Approach to Maintenance Management

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It is evident that maintenance costs are rising sharply due both to inflation and the steadily expanding highway system, which, by nature of modern design, becomes increasingly expensive to maintain. The Washington Department of Highways and probably all of our counterparts are becoming more concerned with this phase of our activities. This is contrary to past history, in which maintenance was generally ignored or shoved into the background.

It is easy to conclude that our maintenance forces and facilities are not well organized—like Topsy, they just grew. With changes in the system, due to new construction, legislative additions, and the superimposing of the Interstate System upon the older structure, many of our facilities are poorly located, some of our equipment is obsolete, and our forces are not organized or located so as to lend themselves to the most efficient operation. If someone today were charged with the responsibility for establishing a maintenance system in our state and none of the present system existed, obviously the resulting organization would bear only a superficial resemblance to the existing one in all too many areas.

In bygone years, because of the difficulty of travel and the necessity for maintaining roads in remote areas, most sections were maintained by a leadman-maintenance man team, frequently living in state-constructed cottages in the immediate vicinity of their work. Today, as travel is less of a problem due to better roads and higher speed vehicles, the increasing population, which has tended to do away with the isolation of many areas, and the complexity of the highway system itself (quite often several roads meeting in or near a common point), we are shifting slowly from the two-man section to a foreman-supervised gang operation. We are closing out many remote stations and are moving toward consolidation of forces and equipment. We will, undoubtedly, continue to reorganize slowly in this manner, which makes for easier control of employees, scheduling of work, and better utilization of labor.

There are four major reasons, not controllable by local management, which bring about increasing maintenance costs:

- Increased labor costs
- Increased equipment costs
- Increased material costs
- Increased area and facilities to maintain

The elements, which make up the total cost of the normal maintenance operation, are shown in Figure 1. Records for our department show that for the year 1967, our maintenance dollar was divided approximately as follows:

Labor	63 percent
Equipment	23 percent
Materials	14 percent

It becomes obvious then that the area in which the most savings could be made would be in the better utilization of labor. Our initial study showed the conditions in Figure 2 to exist.

We noted that, statewide, there was wide variation in the equipment, methods being used, materials being used, and the makeup of crews. Also, the exchange of information on new methods and materials was poor and, if one district had adopted a most efficient way to perform a piece of work, it was quite likely that other districts were

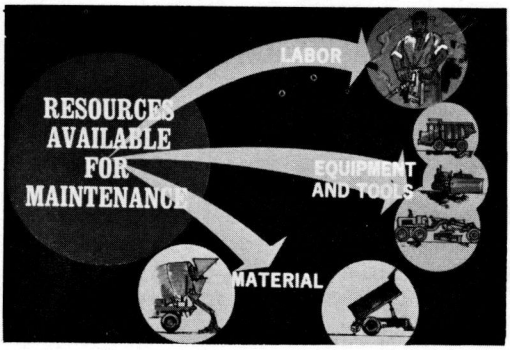


Figure 1.

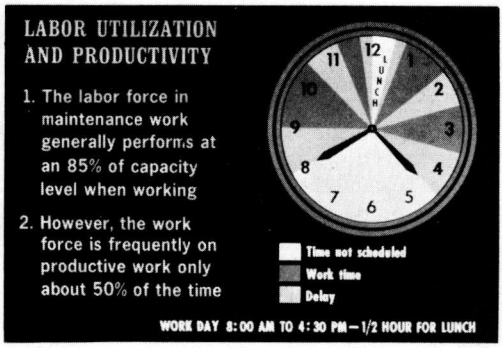


Figure 2.

not aware of it. A very large portion of our work was being carried on by time-honored methods, often not the best, and frequently, for no other reason than that "we have always done it this way." We came to the conclusion that simple modern management tools and techniques are not being applied to the maintenance work. These include:

- Planning and scheduling
- Standardization

As a result, the decision was made to enter into a comprehensive study of maintenance activities to devise better methods of planning, scheduling, and organizing work, and to carry on a statewide program of education and exchange of information. This led to an agreement with a consultant to develop and install a program for the improvement of the control of maintenance forces, establishing uniform methods statewide, and also fixing levels of maintenance to be uniformly applied. The consultants were charged with the responsibility of providing industrial engineers, preparing the training documents, and advising the department; however, it was planned to have ample department representation.

Before discussing the procedures followed, a brief discussion of the organization of that portion of our department concerned with maintenance seems appropriate. The State is divided into six highway districts (the seventh is the metropolitan district in the Seattle area, concerned only with planning and construction and has no maintenance function). Each district has a district maintenance engineer, who reports directly to the district engineer, and he is aided by an assistant district maintenance engineer. Each district, in turn, is divided into four divisions, which are under the supervision of a highway maintenance superintendent. There are, in addition, two special divisions in the Seattle area: one concerned solely with the maintenance of our floating bridges; the other, the signal division, concerned with maintenance of electrical traffic controls.

Each district also has a shop, supervised by an equipment superintendent. These are located at the district headquarters. All fabrication, modification, and major repairs are performed in the district shops. Each division has two mechanics located at the division office to perform minor repairs, tune-ups, and troubleshooting to keep the equipment in the field operating. In the headquarters office, the maintenance staff is supervised by the assistant director of highways for maintenance. His staff consists of an assistant maintenance engineer, roadway maintenance engineer, landscape maintenance engineer, equipment engineer, radio engineer, the management analyst team, and an engineer of capital outlay and inventory.

As the study group was set up initially, the consultant provided two full-time industrial engineers, who were supervised and guided through frequent visits by repre-

sentatives of the consulting firm, plus a group of departmental management analysts, based on a ratio of two department employees for each representative of the consultant. When the study was extended to the district shops, the consultant provided one additional industrial engineer, specializing in this area, and the department two additional employees. Every effort was made to work as closely as possible to achieve near integration of these two elements.

It was planned to have a major portion of the work done by permanent Highway Department employees, who would remain members of the headquarters staff after the consultant's services were terminated. We felt then, and experience has confirmed, that our maintenance employees work better and talk more freely with departmental employees and every effort was made to avoid the appearance of adopting a plan designed independently by an outsider.

While our department has had members who belong to various employee organizations, we have recently moved into heavier unionization and we, therefore, called in employee representatives to discuss the planned program in advance of undertaking the studies. One union representative spent an entire day at one of our training sessions in order to obtain an understanding of what we were undertaking so that he could report back to his organization better informed. Some union members expressed a fear that once work norms were developed, an employee failing to meet his quota would be discharged. If low productivity shows up in the reports, it is more logical to study the standard to see if it is correct and then to look at the methods being used by the crew in question, not the effort of the individual. It is the opinion of the writer that nearly all of our employees are willing workers if they are told what to do. This reduces to a matter of preplanning and scheduling. There was, initially, some little adverse reaction since a few people, understandably, are nervous about being under all-day observation; however, this was minimal and apparently disappeared completely in a short period of time.

