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FOREWORD

This RECORD consists of four reports that concern various aspects of manpower management. Because many state transportation agencies are realizing the complexity involved in managing multiproject programs and manpower, they will more than likely turn toward systems management techniques to program manpower. These reports are intended for those involved in manpower management.

The paper by Oien and Jonas discusses the critical path method (CPM) for management as used in the design of engineering projects and examines the computer program used by the Seattle Engineering Department as part of the CPM approach. The input to the computer includes an estimate of time and manpower requirements for each activity of each project, the logical sequence of work activities for each project, the relative importance or priority of each project, and the total manpower available to accomplish project design.

Miller and Barrett address some issues surrounding systems management techniques, and the paper is based on the authors' experience with the Florida Department of Transportation's multiproject scheduling system and on interviews with many system users. Several behavioral and systems management policies are identified and analyzed in light of emerging management theory. Remedial actions and policies are suggested where management information system deficiencies are evident.

The paper by Wilcox briefly reviews some behavioral science findings on the motivation of employees and describes a system for employee development. Three basic activities of the development system are discussed: delegation of authority, opportunity to perform, and evaluation. They are further divided into steps for accomplishing each activity. The paper also contains a review of the use of the system by the Wisconsin Department of Transportation.

Verheyen contends that today's most critical management problem is change. He asserts that total reliance on systems can prove detrimental and that the manager must focus on the human side of management. He further contends that behavioral science can provide a valid explanation of motivation and productivity, for it is concerned with production and with the individual rather than systems.

CPM-BASED SYSTEM FOR SCHEDULING AND ALLOCATING RESOURCES TO PROJECT DESIGN

Eric S. Oien and Douglas L. Jonas, Seattle Engineering Department

As part of the system for managing the design of engineering projects, the Seattle Engineering Department uses a computer program based on the critical path method. This system, when used with the other parts of the larger project management system, provides a means of controlling a $250 million, 10-year capital improvement program that results in at least $20 million of construction each year. The input to the computer includes the estimate of time and manpower requirements for each project, the logical sequence of work activities for each project, the relative importance or priority of each project, and the total manpower available to accomplish the design of projects. The computer is programmed to calculate a critical path for all projects and to schedule and allocate resources for each project activity, based on priorities and available manpower. The output from the computer includes a critical path for all the projects, a master schedule for all the projects, an individual schedule for each project, reports showing the utilization of each type of manpower, graphs of the manpower utilization, and a time-scaled arrow diagram for each project.

•AN ENGINEERING MANAGER must meet his organization's goals and objectives through the most efficient use of available resources. Allocating resources efficiently with respect for priorities is difficult. Historically, managers have used a combination of experience, charts, and "calculated guesswork" to plan and schedule their work. The critical path method (CPM) offers the manager an additional tool to accomplish his job. A CPM system uses a manager's experience and provides a multiproject schedule that efficiently guides allocation of resources.

In 1963, the Seattle Engineering Department began using a computer to assist CPM scheduling of projects and allocation of resources to preconstruction activities. Since that time the program has been modified and improved. Today it is an important, dynamic management tool. The objectives of the Seattle Engineering Department in using the CPM process are to

1. Obtain maximum utility from available manpower resources,
2. Provide line managers with a tool for planning day-to-day activities,
3. Provide a rational basis for making decisions on projects in progress, and
4. Facilitate long-range planning for the use of resources.

The computer is programmed to calculate a critical path for a whole network containing all projects and to schedule and allocate resources for each project activity considering priority and available manpower.

When scheduling is complete, the computer prints several reports: a critical path report for the entire network of projects; a manpower scheduling report that shows the start or finish of every activity on any work day; a complete schedule on a project-by-project basis; a schedule by craft rather than by project that shows the start of each activity for each craft by workday; and the craft usage graph, which shows the manpower utilization day-by-day for the first 240 working days in the schedule. The computer also generates a time-scaled arrow diagram for each project. All these reports can be used by several levels of management for both long- and short-range decision-making.

Seattle's experience shows that successful application of this system requires that key people in the organization be prepared to accept and use it. In 1963 the program was used on selected individual projects. It required that a CPM specialist work closely with the project manager in each case. Successful multiproject scheduling and resource allocating occurred after management, line supervisors, and project engineers were trained in the process and accepted the objectives of preplanned work flow and openly adopted project milestones. Teaching the technical process has been relatively easy. Gaining acceptance of a change from a process in which project accomplishment was haphazard and unplanned to a carefully planned, performance-oriented approach has been more difficult.

As with any significant management change, support by top-level management has proved essential. Top management need not know all the step-by-step mechanical details but must understand and agree with the concept and objectives of the system and demonstrate management support of the system by using the reports to assist decision-making. Line supervisors have had to realize that a computer program can and does allocate resources and schedule projects by using the same logic they use. It took some experience with the system for many supervisors to realize that the computer was not making design or management decisions for them and that it was in fact a valuable aid in giving them management information and lead time for making decisions. Some sections of the department are more successful in using the system than others. In general, success can be traced to the level of commitment of the supervisor to work planning and results.

The third critical group is project engineers, the managers of individual projects. They must be able to plan their projects in a CPM format. They must be able to identify the activities to be done, to estimate the time and manpower required for each activity, and to arrange the activities in a logical sequence such as an arrow diagram. In Seattle, a 4-hour in-house course in CPM basics was developed and presented to project engineers and their supervisors. Interested top management persons also attended the class.

With these three groups prepared, there is still a need for someone to have an intimate knowledge of the entire scheduling and resource allocating system. In the Seattle Engineering Department, that person is assisted by three others and performs the following duties: (a) advises project engineers and supervisors on system or CPM questions, (b) provides analysis of the output reports, (c) makes recommendations to management based on these analyses, and (d) updates and processes schedule runs on a quarterly basis.

SCHEDULING PROJECTS AND ALLOCATING RESOURCES

Figure 1 shows the CPM process that the Seattle Engineering Department uses to allocate resources for the 130 or more projects in process at one time. A step-by-step explanation follows.

Step 1—Project Planning

One of the great advantages of CPM is that planning for how a job will be done is separated from scheduling when the job will be done. In the first step, the engineer responsible for a project develops an arrow diagram for a logical sequence of work.

Every function that will be complete prior to construction of the project is reduced to detailed work units called activities. Typically, these include numerous reconnaissance and design functions, gathering of soils and survey information, right-of-way and easement acquisition, procurement of construction financing, holding of hearings and public meetings, obtaining necessary approvals, and advertising and awarding a construction contract.

Best results are obtained when activities are small rather than large and all-inclusive. For example, one lengthy activity to cover drawing, checking, and revising base plans would be better represented by three or more activities, shorter in duration, covering the same duties.

Once activities have been defined, the project engineer then specifies the necessary activity sequence. He usually shows the sequence of activities in the form of an arrow diagram. Upon seeing his project as an arrow diagram, he may wish to change some of his original assumptions regarding the number of activities or order of occurrence.

The project engineer then estimates the time and manpower required to complete each activity. The manpower required is specified by craft, i.e., engineers, draftsmen, survey crews, and by the units in each craft (the number of persons of each type to be utilized). The duration estimate for each activity is in workdays. In making his estimate of time required, the engineer takes into account historical data on the productivity of his personnel, sick leaves, and vacation time. His time estimate is then long enough to absorb nonproductive time. This time estimate information should be added to the arrow diagram.

Step 1 applies mostly to projects not previously scheduled. For projects that have been included previously, the project engineer might only review the arrow diagram, remove activities that have been completed, and make revisions to activities that remain. In any case, every project that will be included in the scheduling run is reviewed by the engineer.

Step 2—Create the Activity File

In step 2, node numbers are assigned to the nodes on the arrow diagrams, and all the information from the arrow diagrams (node numbers, activity name, and time and manpower requirements) is coded in a required format and compiled into a data file, called the activity file, for the computer run.

This file presents one of the restraints on the magnitude of the scheduling and resource allocating system. The number of activities in the file is limited by the available node numbers. Nodes may be numbered from 1 to 4,000. The computer identifies activities by their respective beginning and ending nodes (I and J nodes), and each activity must be uniquely defined. Additionally, the numbering of nodes must be such that all the projects are tied together in one master arrow diagram network, and there must be only one entrance and one exit for this network. In the experience of the Seattle Engineering Department, these limitations place the maximum number of projects that could be included in the file at approximately 150 to 160 projects. The concept is not limited, only the particular process now used. Earlier in its development, the system was limited to 1,700 activities; it was increased and could be again if necessary.

When all the activities have been entered into the data file, the file is sorted into proper order and is then ready for input to the CPM program.

Step 3—Create the Control File

A control file must be created before the program is run. This file contains the information necessary to support the scheduling and allocation of resources and to produce the reports. The file consists of five separate parts, which

1. Specify which reports are to be printed;
2. Delineate the total resources available to accomplish the projects;
3. Specify the calendar date on which the reports will start, the name of the report such as departmental schedule, and a heading date to appear on each page of the reports;
4. Are actually a 5-year calendar, the inputs of which include the starting year of the calendar, the number of working days per week, abbreviations for the months, and a matrix that establishes the actual working days, i.e., designating the nonworking weekends and holidays; and
5. Specify which crafts will be grouped together in the craft report in order to provide a unique listing for each section head and give the title for each grouping.

Step 4—Add Priority Data to the Projects

The program for scheduling and allocating resources is set up in six phases. To add priority data to the projects requires that an initial run of the program through its first and second phases be made.

The first phase of the program tells the computer which data and control files to use and how much core storage will be required and generally sets the stage for the rest of the run. This phase also checks for data errors. If errors are found, they are listed and the program aborts.

The second phase analyzes the multiproject network in the activity file as if it were one large project and finds the early and late start, early and late finish, and the total float for each activity. At the directive of the operator, a listing of this information for the last activity in each project is obtained. The critical path duration of each project can be found by listing all the last activities.

Priority data are added to a project by altering the total float on the critical path. Normally, the total float along the critical path is always zero. However, when all projects are in one network, float on a project's critical path will be inversely proportionate to the duration of the project. Therefore, the critical path of only the longest project in the network will have the zero float.

Figure 2 shows this condition. The solid lines represent the critical path durations of projects A, B, C, and D (the noncritical activities are not shown), and the dashed lines represent float time.

It is seen then that only project C, the longest project, has zero float along its critical path. The critical paths of shorter projects in this network have float.

The engineering department management, through a priority committee, assigns a relative priority to the projects. The priority of a project is shown in the program by making the total float along the critical path the same as the priority number. This is done by adding an activity at the end of the project, called the completion restraint, so that the highest priority project has the longest duration. This activity has a duration, but it requires no manpower.

Figure 3 shows how this works. CR represents the duration of the completion restraint.

For convenience in later use of the output, the priority number is also added to the name of the completion restraint activity. Therefore, the activity name, Completion Restraint 12, indicates the project with a priority of 12.

The program is stopped at the end of the second phase. The durations of the completion restraints are calculated and added to the activities in the activity files. These completion restraints play an important part in the remaining phases of the program, which are now ready to be run.

Step 5—Schedule Projects and Allocate Resources

The program is started again at phase one because it is not possible to restart the program at any other point. Calculations using the new data are made in phase two.

Phase three is the resource allocating or manpower scheduling phase. It uses the critical path analysis from phase two to allocate resources and schedule activities according to the following rules:

1. Start an activity on its earliest start time.
2. Start critical activities, identified by least float, first. If two activities are equally critical, start the one with shorter duration first (the theory being that a longer activity has a better chance than a shorter one of making up "lost time"). If the craft called for is unavailable, use an alternate if one is specified. Stop a noncritical activity that is in progress to start a critical activity (the most recently started activity is the first one stopped).
3. Start noncritical activities.
4. Delay starting activities if resources are unavailable. If more than 400 activities, ready to start, are waiting at one time, the program will abort.

This process can be likened to a manual process in which there is a listing of activities, sorted in order of their early start, that are examined day by day.

On the first day only the activities that have an early start on day 1 are considered. Activities are scheduled by allocating resources to activities having highest priority (least float) first. When either all the activities that can start that day have been scheduled or the available manpower has been completely utilized, scheduling for the first

Figure 1. CPM process used for scheduling and resource allocation.

