-6999	Inventoriable: other
7000-7999	SPECIAL ITEMS
8000-8999	INTERDEPARTMENT CHARGES
9000-9999	PROVISIONS

Note: Each Functional Account Might Have Each of These Object Codes.

FIGURE 10

REVIEW AND ANALYSIS

PAY OUT ITEMS

No. of Work Orders:
- a. - During the period
- b. - Same period last year
- c. - This month
- d. - This month last year
- e. - Fiscal year to date
- f. - Last fiscal year to date

No. of Work Orders Awaiting Supplies - a b c d e f*

No. of Work Orders Awaiting Scheduling (Backlog) - a b c d e f

Variance between Estimated Hours and Actual Hours - a b c d e f

Hours by Trade - a b c d e f

Emergency (Unscheduled) - a b c d e f

By Building - No. of Hrs. Labor Cost Material Cost Total Cost a b c d e f

By Department -
Total No. of Hrs. available: a b c d e f

Work Stoppages - by building: a b c d e f
(Site Utilities coded as a building)

Special Interest Work: (President's Projects) - a b c d e f

P.M. - Items of P.M. or Seasonal Maintenance deferred: a b c d e f

Individual P.M. Items
Obsolescence as identified by high dollar cost.

Inventory Control Date**

By Program - (Functional Accounts):

Labor Cost Material Cost Total Cost a b c d e f

* Each item reported in the six categories a - f.

** See Hugill, op. cit.

FIGURE 11

QUESTIONS ON COMPUTERS

COMPUTER APPLICATION TO AN INTEGRATED MAINTENANCE MANAGEMENT SYSTEM.

Q. What is smallest unit of time maintenance work put on computer?

A. 1/2 hour, estimaters compute time and materials and least time used is 1/2 hours. Tradesmen report job time; hope to refine by time and experience; hope to install time clocks at each building to record time in and out. Not seeking 100% accuracy.

Q. Does estimated time show on mechanic's copy of work order?

A. No.

Q. What percentage of work force time is spent on alterations?

A. 50%, or about 1240 manhours weekly. 1/2 hour or less jobs not formally set up.

Q. How is non-production time handled?

A. Tradesman himself reports time - not 100% accurate. Hope to refine by (a) education, (b) better supervision, (c) time clocks at each building. Realize that still will not be 100% accurate.

Q. Who sets priorities?

A. Plant Manager with academic heads.

Q. Does mechanic know number of hours estimated for project?

A. No - that appears on plant office copy

Q. Do you supply all small tools?

A. Yes.

Q. What is scheduling time-lag?

A. Normally one week.

Q. How do you handle parts and pieces left over from job?

A. Loss credited back to job.

Q. Are standards against workers yet?

A. No, not yet.
Comment -- Mechanics who know estimated time, attempt to beat time shown on work orders.

Q. What is cost of the computer program?

A. Presently, about one full man, $10,000.

Q. Are all estimates adjusted when it is found that estimates on earlier jobs are excessive?

A. Yes.

Q. Number of maintenance items in stock inventory?

A. Estimate 5000.

Q. Are furniture inventory records maintained?

A. Yes, by State law.

COMMENT -- Single requests for keys, and other small jobs are not computerized. Shops are not unionized.

Q. How are perpetual inventories maintained?

A. They are maintained, but only spot checks are made.

COMMENT -- M.I.T. -- Preventive maintenance has been installed for heating and ventilating equipment.

Trouble has been experienced in getting computer time-payroll takes priority..

Q. Jobs are scheduled as they originate. What happens when emergency jobs are inserted or jobs take shorter time than estimated?

A. Schedule changes continually. Dead lines can be listed, discussed, sometimes beaten.

George W. Ward, Jr.