The maintenance work improvement program is divided into five major steps:

1. Training the team;
2. Studying and analyzing present operations;
3. Supervisory work management training;
4. Implementing the controls; and
5. Benefiting from the program.

The first step taken by the consultant was the development of an analyst training manual. This included an introduction to the theory of industrial engineering, with specific instructions for its application to highway maintenance. As soon as the necessary analysts were recruited for the headquarters staff, a training program was conducted at headquarters to indoctrinate these employees. Once the training of these analysts was completed, they and the consultants made up the team to carry on the necessary studies in the field.

The maintenance control system is designed to assist those responsible for carrying out the objectives of the department to utilize manpower, equipment, and resources more effectively. The specific objectives of the system were as follows:

1. Planning of work requirements in terms of manpower, equipment and materials.
2. Budgeting adequately to meet these work requirements.
3. Scheduling to achieve budget objectives.
4. Completing work in accordance with standard times and methods.
5. Reporting of accomplishments and resources used.
6. Evaluating the department's accomplishments against known objectives.

To accomplish our goal, we arrived at the following conclusion that the success of a program such as this was based upon two major factors beyond the system design itself:

- Taking the program to the people and involving them in it;
- The educational-comprehension level of the supervision and work force.

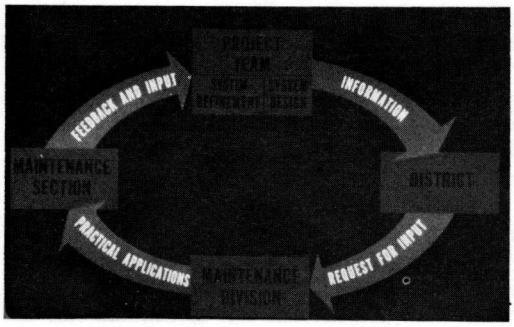


Figure 3. Taking the program to the people.

Figure 3 is indicative of the consultant's concept of the procedure to follow in this program; however, the program, as developed, came very close to being the exact contrary of the procedure shown.

In an enterprise such as a large factory, with a ratio of production workers to maintenance employees in the neighborhood of 1 to 1, it could be expected that supervision would be giving these two areas equal attention and would willingly devote considerable time to improvement in the maintenance program. If the ratio of maintenance employees drops until it approaches that of a highway department, where approximately 25 percent of the employees are engaged in this work, it demands a decreased portion of the supervisor's attention. It does not appear to him to be a major problem area. Engineering studies have shown that some segments of industry, such as chemical plants, are using a very high proportion of maintenance employees to production employees, generally being over 20 percent and sometimes the ratio approaches 1 to 1. In these instances, the supervisor will give maintenance a great deal of attention, whereas, in an industry which may have one maintenance employee for each 100 production employees, so little could be saved by improving maintenance that attention approaches the minimum. While it is true that the maintenance forces in this Highway Department represent somewhat more than 25 percent of direct State employees, if a ratio were to be established, we would have to consider the employees of all contractors as production workers. A look at the budget confirms this conclusion. For the current biennium, the maintenance dollar in the State represents only 6.8 percent of the total budget. On this line of reasoning, we concluded it best to go directly to the people immediately concerned and demonstrate to them the benefits of the program, before requesting recognition from the higher supervisory group. We believe that the results have verified this line of reasoning and, in fact, that this approach was critical to the success of the program. Initially, the study team visited each District in turn to explain the purpose of the study and the procedure we would follow to the district engineer, his maintenance engineer, and the division superintendents. This allowed the study team to be introduced to supervisory personnel in each district and to make arrangements for follow-up meetings with the affected superintendent and his foremen in the pilot areas. Insofar as possible, we also explained to the maintenance people involved the purpose of the study and the type of information we were seeking. We repeatedly emphasized that our studies were not intended to evaluate the performance of an individual but rather to establish, in writing, procedures by which an operation was carried out. Reasoning that the district staff at the higher level was very heavily involved with day-to-day problems, we then concentrated on the collection of data by studying our work at the section level and the group of analysts' contacts were with the superintendents and employees directly below them. In all cases, the districts were kept informed of the work in progress and were invited to attend all sessions.

For the initial studies, we selected three maintenance divisions we felt contained all classes of highways and all types of terrain. This was done to get the broadest possible sampling of the work methods with a minimum of travel for the team. The three divisions were Chehalis, in southwest Washington; Enumclaw, which includes the southern portion of the city of Seattle with a heavily urbanized area and also a mountain pass to the Cascades; Wenatchee, in central Washington, which includes much rural and farming territory; and the Yakima District Shop in central Washington, which has almost a complete range of highway equipment. Also, at the request of the district, we undertook a study of the Seattle signal division. We were greatly encouraged and became more sure of our success when we began to encounter such chance remarks in the field as [from a foreman], "at last I can go home and sleep tonight without worrying about what the crew is going to do tomorrow." [From a Division Superintendent], "Does

the Chehalis Division get to be first again?". There were many other indications of acceptance contained in overheard remarks, inquiries from others at higher staff levels concerning our studies, and requests for specific studies from the districts.

We felt one favorable condition existed when a review of the educational level of our employees indicated a surprisingly high average years of schooling. While we have 241 maintenance employees with no high school education, the average for maintenance employees, statewide, is 2.5 years. Also, among our maintenance employees, particularly at the supervisory level, we find many with some college training—106 of these people have a total combined college education of 655 years, for an average of 2 years beyond high school for this particular group. We found the same condition to exist among the other trades, that is, mechanical, electrical, warehouse, and equipment operation. These groups average very close to high school graduation. It is evident, also, that the lack of any high school education exists, in general, among the oldest employees. In a very few years' time, with their retirements, the average of the group will be much higher. There are as many high school graduates among the group hired since January 1962 as there are among all other employees. It is evident, then, that the increasing average level of education among our populace, combined with our civil service procedures, which have been in effect since that time, has resulted in the hiring of the type of employees who can be expected to understand and utilize modern planning methods.