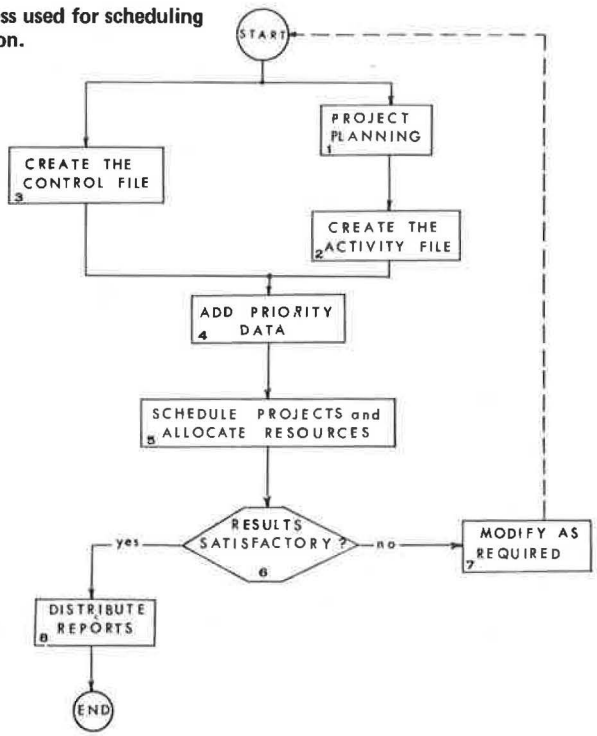


Figure 2. Float time as related to duration of project.

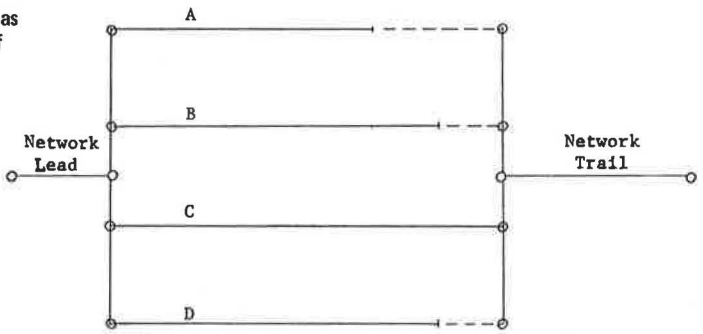
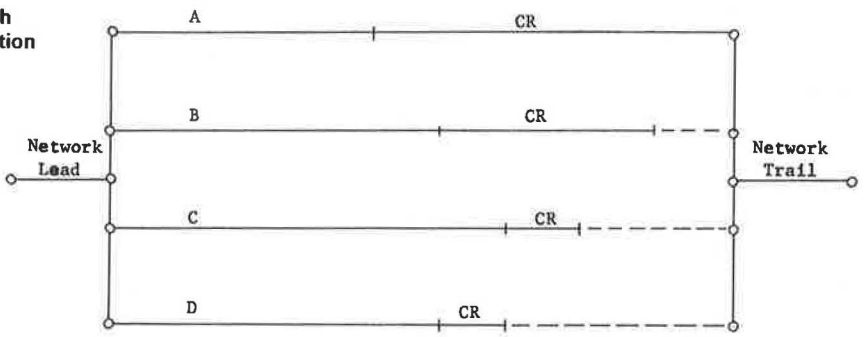


Figure 3. Critical path duration plus completion restraint.



Project A has first priority; B, second priority; C, third priority; and D, fourth priority.

day is complete. Activities that were not started are placed in a waiting table. These activities lose a day of float (and thereby become more critical) for each day they remain in the waiting table. On the second and succeeding days, the activities that will finish on that day are first located, and the manpower is returned to the pool. Next, the activities that have an early start of that day, together with the activities in the waiting table, are considered for scheduling. After the first day, if the required manpower is unavailable, the activities already in progress are examined to see whether a low-priority activity can be interrupted to utilize the manpower on a high-priority activity. When the list of activities has been completely reviewed, scheduling is complete.

The decision rules ensure that work will be done as soon as possible. They also place any float after an activity where it can be used in case the time required has been underestimated. And, because activities are started in order of their priority, resources are allocated according to the priority of the managers.

When all the activities have been scheduled, phase three is over. The remaining three phases sort the information from phases two and three and set up the files necessary to produce the reports.

Steps 6 and 7—Examine Results for Acceptability and Modify as Necessary

The results are examined by department management to determine their acceptability before any information from the program run is distributed. Basically, this is to accept or reject the projected occurrence of important project milestones. If the important dates for one or two projects are unacceptable, it may be possible to manually adjust and reschedule these projects. If, however, the dates for many projects are unacceptable, changes in the activity or control file or both are made, and the program is rerun.

Step 8—Distribute Reports

The following reports can be produced by the program: critical path report, manpower schedule, project report (item report), craft report, craft usage graph, and time-scaled arrow diagram (for each project, as scheduled). These reports make up the departmental schedule.

The critical path report (Fig. 4) is a listing of the network analysis. All the activities are listed in order of their total float. This information is useful in analyzing the allocation of resources and estimating what would happen if there were no resource constraint.

The manpower schedule (Fig. 5) is a listing of the resource allocation. This report includes all activities in the network, listed chronologically in order of workday, and tells the reader which activities are started, interrupted (delayed), and finished on each workday. This report is, in effect, a master schedule. By comparing the total float of an activity shown in the manpower schedule report with the total float shown in the critical path for the same activity, we can find how much later than the earliest possible start the activity was actually scheduled.

The project report (Fig. 6) is a sorting of the manpower scheduling information by project. All the activities in one project appear together, listed chronologically. One column of this report shows the date an activity starts or is delayed; another column shows the total float of an activity at the time it was scheduled. This report is the most useful to the project engineer in planning his day-to-day work.

Information is sorted by craft number as directed by the control file in the craft report (Fig. 7). Usually all the crafts from one work section are grouped together chronologically. The craft report shows the manager at a glance the projected work load for his section.

The craft usage graph (Fig. 8) is a character plot produced by the printer. The graph shows how many people of a craft are working on a given day, but not which activities are being worked on. A graph can be produced for crafts with 34 or fewer people in them. The graphs cover only 120 or 240 workdays, even though the data may be available for longer periods. The + characters indicate the total people available; an X indicates the number assigned that day.

Figure 4. Critical path report.

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PROJECT NO.	JOB DESCRIPTION	I NODE	J NODE	DURATION IN DAYS	EARLY START	LATE START	EARLY FINISH	LATE FINISH	FLOAT
0	NETWORK LEAD	1	2	0	0	0	0	0	0
5	PIPE AND APPURTENANCE DESIGN	2	1413	8	0	0	8	8	0
5	FINAL DESIGN	1413	1414	4	8	8	12	12	0
5	FINAL REVIEW	1414	1415	2	12	12	14	14	0
5	SUPERVISOR REVIEW	1415	1416	2	14	14	16	16	0
5	ESTIMATE AND TRAFFIC SPECIFICATNS	1416	1420	20	16	16	36	36	0
5	PREPARE SPECIFICATIONS	1420	1421	10	36	36	46	46	0
5	***BPW APPROVE PLANS & SPECS***	1421	1423	10	46	46	56	56	0
5	ADVERTISE FOR BIDS	1423	1424	10	56	56	66	66	0
5	***AWARD CONTRACT***	1424	1425	10	66	66	76	76	0
5	BEGIN CONSTRUCTION - MERCER STREET	1425	3802	0	76	76	76	76	0
5	COMPL REST 1 MERCER STREET L	3802	3999	1123	76	76	1199	1199	0
0	NETWORK TRAIL	3999	4000	0	1199	1199	1199	1199	0
1	ORDER SURVEY	2	683	1	0	1	1	2	1
1	SURVEY PROPERTY ADJUSTMENTS	683	684	3	1	2	4	5	1
1	ADJUST PLANS	684	685	15	4	5	19	20	1
1	APPRAISE	685	708	22	19	20	41	42	1
1	NEGOTIATE	708	709	50	41	42	91	92	1
1	NEGOTIATE	708	710	50	41	42	91	92	1
1	DUMMY	709	710	0	91	92	91	92	1
1	LOGIC DUMMY	710	711	0	91	92	91	92	1
1	FILE SUIT	711	712	10	91	92	101	102	1
1	SERVE SUMMONS	712	713	15	101	102	116	117	1
1	LEGAL DELAY	713	734	44	116	117	160	161	1
1	ORDER OF NECESSITY	734	741	1	160	161	161	162	1
1	LEGAL DELAY	741	751	16	161	162	177	178	1
1	PRE-TRIAL CONFERENCE	751	753	5	177	178	182	183	1
1	LEGAL DELAY	753	758	22	182	183	204	205	1
1	TRIAL ROY ST PHASE I	758	762	5	204	205	209	210	1
1	PAY AWARDS	762	763	25	209	210	234	235	1
1	LEGAL DELAY---MOVE OUT TIME	763	769	30	234	235	264	265	1
1	BEGIN CONSTRUCTION	769	3806	0	264	265	264	265	1
1	COMPLETION RESTRAINT 2 ROY ST PH I	3806	3999	934	264	265	1198	1199	1
75	FILE SUIT	2	2928	1	0	2	1	3	2
75	SERVE SUMMONS	2928	2930	5	1	3	6	8	2
75	LEGAL DELAY	2930	2932	44	6	8	50	52	2
75	ORDER OF NECESSITY	2932	2934	1	50	52	51	53	2
75	LEGAL DELAY	2934	2936	16	51	53	67	69	2
75	PRE-TRIAL CONFERENCE	2936	2939	5	67	69	72	74	2
75	LEGAL DELAY	2939	2941	22	72	74	94	96	2
75	***TRIAL***	2941	2942	5	94	96	99	101	2

Figure 5. Manpower scheduling report.

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PROJECT NO.	DATE	WORK DAY NO.	JOB STATUS	JOB DESCRIPTION	I NODE	J NODE	DURATION	CRAFT NO.	MEN REQD	TOTAL IN CRAFT	JOB FLOAT
	APR 24, 1972										
21		39		FINISH CONTRACT PLANS	1068	1069	7	5	1	2	26
72		39		FINISH STUDY PIPE ROUTING	3110	3130	7	31	1	15	112
26		39		FINISH MAP ASSMT AREAS	593	594	6	17	1	0	44
70		39		FINISH CALC ASSMT RATES 2	3061	3063	3	19	1	2	87
75		39		FINISH MAKE PRESENTATN TO DESIGN COMM	2892	2896	2	26	1	2	38
56		39	START	COMPUTE INDIVIDUAL ASSESS	201	202	2	19	1	3	24
21		39	START	DEPT & PLANNING REVIEW 2	1069	1070	15	22	0	0	26
12		39	START	LANSC CONTRACT PLANS	2055	2056	7	5	1	3	29
75		39	START	REVISE LAYOUT POAN	2896	2899	2	26	1	3	40
26		39	START	PREPARE PRELIM ROLL	594	595	6	18	1	2	44
101		39	START	MAP ASSMT AREAS	1762	1763	3	17	1	1	48
36		39	START	FINAL PUMP STA DESIGN	2385	2440	66	31	1	16	65
	APR 25, 1972										
24		40		FINISH INK DRAWINGS	434	438	25	32	1	7	8
111		40		FINISH PLANS SPECS ESTIM	90	91	20	5	1	2	6
15		40		FINISH DIVERTER OR PARK DESIGN	377	378	18	10	1	4	77
4		40		FINISH PREPARE PRELIM ROLL	1988	1989	12	18	1	1	118
37		40		FINISH PIPE & APPURTENANCE DESIGN	2	2584	10	31	1	15	109
5		40		FINISH MAKE REVISIONS	1417	1418	2	31	1	14	5
14		40		FINISH DRAINAGE REVISIONS	2781	2783	2	31	1	13	103
42		40		FINISH DRAW GRADE PLANS	1840	1841	2	14	1	0	119
5		40	START	DRAFT REVISIONS	1418	1419	2	32	1	8	5
5		40	START	CHECK REVISIONS	1418	1421	1	31	1	14	6
111		40	START	PLANS SPECS ESTIM	91	92	15	4	1	7	6
24		40	START	DEPARTMENT REVIEW	438	440	20	22	0	0	8
36		40	START	COORD LOC-IMPR ON PLAN	2385	2426	60	10	1	5	21
78		40	START	PRELIM PLAN	1221	1223	10	5	1	3	31
34		40	START	PIPE DESIGN	605	2404	54	31	1	15	101
222		40	START	DRAFT BASE PLANS 2	2	3343	34	31	1	16	106
4		40	START	CALC UNITS & PUT ON ROLL	1989	1990	1	16	1	1	118
42		40	START	EW	1841	1844	1	15	1	1	119
	APR 26, 1972										
6		41		FINISH PREPARE PSE ESTIMATE & SCOPE	2	878	40	26	0	3	18
7		41		FINISH COMPLETE CONTRACT DRAWINGS	2	3665	40	1	1	8	30
36		41		FINISH REVISE EIS E	2	2374	40	27	1	10	43
75		41		FINISH PREPARE NEW TRAFFIC DATA	2	2876	40	36	1	0	65
245		41		FINISH ESTIMATES AND SPECIFICATIONS	2	3573	40	11	0	7	118
16		41		FINISH REQUEST R/W APPROPRIATION	476	1562	40	40	0	0	187
128		41		FINISH RECEIVE COMMENTS ON DRAFT EIS	969	971	35	20	0	5	31
290		41		FINISH PAY AWARDS	319	320	25	21	0	3	13

Figure 6. Item report.