In order to make use of the time standards developed, it was necessary that a set of standards be devised to specify the desired level of maintenance, this to assure that it is done uniformly, statewide, but it is also critical to the scheduling and budgeting purpose. For example, once it has been determined the units of mowing that can be accomplished by an employee with a given machine in a given time, it is necessary to establish the maintenance level for mowing. This department was fortunate enough to obtain an advance copy of maintenance standards developed by the Subcommittee of the AASHO Maintenance Committee, headed up by Darrell Vail, Maintenance Engineer of the State of Colorado Highway Department. These Standards were quite broad in order to be acceptable to all 50 states. It was necessary that we be more specific in many instances; however, we were guided by them and desired our standards to meet with their requirements. For example, these tentative standards specify that mowing on the Interstate highway shall be carried out 20 ft and maintained between a height of 3 and 12 in. As we establish the work that can be accomplished by an employee for the item specified then a determination of the number of mowings per year to maintain this condition and, of course, the total acres to be mowed are necessary.

The roadway maintenance engineer was charged with the responsibility of developing these quality standards. This work was started in July 1967 and completed in May 1968. They are currently being issued statewide as a guide to foremen and leadmen in establishing a uniform level of maintenance. These standards are currently regarded as tentative in nature and we expect that they will be modified somewhat after their application has been tested in the field. They are to be used also in the budgeting process and it follows that, if the funds available are less than indicated, the standards will have to be altered to reduce the level of maintenance. They were, in every instance, reviewed by the districts prior to implementation and acceptance was indicated. All major items of maintenance work have been covered.

One of the most difficult standards to express in writing is that involving the surface of the roadway, both traveled lanes and shoulders. We considered the use of the PSI rating and decided to apply a subjective method developed by our own research people some time ago for making a statewide condition survey.

It was also apparent then that a statewide inventory of the system was necessary in order to compile the total maintenance work load. This inventory was a critical part of the maintenance work improvement program and required such an expenditure of effort that it was completely beyond the capability of the team, which concluded that the best possible way to do this was to spread the work as widely as possible, therefore, the districts were requested to make this inventory, using our maintenance forces. Many of the data had been previously collected and existed in logs but retrieval called for so much clerical effort that it was easier to obtain directly in the field. Accurate, current sign logs were available. The man-hours involved in taking such an inventory

are considerable; however, many of the employees accomplished it while on patrol. A computer program has been designed to print out these and to provide for updating these through addition and deletion, as the highways change.

In conjunction with collecting methods data in making time studies, it was necessary to establish a job list. Initially, a tentative list of several thousand was established and it was obvious that this was unmanageable. By elimination then the list was reduced to those activities which occur repeatedly and/or have an appreciable impact upon the budget. At the present time, the team has identified 400 activities in the highway and signal maintenance area and 350 activities related to the maintenance of equipment. In man-hours, we estimate that we can cover 80 percent of the former by standards and 75 percent of the latter. The remainder can largely be attributed to down time or enforced idleness, flagging time and other maintenance activities. As of the first of June 1968, we have established 51 work standards for highway and signal work and 106 standards for equipment maintenance. We plan to expand this to cover 280 activities in highway and signal work and 310 activities involving equipment. It is estimated that we expended in excess of 6,000 man-hours developing, analyzing, and completing standards data. Although, originally, these studies were confined to the pilot areas, they have now been expanded statewide in order to obtain better coverage. Also, the assistant district maintenance engineers have completed their training and are now aiding in the collection of standards data. It is expected that this will be a continuing operation since new materials and new equipment will always be coming on the market.

The chart of accounts used by this department is patterned after AASHO's recommendations, although not in strict conformance. It became evident early in the study that an additional function would be required and we have, therefore, added "4600 - Maintenance - General Functions." While other activities may be charged to this function, it was necessary to the plan to cover enforced idleness. If an employee's nonproductive time, such as that brought about by equipment breakdowns, were charged to the activity he had been working on, a misleading figure for productivity would result and, in many instances, the employee (or work group) being reported on might be made to appear inefficient through circumstances entirely beyond his control.

It was apparent early in the study that the concept of work scheduling offered an opportunity for laying the groundwork for the overall program at an early stage, hence the team concentrated on developing a simple method by which the first line supervisor, either foreman or leadman, could easily and comprehensively schedule his work for the next day. To introduce the concept of scheduling, a simple daily scheduling form was developed and introduced to the pilot areas on September 12, 1967. Initially, three forms were developed—one for an informal daily maintenance schedule, an informal shop schedule, and, in the mountainous areas, a winter operation schedule. After some experience with the scheduling process, the winter operations schedule was abandoned as it was found that the informal daily schedule could be used for this purpose. After several months' experience in the various pilot areas, daily scheduling was established statewide in April 1968. Maintenance sections are now scheduling their work on a daily basis. Implementation of this required a concentrated effort from March 7 to April 3. To be sure that the daily schedule was aimed at accomplishing work that conformed to the basic objectives of the department, a monthly schedule was developed.

The maintenance control system anticipates that a yearly schedule will be established by the division superintendent and confirmed by the district. The schedule will eventually become the basis for a budget and the statewide maintenance program. We are, at the present time, preparing our budget for the ensuing biennium and have not, as yet, developed the system to where it can be used for this purpose; however, we will expect the division superintendents to prorate their allocations so as to stay within the funds available. While we are presently working on this part of the program, we anticipate it will be late this year before it can be installed.

The key to implementing the program statewide has been the extensive training program prepared and conducted in every division. This involved the preparation of three additional training manuals, as well as related exhibits and training aids. Approximately 3,200 man-hours were required for the training of district personnel. Approximately 3,500 man-hours were involved in district implementation and follow-up work

by the headquarters staff, bringing us to an approximate total of 6,700 man-hours for training purposes alone. This figure does not include hours spent by team members in informal contacts with foremen and superintendents, it not being feasible to keep a record of these many meetings.

Volume I of the Training Manual explains in simple terms how a work standard is developed. Volume II details in simple form the concept of the overall system. Volume III is essentially an elaboration of Volumes I and II and repeats in more detail many of the aspects previously discussed. The latter also emphasizes the practical application and daily usage of fundamentals covered in Volumes I and II.

While we now believe that the district personnel are advanced in training to the point that they can carry this work on and prepare their own schedules, we will continue frequent visits during the course of our statewide studies and will aid the districts directly later in the year in preparing the annual plan. We believe that this program is succeeding and has been accepted and feel that rapid implementation had much to do with this. In every instance, the division superintendents, foremen, and leadmen were personally contacted by team members within two weeks after the completion of the formal training. Generally, they were accompanied by the assistant district maintenance engineer and ample time was taken to discuss any problems generated. Headquarters assistance was provided in the preparation of daily schedules, monthly schedules, completion of the time cards, and all other phases of the program.

The study team found ample evidence that many of our employees have devised local variations in work methods, of considerable value to the department, which were not known statewide. To overcome this, we have developed a maintenance newsletter, which will be published bimonthly, and, although the initial material was furnished by the headquarters office, we expect shortly that the submission of ideas from the field will make this self-sustaining.

As an aid to the understanding of the development of the system, a "Log of Significant Events" follows:

1967	Event
June 6	Initial meeting of team members
June 14 - 27	Analyst training for team members
July 5	Program orientation for Chehalis personnel
July 6	Time studies began in Chehalis Division
July 24 - 31	Analyst training for additional team members
August 2	District 1 program orientation
August 3	District 2 and District 5 program orientation
August 7	Time studies began in Wenatchee Division
August 14	Consultants assigned an additional consultant to the Yakima Shop
August 15	Time studies began in Yakima Shop
August 22	Time studies began in the Seattle Signal Division
Setpember 12	Started daily scheduling in Chehalis Division
September 13	District 3 program orientation
September 18	Started daily scheduling in Enumclaw Division
September 22	Started daily scheduling in Seattle Signal Division
Setpember 25	Started daily scheduling in Wenatchee Division
September 26	District 6 program orientation
October 9	Started daily scheduling in Yakima Shop
October 24	Chehalis, Enumclaw, and Signal Division training session—"How Time Standards Are Established"
November 2	Wenatchee and Yakima training session—"How Time Standards are Established"
January 29 thru February 2	Began monthly scheduling and work unit reporting on time cards in pilot areas
February 12 - 23	Assistant maintenance engineers received analyst and maintenance control system training

February 26 - March 9	Conducted Volume I, "How Time Standards Are Established," training sessions in all districts
March 4 - 15	Conducted Volume II, "Maintenance Control System," training sessions in all districts
March 7 - April 3	Conducted initial statewide implementation. Topics included daily schedules, monthly schedules, and time card reporting. Two days allotted for each division and shop
April 1 - 12	Conducted Volume III, "How To Use Time Standards," training sessions in all districts
April 8	Districts began work unit inventory
April 16	Pilot area superintendents approved first group of final standards
May 9 - 27	Follow-up implementation statewide. Topics included: use of standards manual, new time card procedure, new job lists, and monthly scheduling. One day allotted to each division and shop
May 22	First volume of "Maintenance Newsletter" distributed
May 23 - 24	Maintenance engineer training session and progress report given in Yakima
June 1	Began reporting on new time card system.

The Appendix includes a discussion of informal shop scheduling and the work order used, an illustration of the scheduling box, and instruction sheet for completing daily work schedules for routine highway maintenance, a daily maintenance schedule, a minor job list, a procedure for completing a monthly work schedule, and a monthly work schedule—highway maintenance. Also included in the Appendix is a flow chart showing the "Sequence of Activities in the System Operation." It should be understood that local supervision is expected to override the schedule whenever conditions require it, this being a matter of personal judgment and initiative. Also, the minor job list is fill-in work, which does need to be done but not necessarily at any given time. It can be used to supplement when the days work runs short of the schedule or whenever changing conditions, such as unfavorable weather, make it necessary to temporarily suspend any schedule.

We believe that Figure 4 realistically illustrates the benefits which can be obtained from the program. Figure 5, for example, shows what standardizing should accomplish. Scheduling in advance the plannable work should improve our operations as shown in Figure 6. It is expected that our studies will aid the superintendents in pre-planning equipment and manpower requirements (Fig. 7).

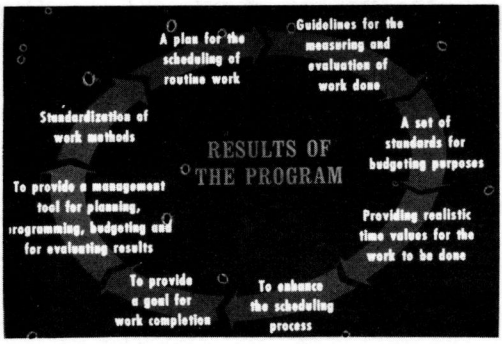


Figure 4.

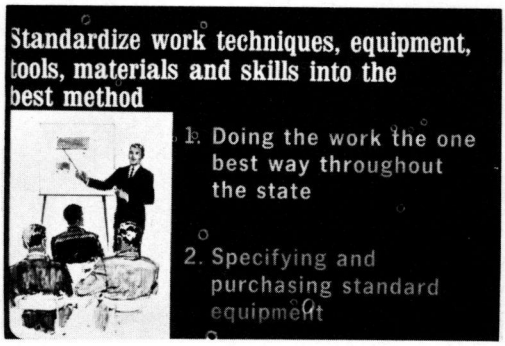


Figure 5.

Figure 6.

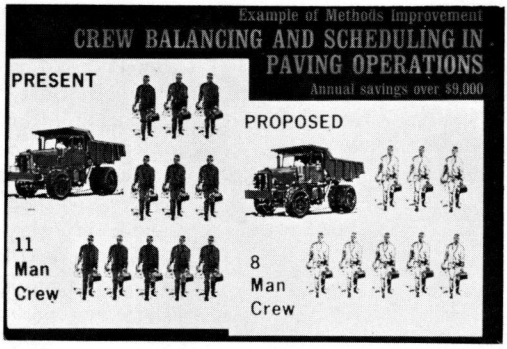


Figure 7.

To make daily reporting possible, each division office has been equipped with an IBM 1050, linked by leased telephone line to the computer section in headquarters. While the data are processed by the maintenance field clerk during the day, transmittal is by automatic call-up by night. This system went into effect on a trial basis in June, but since it was recognized that there will be many problems to be solved, it is being run in parallel with the previous system of hand-posting reported monthly. Assuming that all equipment is on line and that the trial program is successful, it is expected that full implementation will take place in July or August of this year. This will be expanded so that, in addition to the daily labor report, usage for all equipment will be reported daily, by equipment number, as well as all major items of stores. It is planned, in the not too distant future, to expand this further to include a running stores inventory, kept current daily, and also an inventory of parts for all vehicles and equipment. Because of the purchasing procedure we follow, there is a tendency to overstock supplies and parts, with a resultant loss to stores of material being kept beyond its shelf life or the parts remaining in stock after a particular make and model of car has been sold. We believe that through close observation of these inventories in Headquarters, we can develop an interdistrict exchange of surplus items.

In conclusion, the system has been developed and installed, general acceptance among our employees statewide is excellent, and we are very optimistic for the future. No one should undertake such a project lightly. There is a tremendous amount of work required to see such a program through to a successful conclusion, once it has been initiated, At the risk of overemphasis, I would like to repeat at this point the extreme importance of taking the program to the people and getting the maintenance employees directly involved. Stimulate their interest by soliciting help and practice good salesmanship to win their support. This is absolutely necessary to avoid the resistance that is all too often encountered when new programs are undertaken to displace long established habits.