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PROJECT NO.	DATE	WORK DAY NO.	JOB STATUS	JOB DESCRIPTION	I NODE	J NODE	DURATION	CRAFT NO.	MEN REQD	TOTAL IN CRAFT	JOB FLOAT
37	MAR 1, 1972	1	START	DRAFT BASE MAPS	2	2582	0	31	1	16	143
37	APR 11, 1972	30	START	PIPE & APPURTENANCE DESIGN	2	2584	10	31	1	16	109
37	JUL 24, 1972	102	START	CHECK BASE MAPS	2582	2584	5	32	1	8	42
37	AUG 1, 1972	108	START	FINAL DESIGN	2584	2585	5	31	1	16	46
37	AUG 8, 1972	113	START	FINAL REVIEW	2585	2586	5	31	1	15	46
37	AUG 10, 1972	115	START	INK DRAWINGS	2584	2587	20	32	1	8	34
37	AUG 15, 1972	118	START	SUPERVISOR REVIEW	2586	2587	5	31	0	13	46
37	SEP 8, 1972	135	START	DEPTL REVIEW	2587	2588	20	22	0	0	34
37	SEP 11, 1972	136	START	ESTIMATE	2587	2596	15	11	1	7	59
37	OCT 6, 1972	155	START	REVISIONS	2588	2589	2	31	1	11	34
37	OCT 11, 1972	157	START	CHECK REVSIONS	2589	2591	1	31	1	12	35
37	DEC 1, 1972	191	START	DRAFT REVSIONS	2589	2590	2	31	1	11	0
37	DEC 5, 1972	193	START	DUMMY	2590	2591	0	0	0	0	0
37	DEC 5, 1972	193	START	**BPW APPROVAL - PLANS	2591	2592	10	22	0	0	0
37	DEC 19, 1972	203	START	COMPUTE & CHECK AREAS	2592	2593	2	16	1	1	0
37	DEC 21, 1972	205	START	MAP AREAS	2593	2594	2	17	1	1	0
37	DEC 26, 1972	207	START	PRELIMINARY ROLL	2594	2595	2	16	1	1	0
37	DEC 28, 1972	209	START	CALC UNITS & PUT ON ROLL	2595	2596	1	16	1	1	0
37	DEC 29, 1972	210	START	CALC ASSMT RATES	2596	2597	5	19	1	1	0
37	JAN 8, 1973	215	START	COMPUTE INDIV ASSMTS	2597	2598	2	19	1	1	0
37	JAN 10, 1973	217	START	MAIL NOTICES	2598	2599	25	19	0	0	0
37	FEB 15, 1973	242	START	**PRELIMINARY HEARING	2599	2600	1	19	0	2	0
37	FEB 16, 1973	243	START	PREPARE SPECS	2600	2601	15	11	1	1	0
37	MAR 12, 1973	258	START	**BPW SPEC APPROVAL	2601	2602	10	22	0	0	0
37	MAR 26, 1973	268	START	ADVERTISE	2602	2603	15	22	0	0	0
37	APR 16, 1973	283	START	**BPW CONTRACT AWARD	2603	2604	20	22	0	0	0
37	MAY 14, 1973	303	START	BEGIN CONSTRUCTION	2604	3960	0	22	0	0	0
37	MAY 14, 1973	303	START	COMPLETION RESTRAINT 139	3960	3999	897	0	0	0	0

Figure 7. Craft report.

MAR. 1, 1972 PAGE 1

WATER DESIGN

PROJECT NO.	DATE	WORK DAY NO.	JOB STATUS	JOB DESCRIPTION	I NODE	J NODE	DURATION	CRAFT NO.	MEN REQD	TOTAL IN CRAFT	JOB FLOAT
13	MAR 1, 1972	1	START	FINALIZE ROOF SHAPE	2	1528	10	7	1	1	27
45	MAR 1, 1972	1	START	DETERMINE PIPE LOCATION	2	616	65	6	0	0	84
98	MAR 1, 1972	1	START	DRAFT 20 BASE MAPS	2	2622	35	7	1	2	97
82	MAR 1, 1972	1	START	DESIGN	2	1630	20	7	1	3	109
104	MAR 1, 1972	1	START	TRANSMIT PH II CORRIDOR TO R/W	2	2802	0	6	0	0	132
103	MAR 1, 1972	1	START	PUT TOPOG ON BASE MAPS	2	2803	25	7	1	4	132
98	MAR 1, 1972	1	START	DESIGN WATERMAINS PH 1	2	2623	20	6	1	1	137
103	MAR 1, 1972	1	START	SIZE PIPELINE	2804	2805	10	6	1	2	157
13	MAR 15, 1972	11	START	WORK WITH CONSULTANT	1528	1532	10	7	1	4	27
105	MAR 15, 1972	11	START	MAKE REVISIONS	2861	2862	10	7	1	5	39
103	MAR 15, 1972	11	START	DESIGN SOOS CREEK CROSSING	2805	2808	15	6	1	2	162
94	MAR 29, 1972	21	START	WM DESIGN	1661	1662	2	7	1	3	81
13	MAR 29, 1972	21	START	GRADING PLAN	1532	1534	15	7	1	4	27
82	MAR 29, 1972	21	START	DEPT REVIEW	1630	1631	10	7	0	4	109
104	MAR 29, 1972	21	START	DETERMINE MOST ECONOMICAL ROUTE	2814	2815	10	6	0	1	132
103	APR 5, 1972	26	START	FINISH TOPOG	2803	2806	10	7	1	3	132
103	APR 5, 1972	26	START	DESIGN PIPE AT SR515	2808	2809	10	6	1	1	162
42	APR 11, 1972	30	START	WM DESIGN	1836	1838	1	7	1	4	105
104	APR 12, 1972	31	START	START R/W BASE PLANS	2815	2818	20	7	1	4	132
13	APR 19, 1972	36	START	CONSTRUCTION ROAD	1534	1536	20	7	1	2	27
98	APR 19, 1972	36	START	DESIGN PH 2	2622	2625	20	7	1	3	97
98	APR 19, 1972	36	START	PRELIM CIRC & CHECK PT I	2623	2624	10	7	1	4	122
103	APR 19, 1972	36	START	LOCATE PIPELINE ON PLANS	2806	2807	10	7	1	5	132
103	APR 19, 1972	36	START	DESIGN PIPE AT FAIRWOOD RES	2809	2811	15	6	1	1	177
128	APR 26, 1972	41	START	FINAL REVISIONS TO WIDENING PLANS	972	973	5	10	0	5	31
								7	0	5	
98	MAY 3, 1972	46	START	DRAW PROFILE SHEETS	2622	2637	50	7	1	4	154
98	MAY 3, 1972	46	START	REVISIONS PH I	2624	2627	5	7	1	5	122
103	MAY 10, 1972	51	START	DRAW PIPELINE PROFILE	2807	2810	20	7	1	4	127
13	MAY 17, 1972	56	START	PIPING & VALVING PLAN	1536	1538	30	7	1	3	27
98	MAY 17, 1972	56	START	PRELIM CIRC & CHECK PT II	2625	2626	5	7	1	4	107
98	MAY 24, 1972	61	START	MAKE REVISIONS PH 2	2626	2627	5	7	1	4	107
69	MAY 25, 1972	62	START	WM DESIGN	3025	3027	2	7	1	5	110
125	JUN 1, 1972	66	START	WM DESIGN	1813	1815	1	7	1	4	102
45	JUN 1, 1972	66	START	REVISE PLANS	616	617	10	7	1	5	84
98	JUN 1, 1972	66	START	**BPW PLAN APPROVAL	2627	2631	10	7	0	5	107
103	JUN 8, 1972	71	START	DRAFT DESIGN DETAILS	2810	2811	30	7	1	4	127
13	JUN 29, 1972	86	START	FLOOR SLAB & DIV. WALL DESIGN	1538	1540	40	7	1	3	27
13	JUN 29, 1972	86	START	COORDINATE SEWER RELOCATION	1538	1539	10	6	1	1	57

The time-scaled arrow diagram is now only partially produced by the program run. A card deck of each project report is generated by the program. This deck, when used with a plotter, generates a time-scaled arrow diagram of each project as scheduled. The diagram shows activities as solid lines, float or slack time as dashed lines, calendar dates, project name, node numbers, activity names, craft codes, and numbers of people. The diagram is printed at a scale of 1 in. equals 5 days (Fig. 9).

USES OF THE SCHEDULE

The schedule in its final form provides a management tool, useful in both day-to-day and long-range planning. The project report, craft report, and craft usage graph show the line managers a way that projects can be completed on time with judicious use of available resources. When the actual design status is compared with the project report, project progress can be measured and requirement changes that may affect this progress can be assessed.

These reports also are a credible, factual method of predicting the dates of important events throughout a project's life. This type of information is valuable not only to the internal organization but also to citizen groups, other city departments, and state and federal agencies. Often, as a part of an interagency agreement, a schedule for accomplishing the design of a project is required. The project report is well suited to meet this requirement.

Often managers ask, "How and where can the organization take on more work? How can the most important projects be accelerated through design? Where will personnel transfers result in more efficient use of manpower? How would completion dates be affected by letting another firm design some of the projects?"

The critical path report, project report, craft report, and craft usage graph can provide a factual basis for answering these questions. The critical path and project reports show how and where additional resources could accelerate the completion date of a project. The craft report and usage graph show which crafts are and which are not fully utilized. If personnel transfers are possible, the critical path and project reports show which activities could most use additional manpower. Because unscheduled special requests always arise, scheduled full utilization of a craft for long periods of time indicates that activities, and therefore projects, are probably being delayed because of insufficient manpower resources. Reducing the number of projects being done by fully utilized crafts will accelerate the completion of remaining projects. The critical path and project reports can provide a measure of this acceleration.

In long-range planning, the schedule provides an aid in programming money, evaluating overall manpower needs, and preparing a plan to meet a future volume of work.

The project report predicts a completion date for the preconstruction phase of a project, i.e., the date on which construction financing will be required. The schedule then can be used to plan for the requirements from each funding source.

The capital improvement program (CIP) for the City of Seattle shows a 10-year plan for all the capital improvements to be made by all the departments in the city. The CIP shows the project names, cost estimates, funding sources, and year of expenditure. For the engineering department's portion of the CIP, the departmental schedule is used for programming funds in the proper year. Once the funding sources have been determined, we can obtain the requirements from each source by weeks, months, quarters, or years as desired.