Appendix

INSTRUCTION SHEET FOR COMPLETING DAILY WORK SCHEDULES FOR ROUTINE HIGHWAY MAINTENANCE

Highway Maintenance

There are three types of daily schedules for highway maintenance operations.

a. Daily Work Schedule for Highway Maintenance
b. Highway Maintenance Minor Job List
c. Daily Work Schedule for Highway Maintenance Winter Operations

Daily Work Schedule for Highway Maintenance

The Daily Work Schedule for Highway Maintenance will be the Predominant or typical Schedule for Highway Maintenance. The Daily Work Schedule is developed to insure that all personnel in the Maintenance Section are scheduled to a job, that each job is part of a yearly plan, and that realistic thought and preparation have been given to each assignment to assure proper balance of men, equipment and material.

The Schedule form will be completed as follows:

a. From Monthly Work Schedule for Highway Maintenance determine jobs to be accomplished for the day in question and mark on the Daily Work Schedule for Highway Maintenance. The Daily Work Schedule will be prepared the day before the work accomplishment day.
b. Identify specific location where job is to be accomplished.
c. Assign men by name who are to accomplish each job.
d. Assign equipment to each job by equipment number.
e. Specify material required by type and amount.
f. Complete accomplishment expected column through review of Monthly Work Schedule-Highway Maintenance and Time Standards Manual.
g. Add additional comments on possible changes or problems.
h. Post one copy of Daily Work Schedule for employee information and guidance. The foreman keeps a second copy with him at all times to serve as a guide and ready reference point.

Highway Maintenance Minor Job List

The Highway Maintenance Minor Job List supplements the Daily Work Schedule for Highway Maintenance. It is a list of minor jobs that have been identified for accomplishment on a fill-in or substitute basis to round out the Daily Work Schedule. It is in effect a "running list" having jobs added or subtracted on a daily basis. The types of jobs that will appear on the Highway Maintenance Minor Job List will be generated from sources such as:

a. Work requirements reported by men from section patrol.
b. Reports of minor roadway damage-sign knockdown and guardrail damage.
c. Work needed to be accomplished, but which can be accomplished any time as fill-in work.
d. Request for assistance from other areas such as construction.

The jobs as listed on the Highway Maintenance Minor Job List will be transferred to the Daily Work Schedule for Highway Maintenance as time is available each day. Consequently, the Highway Maintenance Minor Job List is prepared in exactly the same format as the Daily Work Schedule for Highway Maintenance.

INFORMAL SHOP SCHEDULING/WORK ASSIGNMENT

To insure complete service records and effective utilization of all shop personnel, the basic procedure for shop work assignment and accomplishment will be as follows:

1. The foreman receives all incoming work requests.

MAINTENANCE SCHEDULING

Foreman _____ Month _____ Day _____

Type of Job	Specific Location	Name of Men Assigned	Equipment	Materials	Accomplishment Expected	Comments

HIGHWAY MAINTENANCE MINOR JOB LIST

Foreman _____ Month _____ Day _____

Specific Job	Specific Location: Control Section Route and Mile Post	Name of Men Assigned	Equipment, (vehicle number)	Materials, Type and Amount	Accomplishment Expected	Comments

2. The foreman initiates Garage Service Order in triplicate (see attachment No. 1) highlighting the following:
   a. Basic work to be performed (specific jobs when possible)
   b. Approximate hours for work accomplishment
   c. Employee/s assigned
3. The foreman keeps the original copy of the Garage Service Order and places copies 2 and 3 in the scheduling box (see attachment No. 2) marked "work to be completed" next to the name of the employee assigned.
4. The employee removes the Garage Service Order forms from the scheduling box, places the second copy in the scheduling box marked "work in process," takes the third copy to the equipment and performs the assigned work.

Several Alternatives can Occur at this Point

Work is completed as originally identified on Garage Service Order

a. Employee writes on third copy of Garage Service Order
   - work completed
   - total hours used for each job listed
   - materials used
b. Employee signs third copy and places second and third copies in schedule box marked "work completed."

Additional work or specific work requirements are identified

a. Employee obtains foreman approval by getting foreman to give verbal work requirements on third copy of Garage Service Order.
b. Employee performs work and writes on third copy of Garage Service Order
   - work completed
   - total hours used for each job listed
   - materials used
c. Employee signs third copy and places second and third copies in schedule box marked "work completed."

Material not available

a. Employee places second copy of Garage Service Order in scheduling box marked "await parts" after writing on third copy of Garage Service Order which remains with equipment.
   - work completed
   - hours used for each job listed
   - materials used
b. When again working on equipment, the employee places second copy of Garage Service Order in scheduling box marked "work in process".
c. Employee performs work and writes on third copy of Garage Service Order.
   - work completed
   - total hours used for each job listed
   - materials used
d. Employee signs third copy and places second and third copies in schedule box marked "work completed."

5. The employee will attempt to accomplish jobs in the order available in his scheduling boxes. Garage Service Order on top of each pile in box is most important work.
6. The foreman in determining work assignments will consider all jobs that he has to do and how best he should split up his team.
7. Some work requirements may involve more than one employee or individual employees in sequence.

Several men working simultaneously on one piece of equipment

a. The foreman will complete one set of Garage Service Order forms containing the names of the assigned employees and place them in the schedule box marked "work to be completed" of the first of the several men (assigned mechanic or main mechanic) he expects to be free to work on the work assignment.
b. Assigned mechanic (main mechanic) writes on the third copy of Garage Service Order (without duplicating information written by other employee).
    - work completed
    - total hours used for each job completed
    - materials used
c. Assigned mechanic (main mechanic) signs third copy and places second and third copies in schedule box marked "work completed". If minor additional tasks such as welding are required and these tasks involve additional personnel, the assigned mechanic obtains approval from the foreman prior to work performance.

Several men working simultaneously (apart-different jobs) on one piece of equipment (major jobs)

a. The foreman will complete a set of Garage Service Order forms for each individual.

Several men work in sequence on one piece of equipment

a The foreman will complete one set of Garage Service Order forms containing the names of the assigned employees in sequence.
b. The foreman will place the second and third copies in the schedule box of the assigned employee in the order required as each assignment in turn is due for accomplishment.

8. Department of Highways personnel will be available to help the foreman get started in this routine.
9. This informal shop scheduling/workload assignment will eventually be expanded to include time standards, standardized job lists, work units, reporting and effectiveness analysis.
10. This informal and limited shop scheduling/workload assignment is therefore a basic starting point in a much larger and more formal maintenance work improvement program. In this regard, the foreman is a most important individual, for his skills determine much of what is to follow.

Attachments
Garage Service Order
Layout of scheduling box

PROCEDURES FOR COMPLETING A MONTHLY WORK SCHEDULE-HIGHWAY MAINTENANCE

COLUMN ON MONTHLY WORK SCHEDULE-HIGHWAY MAINTENANCE	ACTION
Column 1 - Major Job Categories Listed in Order of Importance	Foreman reviews the Yearly Planning Schedule for his Maintenance Section to identify Major Job Categories that have been scheduled for accomplishment by the Superintendent. Foreman marks in Column 1 of the Monthly Work Schedule-Highway Maintenance the first Major Job Category scheduled for the month.

WASHINGTON STATE HIGHWAY COMMISSION
DEPARTMENT OF HIGHWAYS

SHOP SERVICE ORDER

WORK ORDER NO _____

EQUIPMENT NO. _____

MILEAGE _____

DEPARTMENT _____

DATE RECEIVED _____

DATE WANTED _____

DATE FINISHED _____

MECHANIC _____

PARTS & MATERIALS	QUANTITY	UNIT PRICE	TOTAL
		TOTAL	

STD NO	OPERATION DESCRIPTION	TIME HOURS	TIME STD
	TOTAL		

SUMMARY OF COST

Parts Total $ _____

Labor Total $ _____

TOTAL CHARGE $ _____

SHOP SCHEDULING/WORKLOAD ASSIGNMENT				
EMPLOYEE	WORK TO BE COMPLETED	WORK IN PROCESS	AWAIT PARTS	WORK COMPLETED

SCHEDULING BOX EXAMPLE

Column 2 - Control Section	Foreman reviews the Planning Sheet for his Maintenance Section to identify Control Sections that have been scheduled for the maintenance work. Foreman marks in Column 2 of the Monthly Work Schedule-Highway Maintenance those Control Sections that should be worked on so the units associated with these Control Sections approximate the units on the Yearly Planning Schedule for the month.
Column 3 - Specific Job Name and Number	Foreman determines conditions in the Control Section that have been scheduled for work and reviews Job List-Highway Maintenance and Minor Job List to determine specific type of jobs to be accomplished. Foreman marks in Column 3 of the Monthly Work Schedule-Highway Maintenance the Job Name and Number of the Specific Job to be accomplished.
Column 4 - Units (Amount of Work to be Done per Month per Job)	Foreman reviews the Yearly Planning Schedule for his Maintenance Section to identify units per Major Job Category that have been scheduled for accomplishment by the Superintendent. Foreman also reviews the Minor Job List to identify additional units that may have to be accomplished. Foreman marks in Column 4 of the Monthly Work Schedule-Highway Maintenance the units to be accomplished per specific job.
Column 5 - Standard Time per unit per Job (clock hours)	Foreman reviews the Maintenance Standard sheet for the Specific Job identified in Column 3 to determine the Standard Time per Unit. This is the clock hours (elapsed time), without regard to the crew size, that are required for completing one unit. (Travel time to and from work site is not included, however travel time that is involved in unit accomplishment, such as trips to hot mix plant, is included.) Foreman marks in Column 5 of the Monthly Work Schedule-Highway Maintenance the Standard Time per Unit per Job.
Column 6 - Standard Time Required Per Job (Column 4 x Column 5.)	Foreman calculates the Standard Time Required for Specific Job by multiplying the Units in Column 4 per Specific Job times the Standard Time per Unit per Specific Job in Column 5. This gives the clock hours (elapsed time) without regard to the crew size, that are required for completing all units scheduled for the Specific Job. (Travel time to and from work site is not included, however, travel time that is involved in Job Accomplish-

	ment, such as trips to hot mix plant, is included). Foreman marks in Column 6 of the Monthly Work Schedule-Highway Maintenance the Standard Time Required per job.
Column 7 - Crew Size per Job	Foreman reviews the Maintenance Standard sheet for the Specific Job identified in Column 3 to determine the Crew Size per job. This is the number of men, not counting flagmen, that are required for job accomplishment. Foreman marks in Column 7 of the Monthly Work Schedule-Highway Maintenance the Crew Size per Specific Job.
Column 8 - Total Standard Time Required per Job Including Travel (Column 6 x 115%)	Foreman calculates the Total Standard Time Required per Job Including Travel by multiplying the Standard Time per Job in Column 6 times a Travel Allowance Factor of 115%. This means that the clock hours (elapsed time) for job accomplishment is increased by 115% to reflect the normal (average) travel time associated with most jobs. (As more data become available and foremen become more familiar with the scheduling, the 15% travel allowance average may be replaced by a more specific travel allowance per type job). Foreman marks in Column 8 of the Monthly Work Schedule-Highway Maintenance the Total Standard Time per Job Including Travel.
Column 9 - Number of Flagmen Per Job	Foreman reviews the Flagging (safety) Manual for the Specific Job identified in Column 3 to determine the recommended Number of Flagmen. Flagging requirements will vary depending upon circumstances, consequently the recommendations for flagging are approximate. Foreman marks in Column 9 of the Monthly Work Schedule-Highway Maintenance the Number of Flagmen per Specific Job.
Column 10 - Total Number Men Required Per Job (column 7 + column 9)	Foreman calculates the Total Number Men required for Specific Job by adding Crew Size per Job and Number of Flagmen per Job. Foreman marks in column 10 of Monthly Work Schedule-Highway Maintenance the Total Number Men Required per Specific Job.
Column 11 - Number of Days Required per Job (Column 8÷8 Hours per day)	Foreman calculates the Number of Days Required Per Specific Job by dividing the Total Standard Time Required Per Job including travel by 8 hours per day. This determines the number of full days that are required for job accomplishment. Foreman marks in Column 11 of Monthly Work Schedule-Highway Maintenance the Number of Days Required per Job.

Foreman repeats the procedure associated with Column 1 through Column 11 until the Man Days Required Per Month approximates the Man Days Available per Month. This will mean that the work requirements for the month will have been firmed up and in line with availability of men. Even though the schedule will be "firmed up" the Foreman must regard it as being flexible—additional jobs may be added or substituted based upon circumstances.