A measurement of the manpower needs in each craft can be made by using the critical path report. By using the early start date for each activity, we can plot the usage graph that would result if unlimited manpower were available; but unlimited manpower is an uneconomic and impractical, if not impossible, condition. However, such a plot is useful in making comparisons in related skill groups. For example, the plot may show that the number of structural draftsmen required is approximately equal to two and a half times the number of structural engineers. This assumes that supervisors are correct in their evaluation of both skill level and time required to do a task. If the schedule is representative in both types and volume of work usually done, management can then use the plot to establish the numbers of each craft to be employed. Also, the size of a craft

Figure 8. Craft usage report.

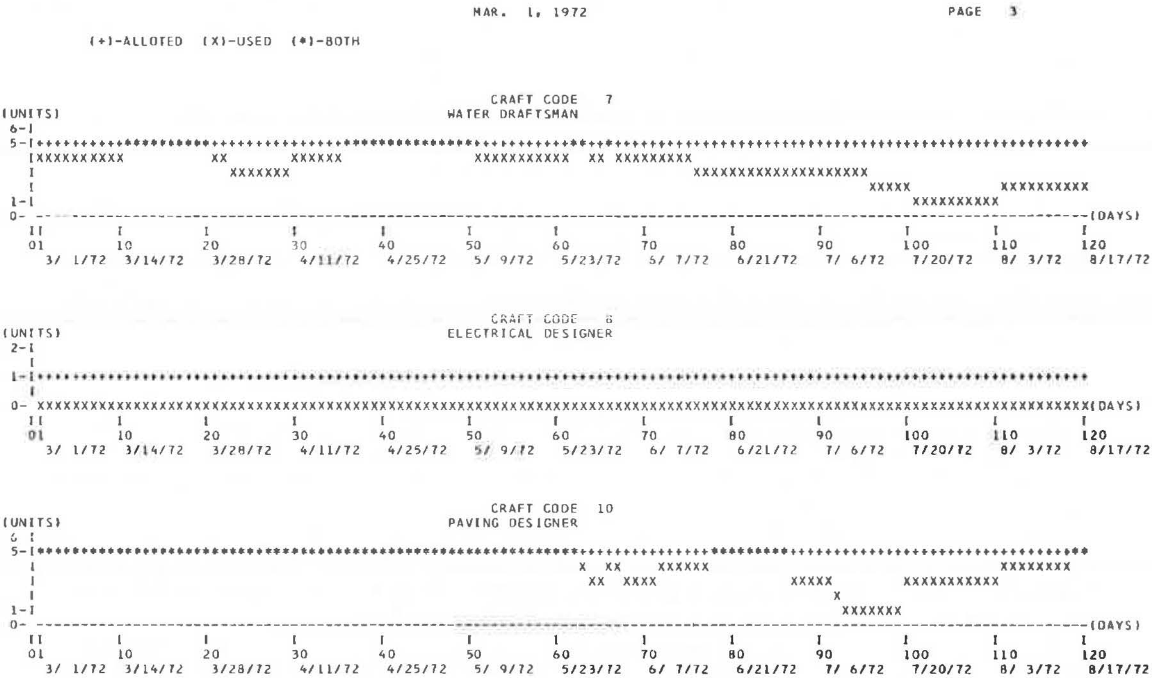
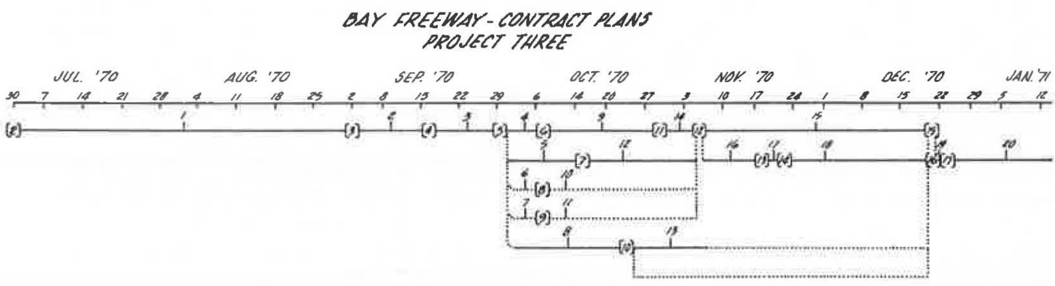
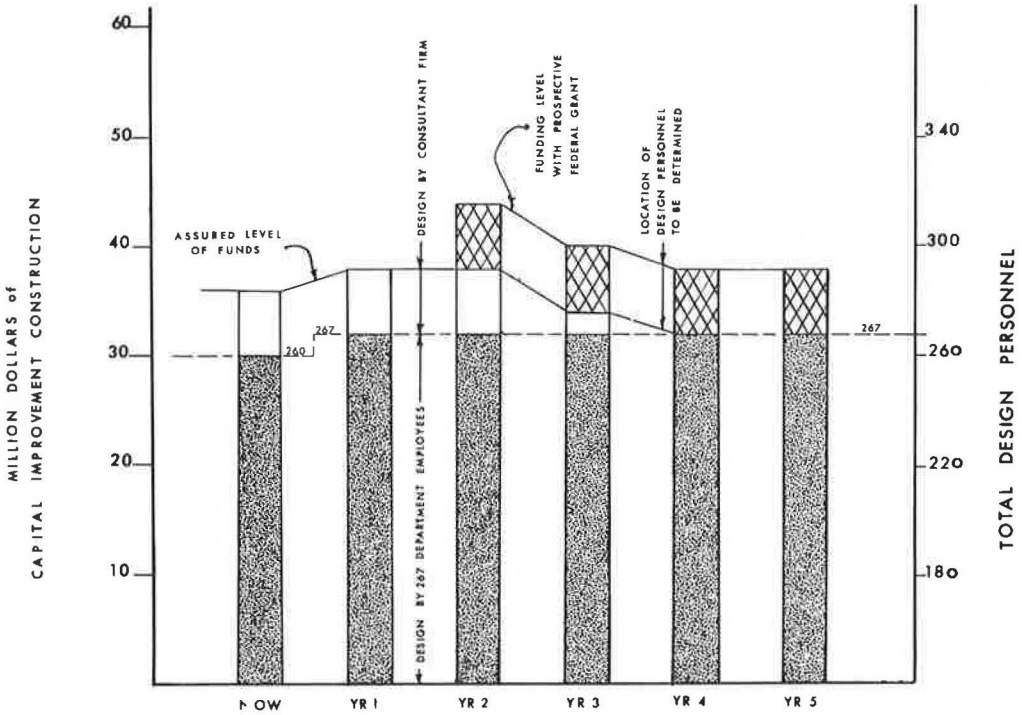


Figure 9. Time-scaled arrow diagram (original scale: 1 in. = 5 working days).



1. Prepare Design Criteria
2. Design Commission Approval
3. Design Paving & Widening
4. Access Design
5. Finish Paving & Widening
6. Lighting Design
7. Layout & Check Drainage
8. R/W Title Check
9. Landscape Design - Trees
10. Draft Lighting
11. Draft Drainage
12. Draft Paving & Widening
13. Calculate R/W Areas & Appraisal
14. Draft Landscape Design
15. Specs & Est.
16. Check Design
17. Make Revisions
18. Department Review
19. Final Revisions
20. Board of Public Works Approval

Figure 10. Personnel requirements for design of capital improvements.



may be established so that the craft would be fully utilized by activities starting on its early start for a period of 6 months. The activities delayed on that basis might result in full usage for, say, 1 year, at which time new projects would be undertaken.

By relating numbers of personnel to total dollars of construction contracts, we can begin to prepare for fluctuations in the number of projects or construction dollars available. For example, if with the current manpower resources an average of $30 million in contracts is designed each year and if inflation is estimated at 7 percent per year, in 5 years the same manpower could design $42.09 million in contracts. If projections of funds available are generally consistent with the ability to design projects, it could be assumed that current personnel levels are adequate for the next 5 years. Projects that come about through the development of any unexpected funding sources could be expected to be designed by a consulting firm. Figure 10 shows how such an analysis might be presented graphically. The solid portion of the bar indicates that approximately $32 million per year in construction contracts would be designed in-house with the addition of seven people. The portion between the solid and the XX portion of the bars would be let to consultants for design. If in the first year the prospective federal grant proves to be a reality, the department may wish to reevaluate the manpower requirements using the CPM system and perhaps increase the in-house staff.

ACKNOWLEDGMENT

The project management system discussed in this paper was developed over a period of years by Douglas L. Jonas, while he was with the Seattle Engineering Department; he is now an independent consultant. The paper was written principally by Eric S. Oien, who at the time was directly overseeing operation of the system; he is now city engineer at Vancouver, Washington. Kirk T. Jones, involved with development of the system since its early years, is now continuing the work and may be contacted for current information.

MANAGEMENT INFORMATION SYSTEM IMPLEMENTATION IN THEORY AND PRACTICE

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More state transportation agencies are realizing the degree of complexity involved in managing multiproject programs and manpower in a multifund environment. Many are turning toward systems management techniques to effectively program manpower and consume federal funds. However, many potential pitfalls loom for systems management techniques or management information systems. This paper addresses some of the issues surrounding these systems and is based on the authors' experience with the Florida Department of Transportation's multiproject scheduling system and interviews with many system users. Several possibilities for enhancing similar systems and their implementation are suggested. Several behaviorial and systems management policies are identified and analyzed in the light of emerging management theory, and policy actions are suggested for the effective interface of system, organization, and user.

•CHANGING TECHNOLOGY in all fields of transportation, methods of funding, and complex operating procedures have resulted in a massive number of critical production activities. Efficient allocation of human resources must be stressed to achieve financial goals. Many essential data must be examined, analyzed, and manipulated to prevent depletion of manpower expertise by production requirements. Therefore, several transportation agencies are searching for a management information system (MIS) to help in the timely and efficient use of data.

There are many areas of concern in the decision-making process:

1. Fund consumption by category through time,
2. Pools of resources by their availability, requirements, or time span under alternative patterns of prioritization,
3. Particular critical activity (e.g., the environmental impact statement) reviewed for all projects simultaneously for resource requirements of specific expertise,
4. Entire project's work flow and status by task and responsible person.

The need for MIS first became evident to the Florida Department of Transportation management when it was realized that today's spiraling costs for right-of-way and construction materials were putting greater demands on the unrestricted state dollar. This demand has made it important to capture as many federal dollars as possible for construction of transportation facilities, thereby releasing state dollars for preconstruction activities.

The ability of a transportation agency to accomplish this game plan of increased federal-aid activity depends entirely on its ability to comply with all applicable policies of FHWA in a timely and efficient manner.

Before the development, design, and implementation of an MIS are analyzed, a framework in which to weave interrelated policies of management systems and management theory should be constructed. We will use two general categories: behavioral (theory Y) and nonbehavioral (theory X).

Some of the popular names of the various schools of thought associated with the behavioral school include social systems, behavioral science, value theory, and human relations. The nonbehavioral school is usually associated with functional or classical

scientific schools, management systems, information theory, decision theory, mathematical schools, management science, managerial economics, and operations research.

It is important to point out that few if any theorists or managers follow either extreme school of thought. Rather, most effective managers use theories and philosophies from several, if not all, schools. We will discuss using an MIS to integrate and resolve some of the conflicts in finding an optimum overall management strategy and the way to successfully implement such a system. Both categories of management theory should be applied to effectively manage a large transportation organization, and a properly designed policy package, an MIS, organizational framework, and implementation procedure can optimize and implement the mix of managerial philosophies in a complex organization.

A separate category is proposed for those schools of management that incorporate the variables of both the nonbehavioral and behavioral categories. We believe that the closely related schools of decision theory, information theory, and management systems can provide the focal point for achieving both human and organizational goals within a large organization. However, to do this within the framework of the traditionally slow-moving machinery of a transportation agency creates several interrelated issues. This paper addresses three categories related to potential factors that may affect the success or failure of an MIS. These categories are (a) the organizational environment, including internal managerial policy, organizational structure-role definition, individual behavior, and group behavior; (b) system variables, including software design features, MIS staffing patterns and loads, and human procedures; and (c) organization-system interface or the implementation procedure.

OPTIMIZING THE MIX OF MANAGEMENT AND ORGANIZATIONAL POLICIES

Some of the major problems regarding the implementation of these systems are produced by the environment in which the system is immersed. Top management's control over the organizational environment is exerted primarily through policy decisions that affect the roles and behavior exhibited by the people in the organization. These people, in turn, control the success or failure of the system. One of the major points of this paper is that it is naive to assume that a major change in an organization, such as the installation of an MIS, can be achieved through the application of purely authoratative, nonbehavioral management policy.

At the same time, it is naive to assume that a behaviorally oriented system can be installed under a behavioral strategy and survive in a nonbehavioral organizational environment. A policy package is presented that should prime the organization for acceptance of MIS.

Specialization

The principle of division of labor is sound in theory inasmuch as it is based on the assumption that one man does few things better than many men. This logic seems unshakable until the behavioral components of monotony and fatigue, which decrease efficiency, are introduced. The need of man to feel important and take pride in producing a quality end product seems to be overlooked by the nonbehavioral approach. The point is that both extreme specialization and extreme nonspecialization have the capacity to defeat the purpose of the organization. The MIS can overcome this dilemma by assigning responsibility and credit for task achievement to a project manager and his team. When project managers are set up at the operating management level, the labor is divided and can be specialized within reasonable bounds.

Departmentalization

The principle of departmentalization may be termed a macroapplication of specialization when accomplished by process. However, departmentalization may also take place by purpose, clientele, and place. Departmentalization by process lends itself to the same economies generated by specialization with possible losses due to scheduling,

interdepartmental coordination, and cooperation. The behaviorist's view emphasizes the need for man to feel important in achieving an end product and warns of dangers of lowered quality due to departmental subgoal dominance over total organizational goals. Behaviorists point out the possible loss of additional energy potential generated by "synergistic," cohesive social groups. In designing and applying management information systems, the project manager and his team form the informal working group within the formal organization which creates a grass-roots nucleus for a highly motivated group that is well-run and effectively controlled. Potential departmental communication gaps are also bridged by MIS.

Coordination

Coordination is essential in the application of specialization to ensure a unified direction. The effectiveness of any coordinative activity depends on the communication system of the organization. Nonbehaviorists prefer using the hierarchy as their coordinating device. The formal organization chart, with well-defined job descriptions that eliminate overlap of functions, makes the mission of the parts clear by relying on principles of control and communication.

The behaviorists complain that coordination by hierarchy dampens creativity, restrains free informal communication, and overloads the formal communication systems, which can defeat the attempt to coordinate. The preferred behavioral means of coordination eliminates the superior-subordinate relationship of the hierarchy and replaces it with a spontaneous group approach that takes orders from the situation.

MIS can make the situation known not only by enabling top and middle management to make good decisions, but also by providing direct information to operating management, which negates some need for direct superior-subordinate control and direction, except in cases of deviant performance. The fact that decision-making is delegated to operating management also helps to motivate production. The fact that formal and informal channels of communication are supplemented with an MIS only further enhances the degree of coordination achieved by an organization. Even though MIS is a formal device, its pattern of interaction with the organization's participants is informal.

Coordination by committee is another way of achieving participation in decision-making. Advantages include better decisions based on error scattering and specialization within the group and more sharing of information, interaction, and cooperation. Nonbehaviorists argue that committees encourage irresponsibility; are less considerate, indecisive, more unscrupulous, and expensive; and cannot lead. However, MIS may require the committee approach in the goal-setting process. We feel that participative decision-making sessions are required in the management's planning and organizing sequence and should be used in preparing first-cut man-loadings, schedules, and production standards.

Decentralization

The need for coordination may be minimized by decentralization. The creation of an autonomous, independent unit negates the need for interdepartment negotiations and cooperation. All the components essential for achieving the objective are self-contained, and authority is set equal to responsibility in the unit head. Central controls depend extremely on communication when decentralization is applied. This suggest that MIS ensure a reliable, truthful communications bridge over the decentralization gap.

Decentralization is a combination of departmentalization by purpose and delegation. Many large highway or transportation organizations, such as the Florida DOT, decentralize by place, naming district engineers responsible for overall district production. MIS can be misused or misinterpreted by district engineers in this type of organization.

Unity of Command

The principle of unity of command states that only one person should have ultimate authority over others. The general premise is that conflicting commands must be resolved and that inefficiency arises if a mutual superior of two supervisors must be

continually consulted concerning overlapping authority. Conflicts with this principle sometimes arise when the staff approach is used to operate and maintain MIS. The MIS staff must serve cooperatively and share the responsibility of production with the line supervisor.

Departmentalization and Staff-Line Relationships

Where and how to locate the functions related to day-to-day operation and maintenance of MIS are key issues. The choices are clear: (a) Allocate MIS operation functions among existing departments and personnel, or (b) create a new department or staff for this purpose. We recommend b for several reasons:

1. Quality control over the reporting process needs to take place in a department or scalar level separate from the department doing the reporting, and it is unlikely that top management would find time to do this;
2. Addition of new functions to already overloaded work centers could find MIS operation functions taking a back seat to other seemingly more important day-to-day production functions; and
3. Training and advocacy functions are required on a full-time basis during implementation and are best executed by a separate bureau.

The most rational location for a new bureau is usually a staff position. In decentralized operations, the bureau should also be decentralized to provide the closest possible communications linkage between actual operations and the system.

At the Florida DOT both of these policies were carried out. A new program development, management, and scheduling (PDMS) bureau was created in the planning and programming division, and decentralized PDMS engineers are located in each of the district organizations. Even though this bureau was located in an existing division, it behaved like a staff bureau because it generated information of critical importance to top management decision-making. In short, the PDMS bureau's level and pattern of interaction with top management took on direct and frequent characteristics more closely associated with a staff-advisory role than with a formal, chain-of-command pattern. This suggests the unnecessary possibility of conflicting informal and formal communication patterns between top planning officials and top PDMS officials. Although this possibility of conflict did not manifest itself in any serious manner in the Florida DOT, the location of the MIS function in a formal staff role could improve the overall organizational setting and enhance the probability of successful, rapid implementation of MIS.

Unavoidable traditional staff-line problems can be minimized through careful selection and training of staff personnel in the role they are to play. This does not imply deceit, but stresses the fact that new staff people should strive not only to avoid actual "take-over" of many managerial functions but also to avoid allowing their actions to be interpreted as such. At the Florida DOT, the role of PDMS was defined in the districts as service-oriented and was only to assist management functions normally performed by others. This role was not an entirely accurate picture of PDMS functions, but any of management's fear of bureaucratic, territorial infringement was allayed.

Delegation

Behaviorists' approach to delegation is also more liberal than that of nonbehaviorists who tend to centralize authority while assuming that subordinates have no initiative; this justifies their authoritarian leadership style. Behaviorists urge maximum delegation of responsibility to develop initiative, morale, and energy. Higher motivation can be achieved by establishing a feeling of personal self-worth. The delegation of project management responsibility to operating management is required by an MIS in order to obtain firsthand, high-quality project status reports and manpower forecasts. MIS enables subordinates to participate in and influence the project management planning process and thereby produces a greater feeling of importance.

Span of Control and Impact on Organization Structure

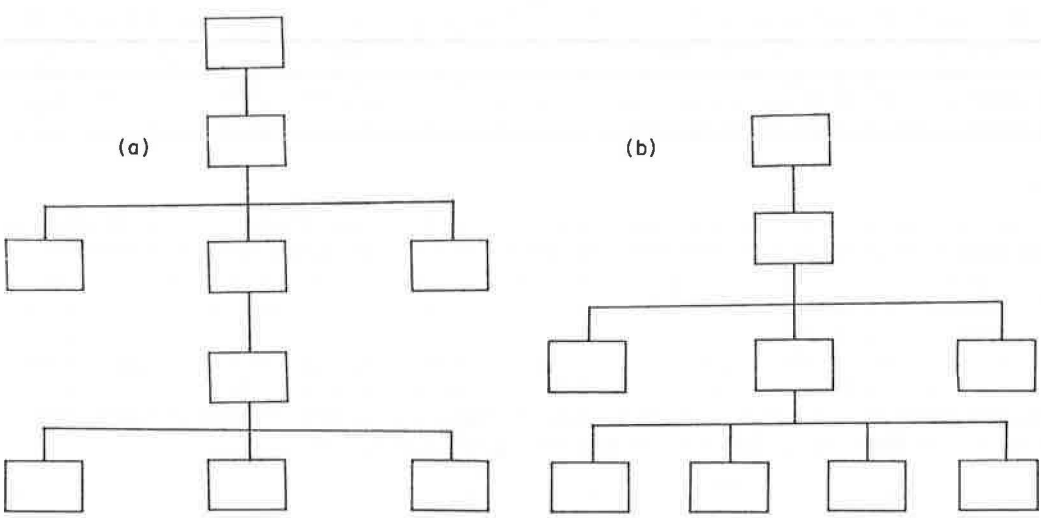
The principle of span of control restricts the number of a superior's subordinates to an effectively managed quantity. This is a prime factor in organizational design. It governs the number of levels in the organization. Although it is efficient to minimize the number of scalar levels, this may place a burden on supervisors' span of control.

As pointed out by Simon (22), the installation of a computer-based MIS (if effective) will increase the span of control of top management by enabling more effective use of time. Eventually, automated systems could negate the need for a middle management level and reduce the number of filters through which information has to pass. This would eliminate a source of information distortion and bias. It then becomes possible to restructure organizations toward behavioral organizational goals as opposed to classical or authoritative approaches. The systems view toward organization design should also be within the scope of an implementation strategy for MIS.

It now appears that emerging management theory realizes that many authoritative or classical principles of management still have a role to play despite disagreement by psychologists and behavioral scientists. But this role appears limited in its application to routinized functions and decision systems. It is suggested that bureaucratic procedures would continue to be effective in managing these functions. However, the increased efficiency of the reporting system would negate many of the functions now performed by middle management and suggests a need to diminish manpower allocated at this level or to reallocate it to a production or operating management level. A conservative example of the restructuring of a formal organization is shown in Figure 1.

Although this formal restructuring of the organization takes place on a functional basis, behavioral or social-systems-related changes in the informal organizational structure must be made to more effectively achieve the management functions of planning and organizing. Regarding the Florida DOT multiproject scheduling system (MPSS), these functions encompass the process of developing the trial activity chart. This process, by design, requires some balance of forecasting skills and goal-setting talent. The structuring and sequencing of activities through time lend themselves to a participative approach as suggested by emerging management theory. In the development of the project work plan, the issue of what is most likely achievable is hammered out. Demands of top management for higher productivity and more stringent, pressing schedule goals and production standards must be conditioned on operating managements' ability to achieve these goals. The negotiating or partisan mutual adjustment process that must take place at this point cannot be effectively conducted within the confines of a formal organizational mechanism. Here the social-systems

Figure 1. Organization structure (a) before and (b) after successful implementation of MIS.



or team approach to problem solving appears most appropriate (e.g., Likerts' "linking pin" organization).

This structure calls for some dissipation of the formal superior-subordinate roles and a complex pattern of interaction as opposed to the chain-of-command approach. A less well-defined division of labor that permits freer corporate role definition and more effective expression of group inputs is also characteristic of this organizational form.

Control

The behavioral view, with emphasis on self-control, asks, "Who has the ultimate operational control?" The answer is the man at the bottom of the hierarchy, the worker. This is a good argument for stressing motivation and self-control. However, nonbehaviorists stress the aspect of administrative control. Communication becomes a necessary prerequisite of any administrative control technique. Information on accurate standards of production must be communicated if measurement, comparison, and analysis of deviations from the planned tolerance band are to take place.

Control serves the planning function, pinpoints locations of coordination difficulties, and aids top management in revising policies and procedures to better effect organizational goals. Behaviorists contend that budgets, MIS, and similar controls evoke feelings of dependency and passiveness that negatively affect efficiency. They also argue that formal controls introduce pressure, interdepartmental strife, psychological failure, and communication failures between the line and budget people. The degree of control also affects the goals of decentralization: Too much control by the central office can defeat its purpose. Control techniques should be motivational and selective in character and avoid stimulating resentment.