COLUMN ON MONTHLY WORK SCHEDULE-HIGHWAY MAINTENANCE	ACTION
Man Days Required per Month (The sum of Column 10 x Column 11 for each specific job).	Foreman multiplies for each Specific Job the Total Number Men Required Per Job times the Number of Days Required per Job to obtain man days per job. The man days for all specific jobs are added to obtain the Man Days Required per Month. Foreman marks this figure on sub-total line called Man Days Required Per Month.
Man Days Available Per Month (Work Days Per Month x Average Number of Men at Work).	Foreman multiplies the number of work days per month times the average number of men expected to be at work per day to obtain Man Days Available per Month. This indicates the number of man days of work that could be performed. (This figure will approximate the Man Days Required Per Month). Foreman marks this figure on sub-total line called Man Days Available Per Month.
Days on Which Jobs will be Accomplished	Foreman decides on time period (Days of the Month) when Specific Job will be accomplished by analyzing for each job. - Number of men required - Number of days required - Number of men available - Priority of job - Anticipated weather and problems Foreman marks on days of the month the number of men required and portion of day required in half day increments (per job). Foreman continues process—sometimes through trial and error—until all jobs are scheduled and men required per day approximate men available per day.

NOTE: The scheduling procedures per area involved may differ somewhat in detail depending upon varying conditions such as:

- Foreman may have more than one shift
  - may have schedule per shift
  - may put all on one schedule
- Foreman may have to plan on crew availability for winter operations (stand-by or patrol).

In any case, the objective is to plan work requirements for the month considering:

- Yearly plans
- Men available

so that both are maximized

- Yearly plans are accomplished
- Men are utilized doing required work

The information sources and procedures associated with the Monthly Work Schedule-Equipment Maintenance are similar to those for the Monthly Work Schedule-Highway Maintenance. The basic differences are:

- Control Section is replaced by Equipment Number as means for identifying work location.
- Travel Time Allowances and Flagging need not be considered.

In addition, unique schedules may be generated for specialized operations. Following are examples of:

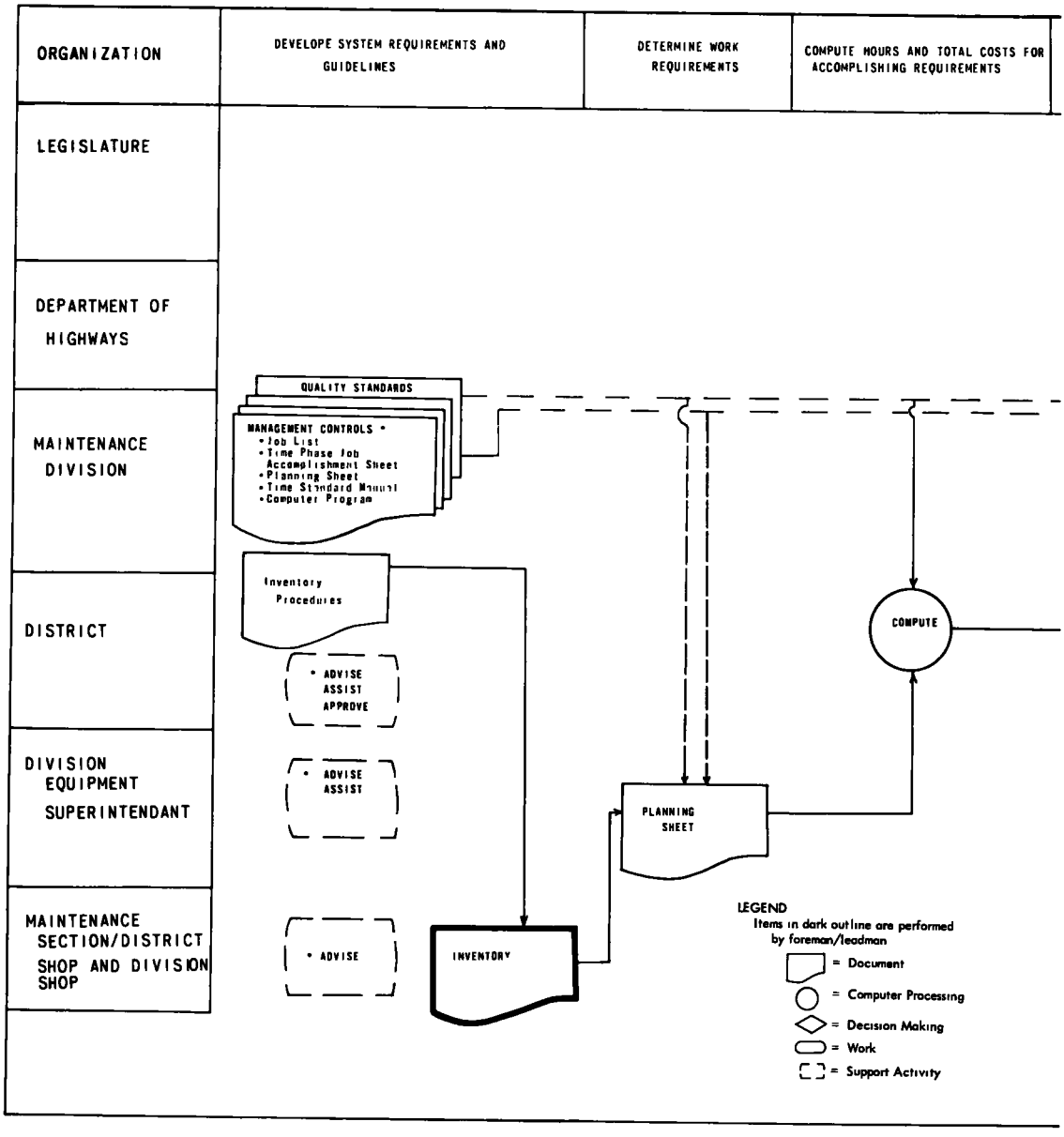
- Monthly Work Schedule-Equipment Maintenance
- Signal Work Schedule and Record

MONTHLY WORK SCHEDULE - HIGHWAY MAINTENANCE

MAINTENANCE SECTION____ MONTH____ YEAR____

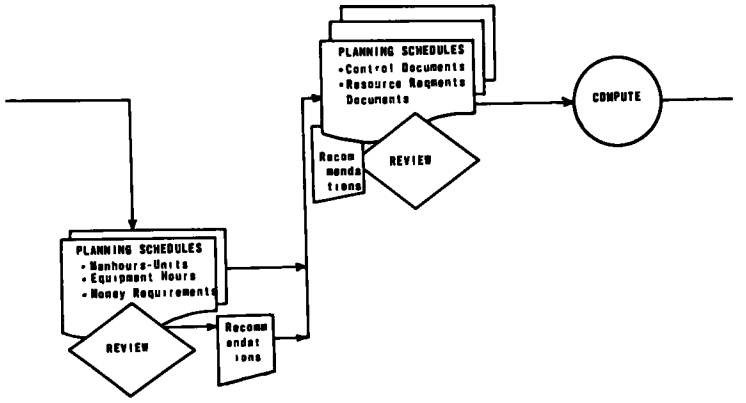
1	2	3	4	5	6	7	8	9	10	11	Days on which jobs will be Accomplished																							
Major Job Categories Listed in Order of Importce.	Control Section	Specific Job Name and Number	Units (amt. of work to be done pr month per job)	Std. time per unit (clock hours)	Std. Time Req. per job (Col. 4 x Col. 5)	Crew Size Per Job	Tot. Std. time req. per job incl. travel (col 6x115%)	No. of Flagmen per job	Tot. No. men req. per job (column 7 + column 9)	No. of days req. per job (column 8÷8 hrs./day	1	2	3																		29	30	31
MAN DAYS REQUIRED PER MONTH (The sum of Column 10 x Column 11 for each specific job)																																		
MAN DAYS AVAILABLE PER MONTH (Work days per month x average number men at work)																																		