To effectively design MIS into an organization requires that behavioral circumstances and needs of the organization be assessed. This indicates the degree of control and the level of communication required and some possible adverse consequences. Aspects of both the behavioral and nonbehavioral schools should be used to minimize the negative impact of the system. Whether MIS is perceived as a spy-machine will depend on the procedure used for implementing the system, the personalities and mode of operation of the people implementing it, and its actual design purposes.

DESIGN OF TOTAL MAN-MACHINE SYSTEM

Human Behavior, A Relevant Variable in Systems Analysis

The authors believe that the singular application of either the behavioral or nonbehavioral approach in the design of MIS will certainly lead to failure of the system. For example, if only behavioral techniques are used in the design of the system, the managerial goal of economic performance will likely be compromised by individual needs, thus limiting MIS's ability to assist top management in controlling and effectively managing the organization. On the other hand, if only nonbehavioral constraints are used in the design of MIS, the system will likely be sabotaged or rejected or both by the human element of the organization.

Ironically, most designers of MIS probably lay some claim to the title systems analyst. It would appear that professionals well versed in the systems approach could never make the mistake of foregetting to incorporate the relevant variable of human behavior into their systems, yet it happens. Surprisingly, most systems analysis texts either totally neglect or only give lip service to the human behavior variable of man-machine systems.

MIS Design Objectives and Policies

One of the essential ingredients in the successful implementation of MIS is the system itself. Too often, system designers are product-oriented rather than market-oriented. The system must respond to the needs of the organization and its users. We regard becoming product-oriented as a mistake; the product design must be based on user needs.

To achieve this requires that the system designer solicit and obtain top, middle, and operating managements' inputs into the goal-formulation process. What specific decisions should the system assist each "market segment" in making? What information is relevant to the execution of these decisions, and how can this information be most effectively displayed? Such questions should be asked at the outset to secure the participation of all levels of management. This will assist in the implementation of the system by avoiding the appearance of something new being "rammed down the throats" of the users. Opposite feelings can be evoked by giving the users a strong voice in the system design process. This is one area where the Florida DOT design procedure could have been improved. Some complaints of MPSS users were centered around the facts that the MPSS did not adequately fill their needs and it was something being forced on them over which they had no control. This implies a certain amount of resentment due to nonparticipation in the planning process.

The system design process should also focus on the human aspects of the man-machine system. It is likely that a computer program could be written and debugged to permanently avoid any deficiency or anomaly on the part of the machine's responsibilities. It is unlikely that an error caused by human performance will never occur. Therefore, several basic system design policies are recommended.

Equal or greater emphasis, effort, and dollars should be expended to develop simplified, concise, clear, and meaningful user instructions. As much analysis is needed to find an optimum human procedure as to formulate a computer procedure.

Paper work should be minimized. An all-out effort needs to be directed to avoiding the "probe effect," disrupting production—the variable being measured—by MIS—the tool being used to measure production. The Florida DOT found that many reports could be eliminated and replaced by the MPSS and this would mean less paper work, a positive attribute for acceptance of the system. However, some reluctance to release the old procedures of reporting was experienced in districts that did not achieve a satisfactory level of reliability in the MPSS immediately. This created an unnecessary work load that eroded confidence in the system and absorbed efforts that could have enhanced the system's reliability.

In addition to minimizing paper work, the system should be designed to minimize the number of MIS staff people required to operate the system. One feature discussed but not yet installed in the Florida DOT MPSS is an automatic resource-leveling module, which would relieve the PDMS engineer from hand-allocating and gaming manpower imbalances to achieve an optimum multiproject manpower plan.

The system should be modular and provide flexibility for future modifications to the system in order to continue to be responsive to user needs. An important additional feature of the system is the level of manpower allocated to perform system servicing functions. This allocation should include sufficient manpower to solicit user perceptions and continually update and enhance the system in response to changing user needs. The Florida DOT system has sufficient modularity, but users have complained of an inability of PDMS to modify and improve the system in accordance with their requests. This stems primarily from an insufficient manpower capability at the working level on the PDMS staff.

It is important to ensure that both the system and the user procedures produce relevant, useful, coherent information in a timely manner. Outputs should be uncluttered, readable, and concise and produced in accordance with a reliable schedule.

Specific Features

Florida DOT experience with MIS relates mainly to MPSS (the first data based system) and the later base subsystems and parallel data systems.

MPSS was first developed "to provide a two-way communications network covering the entire state, within which everyone speaks the same language." This allows management at all levels to analyze the production capabilities of all areas of expertise for manpower needs within any specific time frame over 2 fiscal years.

The project record system (PRS) was later developed to define each implementable project within the 5-year work program and budget. PRS also established project

identity parameters, common to the MPSS and its subsystems, and identified the "multi-fund environment" with respect to those projects, funding alternatives, and total goals of Florida DOT.

Several secondary objectives were immediately realized from these two parallel systems while subsystems were being developed to satisfy newly defined needs. These objectives include the abilities to

1. Forecast preconstruction manpower (production) requirements to accomplish the work program,
2. Properly allocate and collect work changes by phase of project,
3. Report accomplishment of work activities, keeping key levels of management informed of overall project status as well as intraproject activity,
4. Estimate needs and relative control over external production necessary in reducing peak-period production requirements, and
5. View expected project completion dates.

Besides the accomplishment of these objectives, there is a need for having an ability to forecast cash payouts. This would help management discover its level of contracting power in right-of-way acquisition and construction contracts.

Before this could be totally accomplished the need to analyze jobs scheduled to be let during any given month was evident. Hence, the contract-letting schedule system (CLSS), which gleans project completion dates from the MPSS and identifies them by fund from the PRS was created, thus producing a monthly letting schedule of projects completing production. The financial forecasting system was created to track anticipated payouts in right-of-way from the MPSS and anticipated payouts in construction contracts from the CLSS.

These systems and subsystems provided the basic operating components of Florida's MIS. There are many other subsystems that interact with these systems, but to elaborate in detail on Florida's MIS and all its subsystems would necessitate an independent paper in itself. The description here relates the cohesive interaction of experience in MIS to some of the important features a general MIS could contain in a large transportation agency. Figure 2 shows a simplified flow diagram of Florida's overall MIS.

In considering desirable system features, an MIS designer should always consider simplicity first. The system should function effectively with the smallest amount of input data possible yet yield the most flexible data displays for all managerial levels.

The Florida MPSS in its biweekly update cycle displays to operating management what has been done against what was to be done. This update takes "actual" manpower utilization by job class expertise for any specific phase of production during a 2-week period and stores it against originally scheduled manpower utilization "predictions."

The operating manager can look at the updated project plan (a full work element flow diagram of interfaced critical activity and events) and discover what work has been accomplished as it relates to other satellite production units' work. Any discrepancies should be analyzed with the operations manager so that any reassignments of work efforts are balanced with overall unit objectives.

The middle manager reviews the top management report for overviews of project development, by examining and investigating exceptions, and weighs management's yield against the LOB for efficient manpower utilization. This provides the proper interface through formal communication with operating management and project management for final production and program decisions before top management stabs at the problems unresolvable at lower levels.

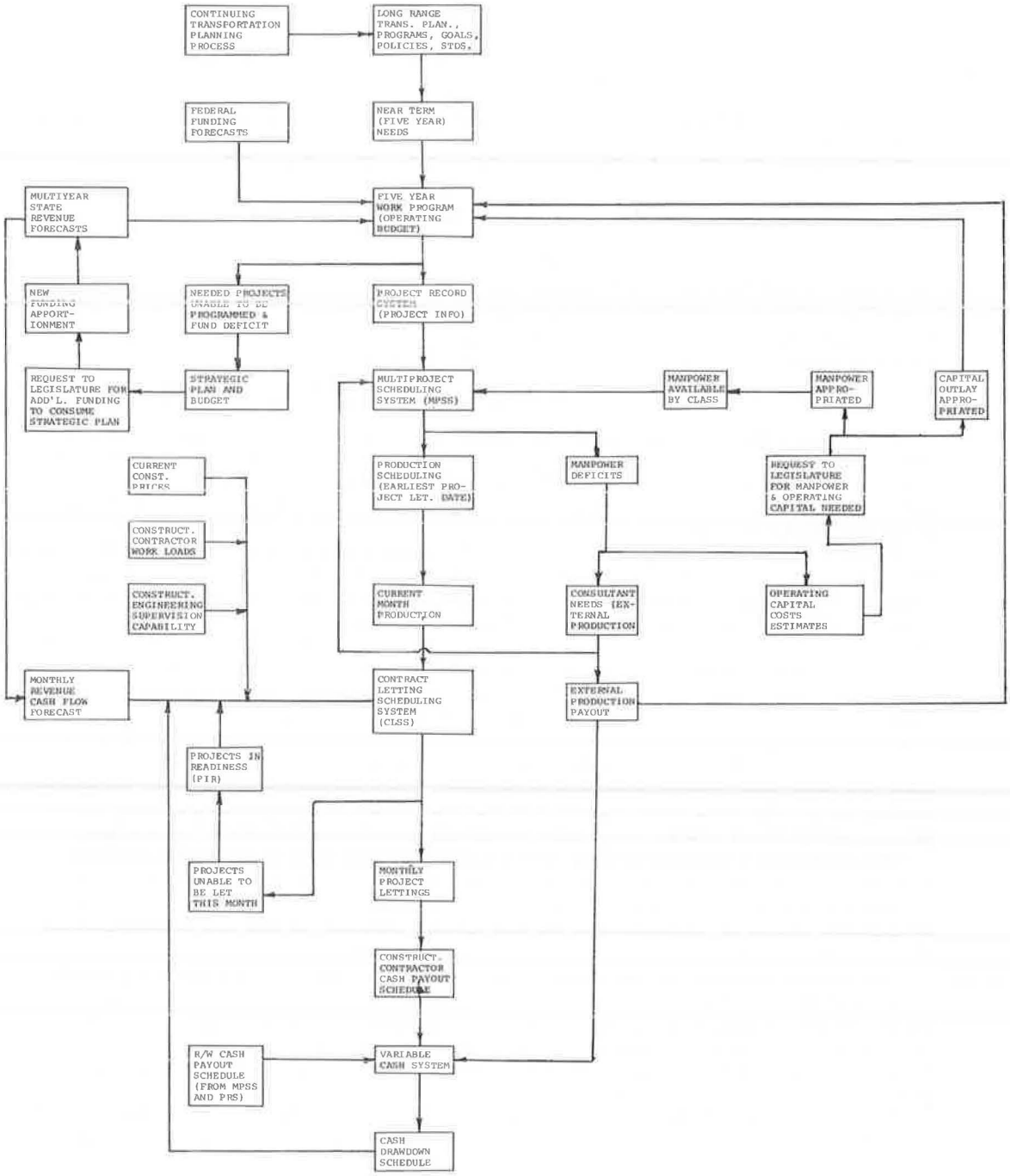
The next important step in features design is human operations. Input requirements should be minimized to allow the systems to become operational as soon as possible.

IMPLEMENTATION

Top Management's Perceptions of Decentralized Organizations

One potential source of difficulty in a large decentralized organization that attempts to install an MIS is the use and purpose of the system as viewed by top management. It is not difficult for an uninformed district manager-engineer to perceive the installa-

Figure 2. Simplified model of the Florida DOT management system.



tion of such a system as (a) a power play by some individuals in the central office, which is designed to further their own self-interest and stature or justify their existence in the organization or (b) a spy machine that is designed to find out what the district manager is doing wrong and discredit him wherever possible.

If either of these views or similar views are permitted to exist, then surely only minimal MIS success can be realized in those district units. At worst, the district manager can assist lower management in discrediting the new system and succeed in its complete sabotage.

The remedy for this syndrome is simply for top management in the central office to enlighten the district unit and gain its participation in the planning and design of the system. As a result, the credit for its success will be shared with district management as well. Because top management will not likely learn of interdepartment rivalries and jealousies, it must assume that they exist and take actions to ameliorate the conflict by formulating and presiding over formal or informal policy committees composed of potential groups that are responsible for system development and implementation.