SEQUENCE OF ACTIVITIES IN SYSTEM OPERATION

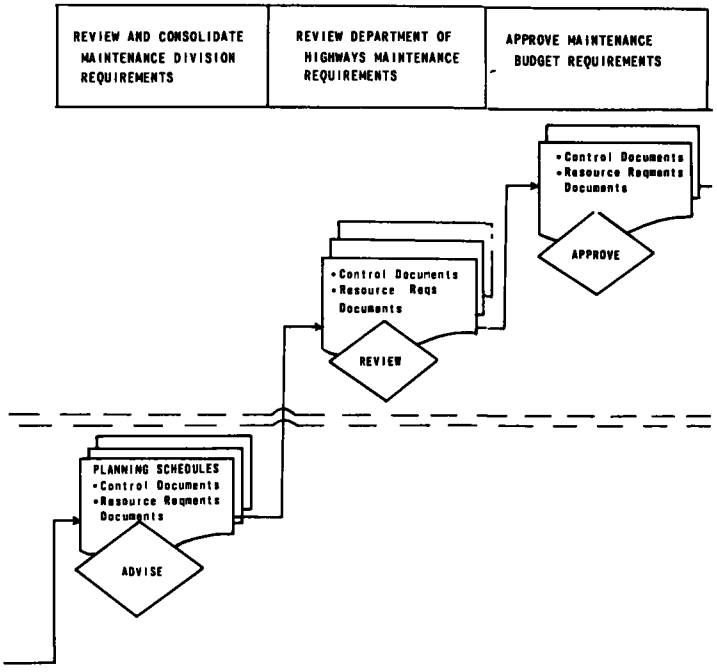


SEQUENCE (Continued)

REVIEW REQUIREMENTS AS COMPUTED AND MADE RECOMMENDATIONS	REVIEW AND CONSOLIDATE DISTRICT REQUIREMENTS	COMPUTE HOURS AND TOTAL COSTS FOR ACCOMPLISHING DISTRICT REQUIREMENTS

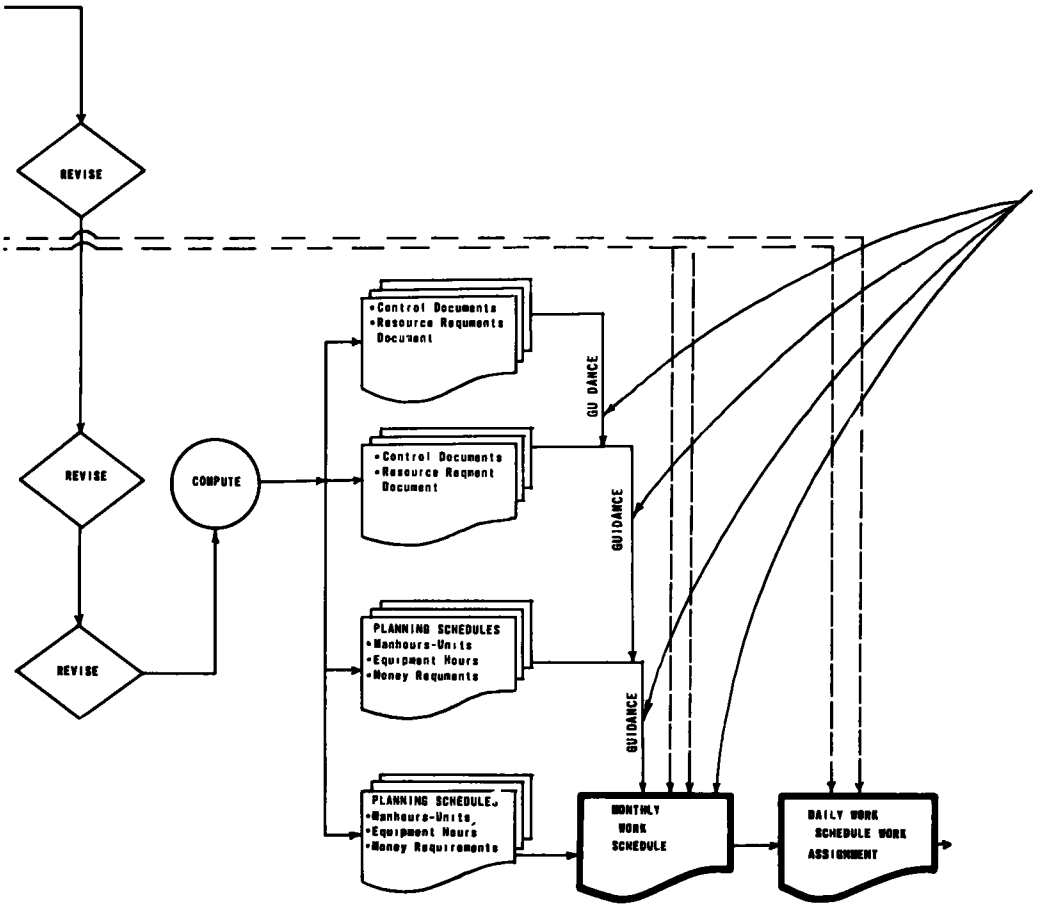


SEQUENCE (Continued)



SEQUENCE (Continued)

INCORPORATE LEGISLATIVE MODIFICATIONS INTO PLANS AND COMPUTE MODIFIED REQUIREMENTS	DEVELOPE MONTHLY WORK SCHEDULE	DEVELOPE DAILY WORK SCHEDULE/ WORK ASSIGNMENT



SEQUENCE (Continued)

ACCOMPLISH WORK	REPORT ACCOMPLISHMENT AND COMPUTE PROGRESS	EVALUATE REPORTS AND TAKE REQUIRED ACTION