Potential Lower Management Resistance

Fears are the foremost reason for rejection of a new system of management operations. Being "found out" by MIS is one fear felt by the less competent operating managers. MIS, when properly designed and executed, can assist top management in discovering units that exhibit poor schedule or production performance. This should not be concealed in any way inasmuch as it would only lead to lack of confidence in top management's integrity. In fact, there should be no attempt to alleviate this type of fear because it could be the motivational force that makes effective managers out of some ineffective ones. Although the threat to security is a negative force in the implementation of MIS, it can be a positive force in the motivation of those managers most likely to exhibit the greatest fears.

Another fear that may be exhibited by middle management is that of losing authority. In cases where middle management hordes information to gain dependency relationships with its colleagues, MIS can force a release of this bottlenecked information through required reporting procedures. There is no remedy, nor should there be any, for this type of fear because individuals guilty of this practice are defeating the purposes of the organization for self-gain. Attempts on the part of these individuals to sabotage the system can be thwarted by instituting close quality control over the information supplied by these managers to the system and by inducing more participative decision systems into the organization before MIS is implemented. This will also ease the pain of any redistribution of authority and power after the installation of the MIS.

The type of fear that should not be allowed to exist is fear of the unknown. It is the responsibility of top management and its MIS implementation force to ensure that the system, its functions, purposes, advantages, and disadvantages are honestly displayed and understood by all involved.

Interdepartmental Politics

A final form of resistance may develop where decision-making responsibility appears to be infringed on by a newly formed MIS bureau of staff authority. Although many MIS functions will be newly created functions, those related to personnel requirements (man-loadings) and accounting (financial planning) may create fears or overlap of MIS management functions with those of the personnel department or the accounting department. The concept of bureau territoriality and its resulting conflicts (8) can result in the demise of the system if top management does not take actions to see that the competing bureaus identify the same specific objectives and ultimate departmental goals. Once the correct objectives are clearly identified, it then becomes possible for top management to direct and induce by policy the mutual cooperation, participation, and responsibility for seeking out and achieving staffing levels and lines of responsibility necessary to consume anticipated (or gamed) funding situations dictated by the external organizational environment.

A classical example of prime importance to top management in establishment of MIS

is the conflict of attempting to "zero-out" accounts or lower existing cash balances that are in excess of legal requirement and flow more usable cash into the economy versus attempting to see that balances do not fall below a higher level. The accounting function deals with finance in real time, the here and now. The MIS function is one of forecasting, anticipating, predicting, and attempting to consume forecast financing by making optimum manpower allocation decisions now. It is important to recognize that the strategic decisions suggested by information gained from MIS must be subject to the dictates of the legislative authority vested in the accounting system. Therefore, it is incumbent on top management to see that this relationship is clearly understood by both parties and that unified objectives are applied by those in leadership roles in the potentially competing bureaus. It is also important to recognize and be sensitive to the value of equally distributed rewards in defeating competitive, jealous, antigoal sentiments generated by potential or actual overlaps in areas of functional responsibility.

These same policies apply to personnel-MIS relationships. In fact, a new role may be carved out of the MIS implementation process for the personnel department: monitoring social and behavioral tendencies precipitated from current system implementation policy and suggesting alternative policies as required. The personnel department can also be of great assistance in solving turnover problems in critical production units and by altering obsolete personnel policies.

Strategy for Implementation

MIS implementation by its very nature affects the people in the organization, the policy systems of the organization, and the design of the organizational structure itself. Being incompatible with any of these elements will certainly help the demise of the system. Therefore, one of the broad design objectives of MIS should be to maximize its compatibility with existing human behavior patterns, organizational policies, and organizational structure. However, achievement of this objective is limited severely by the fact that the system, its implementation, and operation will certainly alter each of these elements of the organization. In short, some changes will be necessary in the organizational environment of the MIS if it is to survive. These changes must come from top management.

This was found to be particularly true in the Florida DOT. In interviews with MPSS users in the various districts, the degree of success of the system in a particular district was very strongly correlated with the degree to which top management in that district supported and used the system.

The support needed from top management should be spelled out, and commitments should be obtained before MIS is designed. This support should come in the form of new policies, organizational structure modifications, and a total commitment to install the MIS successfully.

It is assumed that most large state transportation organizations are managed predominantly under the traditional or nonbehavioral approach. Unpublished surveys studied by the Business Science Corporation, during management seminars conducted for state transportation agencies, support this. If MIS is to incorporate behavioral tactics and simultaneously be consistent with the organization's policies, then it would follow that some measure of behavioral policy will need to be integrated into the nonbehavioral organization.

Top management must modify the organization's structure in a way that houses and interfaces MIS and its procedures with the rest of the organization. These modifications can be formal or informal.

Formal modifications include the creation of a staff to operate and manage the system (and possibly the alteration of the number of scalar levels or the broadening of spans of control). However, these modifications can be achieved informally through rechanneling informal informational flow patterns and redefining roles.

Top Management Commitment to Install MIS Successfully

Top management must seek out the goal of successful implementation and operation of MIS and convey that desire to the organization as a whole. The importance and sig-

nificance of top management's commitment to this end are summed up by a middle manager at the Florida DOT: "When you are told to get with it, you get with it, even if it is not worth getting with." Whereas the negative sentiment implied is not typical of all Florida DOT middle managers, it does point up the fact that a top management commitment can have considerable influence on the behavior of system users who are undecided about the usefulness of the system.

Successful selling of a new product depends first on developing a product that is responsive to some market need and then on demonstrating that it does, in fact, fill that need. The top management commitment to absorb beginning costs and get the ball rolling is crucial to achieving the demonstration goal inasmuch as it can be guaranteed that everyone will not be sold on the product during orientation and training. However, it is during the orientation and training program that top management should mention its desire for successful implementation of MIS and demonstrate knowledge of the system and its goals.

EXTERNAL MANAGEMENT STRATEGY

External Organizational Goals and Interorganizational Relations

The overall external strategy of any organization is entirely a function of the philosophy of top management in the organization and the external environment with which top management is confronted. The important message here is the fact that a successfully operating MIS presents top management with an infinitely greater capability to compete, affect, and exploit, rather than adapt to, the external environment. These same strategic planning concepts apply to the decentralized units of organization that compete with one another to consume their work programs within minimum time spans by exploiting and capturing discretionary statewide expenditure commitments when other districts are unable to consume their monthly or quarterly program allocation. These concepts also suggest some notion of a distorted profit objective in public administration, which has been criticized for its lack of survival motivation prevalent in private industry. But, again, an entire paper could be devoted to this subject alone. Let it suffice to say that MIS can assist in producing healthy, competitive, strategic intraorganizational behavior through a strategic planning mechanism.

SUMMARY

This paper has not attempted the impossible task of designing in detail MIS for universal use by all large transportation agencies. It has identified the key issues associated with the organizational environment, general development and design of the system, and strategy development for implementation based on the Florida DOT experience. Specific goals, policies, and stragegy are recommended for use in resolving many of the more pertinent policy issues that large decentralized transportation organizations should expect to confront once the decision is made to install MIS. The relationship between the many factors affecting the success or failure of MIS is addressed, and a total systems approach, which includes emphasis on human behavior as a relevant variable, is suggested. A short comment on the relationship between successful MIS operations and strategic internal and external organization behavior is offered.

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MANAGEMENT RENAISSANCE

John L. Wilcox, J. L. Wilcox and Company

Knowledge, technology, attitudes, trends, and events create today's most critical management problem: change. Results or achievement is important to the manager who must deal with change and who must maintain a balance between the management of systems and the management of people. Total reliance on systems can prove detrimental. The manager must focus on the human side of management. Behavioral science can provide a valid explanation of motivation and productivity, for it concerns itself with production and the individual rather than with systems. Behavioral science can help to convert professional engineers into professional managers through self-development and organization development.

•MOST MANAGERS identify critical management problems as crises in labor relations, availability of adequate financing, lack or excess of information, rate of technological advance, and other equally disturbing conditions. Whether a condition or group of conditions exists in deficit or surplus makes little difference; the problems created for today's manager by society are truly staggering. Other managers, however, are saying that today's most critical management problem is change.

Regardless of specialization, nothing affects our vocational life more than change. Knowledge and technology—not to mention attitudes, trends, and events—are confronting us at such a rate that change has become a constant. The pressure on managers not only to be abreast of events but also to be able to predict future trends and conditions is increasing daily. It should not be surprising, then, that learning to deal with change, to manage it by developing a climate that not only accepts it but is conducive to it, has become a mark of the professional manager.

THE CHALLENGE

Our society is built on service and profit. Service is important from the public sector and is measured by citizens in terms of physical facilities, protection, and social assistance. Profit is important from the private sector and is measured by citizens in terms of dollars. In one respect the public mind does not necessarily distinguish between the two: Both represent or are a measurement of results. Results not only are important to the effective manager but also must be foremost in his mind.

Within that results-oriented atmosphere, managers are faced with developing processes that will allow them to manage in an intelligent, informed, and expeditious manner. Given that American managers work in the most technologically advanced society in the history of civilization, it is easy to understand why so many have turned to manual and computer-based systems for assistance in dealing with change and producing results.

The challenge seems to be achieving a certain detachment from the day-to-day pressures brought about by change and demand for results to determine the most appropriate balance between management of systems and management of people. We contend that an imbalance between the two exists and that in many sectors the reliance on systems to do the entire job has reached a detrimental level.

A CASE STUDY

A large public works department was beset by a difficult but not unusual dilemma. The department had a large number of approved projects on its capital improvement

program. There were pressures from citizen groups, political forces, and other groups to reduce the preconstruction time required by the department to increase the tangible results of the department. Upper middle management personnel, protected by civil service, had historically enjoyed near autonomy over its areas of responsibility. An exorbitant amount of time and energy was spent in protecting that autonomy.

The usual ploy used to increase power was to increase staff. This was accomplished by stockpiling and inventing work and requiring overengineered designs. The managers further increased their power by reviewing designs of other sections in great detail to find and recommend some slight modification or change. The result often was arbitrary and unneeded design changes. The managers also increased their area of responsibility by unilaterally assuming new responsibility. This led to duplicate functions within the department and jurisdictional disputes.

Department management's challenge was clear. Projects had to be speeded through a hostile and competitive group of divisions and sections. The department's solution was to install an expensive but well-conceived project management system. Theoretically, the system gave project responsibility for the entire preconstruction phase to a single engineer. It was assumed that a secondary benefit of the system would be the reduction of the competing supervisors' power and an increase in interdivisional and section cooperation.

In practice neither happened. The project management system was installed. Project engineers, buoyed by the opportunity to demonstrate their competence, seized the challenge. Section managers watched with alarm, thinking that the new system was a direct attack on their own power and authority. Still having the power of promotional recommendation and veto in their hands, the managers were soon able to kill the results orientation of the project engineers, and within months the project engineers were reduced to little more than clerks. Department management had failed to recognize that solidly entrenched, autocratic supervisors would see change as an attack and would react with active, open resistance to it. Management had failed to recognize the importance of a concomitant effort to prepare the department for change when the system was being introduced.

Today, this public works organization is faced with a system that makes tremendous demands on the organization but does nothing to support the organization's efforts. It requires a major expenditure of time and attention, yet it does not relate to the actual work being accomplished. To revert to the old method of project management would be a clear invitation to chaos and disaster; therefore, management is attempting to repair what it now has. Fortunately, these efforts are succeeding, and the department can look forward to the day when the project management system will play its proper, supportive role within a full-productivity climate. This role is based on interpersonal competence, meaningful goals, helpful systems, and individual and group self-actualization.

This department discovered that there is more to effective management than the development of sophisticated systems. Such discoveries are bringing the human side of management back into focus.

BEHAVIORAL SCIENCE

Coincident with our country's rush to embrace technological advance has been a rush to discover the nature of the American worker and his relationship to groups within the work environment. The growth of professional engineering, for instance, has been matched by the growth of a smaller, but equally dedicated, group: behavioral scientists. Their research, opinions, and findings with practical applications for industry and government are already affecting us all.

This century has seen the development of three major schools of management theory: scientific, human relations, and behavioral science. Only behavioral science remains a valid explanation of motivation and productivity and has answered the questions about individuals and groups that managers have asked. That does not mean, however, that scientific and human relations management have not provided some foundation on which behavioral scientists could build.

Scientific management's best known champion was F. W. Taylor, who emphasized time and motion studies, standards of performance, organization structures, and an identification of the placement of authority and responsibility. Taylor's work is criticized, often unjustly, for its lack of concern for people.

The human relations movement is often identified with an outward concern for people, company-sponsored activities, and fringe benefits; it is also known as manipulative and insincere. In an effort to create a happy family atmosphere, morale was emphasized at the expense of results. The outcome was often happy, but unproductive, workers.

The behavioral science movement is marked by a concern both for production and for the individual. Its research not only is applied to the total organization and is oriented toward economic objectives or results but also is humanistic and concerned with the development of both vertical and horizontal interpersonal competence. One of the most notable characteristics of the movement that sets it apart from its forerunners and adds to its credibility is the interdisciplinary nature of its research. Psychologists, economists, sociologists, anthropologists, linguists, and educators are now contributing to a growing body of knowledge in a unified, interdependent fashion.

It is generally agreed that the work of Elton Mayo and his associates at the Western Electric Company's Hawthorne plant marked the merger of industry and science. This classic study has given us the term Hawthorne effect and is known by even the most junior manager. Although Mayo's findings are still debated by behavioral scientists, their general thrust is the effect of group pressure on individual behavior.

Roughly 10 years after the publication of the Hawthorne studies, Lewin (6) was able to prove that groups have a personality of their own and that the group personality was identifiable in terms of attitudes, values, and goals. These basic discoveries, coupled with knowledge generated by the Hawthorne studies, spawned a new field of study known as organizational behavior. Organizational behavior, in turn, grew into the larger discipline of behavioral science.

In 1959, Herzberg (4, 5) published his highly controversial motivation-hygiene theory, which states that the opposite of job satisfaction is not job dissatisfaction, but a lack of satisfaction. Conversely, the opposite of job dissatisfaction is not job satisfaction, but a lack of dissatisfaction. Herzberg identified certain conditions called job content factors or, simply, satisfiers, the presence of which allowed job satisfaction and the absence of which disallowed the opportunity for job satisfaction. He also identified certain job context factors or dissatisfiers, the presence of which led to job dissatisfaction and the absence of which simply disallowed the opportunity for job dissatisfaction.

Satisfiers are the opportunity for achievement, recognition, responsibility, advancement, growth, and the work itself. Dissatisfiers are company policy and administration, supervision, working conditions, interpersonal relationships, salary, status, job security, and family life.

McGregor's book (8) has become a classic text on the theory of management. McGregor saw management as a profession but one that must be based on available scientific and technical knowledge to be professional. He saw a gulf between businessmen and those who were developing behavioral theory, recognized a need for mutual support, and devoted much of his life to bringing the two together.

In his theories of management, McGregor saw that men's assumptions of what people are like fell into two distinct and opposing attitudes: X and Y. Theory X states that people have an inherent dislike for work, that they will avoid it if they can, and that they must be coerced to work toward organizational goals. It also proposes that the average human has limited ambition, prefers to be directed, and wants security but little or no responsibility.

Theory Y is an optimistic and realistic view. It postulates that work is as natural as play and rest and that men will exercise self-direction and self-control. It also says that commitment to objectives is a function of reward and that people not only will accept but will seek responsibility. Finally, theory Y states that most people are imaginative and creative in problem-solving tasks but that their potentialities are being only partially utilized in vocational life.

Theories X and Y have been confused by many managers. Many see the difference between X and Y management as the difference between hard or tough management and

soft or easy management, and this is a misunderstanding of McGregor's basic findings. The misunderstanding is unfortunate, for the accurate definitions well illustrate the way managers look at themselves and their subordinates.

Maslow (7) had no prior contact with either industrial or managerial psychology; however, he was aware of possibilities for applying general psychological theory to the business environment. His journal (7), a diary of random thoughts, notes, and outlines, accomplished that application. The effect of this short publication on the behavioral science movement has been nothing short of explosive. Today his work is generally regarded as the modern foundation or cohesive force behind the entire behavioral science movement.

His primary contribution was the application of his hierarchy of needs theory to the business environment. He postulated that, although external stimuli have an effect on motivation, true motivation is an internal force that comes from within a person and cannot be imposed. He viewed man as a goal-oriented creature whose goals, or needs, fall into a clear hierarchy. These needs such as food, warmth, and sleep will motivate a person to act. Most importantly, once a group of needs has been fulfilled it no longer motivates, and the individual will then be motivated by the next higher level of needs. Conversely, the next level of needs will not motivate until the first group has been met. The hierarchy of needs proceeds as follows: physiological, safety, belongingness and love, esteem, and self-actualization (self-actualization is defined as becoming what one is able to become).

Thus, with the discovery of the importance of groups and the fact that the personality of groups could be studied and recorded, business and science came together. Maslow contributed an understanding of the nature of motivation and the primary forces that motivate humans, Herzberg added complimentary knowledge on the nature of motivation in work groups, and McGregor gave us an understanding of the nature of man and the appropriate ways to deal with him in vocational society. Throughout the 1960's many more highly original contributions were made to the knowledge that now forms the basis for professional management.

APPLICATION OF THEORY

The most important comment that can be made regarding behavioral science is that all research has been directed toward the fact that men must manage and that their ability to do so successfully rests on their ability to understand and to deal with other people.

The thrust of the research has been to develop understanding of such an order that a person may become what he has not been in the past. Although self-actualization can be difficult to achieve, it is far from impossible. Many scholars, academicians, and businessmen ask, How do we make professional managers out of nonmanagers, or how do we turn professional engineers into professional managers?

The answer lies in knowledge and its application. The process involves two basic steps: self-development and organization development. The self-development tasks require a study of the important management-related ideas developed in the last 15 years, considerable self-analysis, and development of a personal philosophy on management that accepts both motivation theory and the need for results.

The second step, organization development, is designed to introduce and perpetuate the conditions required in an organization for human effectiveness. These conditions fall into four basic groups: interpersonal competence, meaningful goals, helpful systems, and achievement (self-actualization). Interpersonal competence involves respect for individuals, honest relationships, freedom to act, team orientation, and high expectations. Meaningful goals are understandable, desirable, and attainable. Helpful systems are understandable, goal-oriented, controllable, and adaptive and provide feedback to the users. Achievement (self-actualization) provides profits or service, personal and professional growth, high mobility, minimum dissatisfaction, and a high trust factor and is committed to goals.

Obviously, this portrayal is somewhat simplistic. Transforming a rigid, autocratic, disjointed organization like the public works department discussed earlier is an intri-

cately detailed, difficult, and above all time-consuming task. The department recognized that its problems were brought about by change soon after it implemented the new management concept. The system design was valid and potentially helpful, yet the system could not be managed because supervisors had not been prepared to manage it. The department correctly determined that the solution to its dilemma lay in adjusting the attitude of supervisors toward the system, not in adjusting the system, and chose three concurrent means to accomplish this adjustment: modification of the organization structure, selected personnel reassignments, and an extensive training effort.

Management was able to turn certain elements of the organization from a craft to a functional orientation through reorganization. This step was essential to introduce the importance of externally generated goals over the more usual set of internally generated goals. Modification also identified areas of duplicative work and forced its consolidation or elimination. Finally, the change did much to reduce and eliminate the artificial barriers to communication and cooperation that had existed between organization elements.

Personnel actions also played an important role. Most notable was the forced rotation of position assignments that maintained each supervisor's level of authority and responsibility (and his pride) but stripped away his carefully constructed supportive and protective devices.

The personalized training effort was the cohesive element of the work. It used an unusual approach that drew on a variety of sources and included both classroom and highly individualized work with key supervisors. The goal of the training was a department-wide change in attitude from one of negativism and pessimism to one of positive, objective humanism with an orientation toward quantifiable results.

The task faced by the public works organization is not to be taken lightly or in haste, yet the department's problems are nothing more than a management challenge. The vehicle used to solve the problems will not be a system but will be the application of professional management expertise. Therefore it is up to the professional manager rather than the systems designer to solve what is the most important, exciting, and challenging task.

CONCLUSION

We have discussed the tremendous impact of change and the concomitant requirement on managers to deal effectively with change. Managers have been presented with a clear choice regarding how they might approach this task: They might build and rely on systems, or they might rely on the management knowledge at their command. Because they recognized a limited time resource and were unsure of their management talent, managers, during the 1960's, turned more to systems. A technologically oriented society, fascination with mathematically based decision processes, and computer availability underwrote this growing trend. Today many business managers are finding that the systems have grown out of proportion to their potential benefit, and some suspect that many systems have become an end in themselves, that they have developed to a point where they no longer relate to the problems they were originally designed to solve. They also feel that the care and feeding of systems have spawned a whole new breed of specialists whose contribution is negligible at best.

The science of management is becoming recognized. The successful application of its principles cannot be ignored. We predict a management renaissance in this decade and look forward, with anticipation, to the continuing development of professional managers.

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THE EMPLOYEE DEVELOPMENT SYSTEM

Leland G. Verheyen, Wisconsin Department of Transportation

The paper consists of a brief review of some behavioral science findings on the motivation of employees and the description of a system for employee development. The development system consists of three basic activities: delegation of authority, opportunity to perform, and evaluation. The final part of the paper contains a review of the use of the system in the Wisconsin Department of Transportation. Each of the three basic activities is made up of steps to be followed in accomplishing these activities. Delegation is divided into defining job responsibilities, defining work objectives, and reviewing the required resources. The opportunity to perform is made up of the employee performing the job while the supervisor observes, assists, coaches, and trains him. The evaluation process consists of the employee reporting progress, the supervisor checking progress, and the employee and supervisor measuring progress against objectives.

•THE FOUNDATION for the Employee Development System (EDS) of the Wisconsin Department of Transportation lies in a statement by Herzberg (1): "The precept that the worker has to work out of duty is no longer valid and it is becoming apparent to management that the worker must be willing—if not eager—to work. Once this is recognized, managers have a responsibility to do something about the motivation to work." EDS was developed to provide a supervisory process based on recent developments in the field of management. This paper will review several concepts on the theories of motivation and present a system that uses these concepts in supervising employees.

BACKGROUND

Maslow (2) states that there are only five basic needs that motivate man: physiological needs, safety needs, belongingness and love needs, esteem needs, and the need for self-actualization. If an employee can satisfy these needs through his job he should be willing to work. The physiological needs of our employees, and in fact of most working people in this country, are being met to a reasonable degree. There are very few employed persons who do not earn enough to provide food, shelter, clothing, and other basic essentials for themselves and their families. Therefore, this need will not be addressed.

Employee safety needs can be viewed from two perspectives. Part revolves around his desire to be free from physical harm. The safety program of our department is designed to safeguard the employee from physical danger at work. The other part is related to the need for job security. This security is threatened by the supervisor's evaluation of the employee and changes in the job. EDS recognizes this need and tries to satisfy a portion of both the safety need and the belonging or love need. The major emphasis of this system, however, is to satisfy the esteem needs and the self-actualization need.

Employee motivation can also be viewed from the perspective of the responsibilities given employees. Many management systems used in the past and much of the theory used by some present day managers are based on relieving the employee of any type of responsibility. This is one of the basics of scientific management as seen by Taylor (3), the originator of many concepts of industrial engineering. Herzberg (1) analyzed the effects of Taylor's theory as

> Managers soon adopted the principal of scientific management, with its basic discipline—industrial engineering. The essence of industrial engineering as applied to people is to remove the effects of one of the prime laws of psychology, the law of individual differences. This is, if one man has ten talents, another nine, and others eight, seven, six, and on down the line to one, the most efficient procedure would be to structure and limit the work task so that the one talent held in common would be utilized. This technique provides for the elimination of variability or individual differences. In this way the possibility of error is minimized, but the maximization of the waste of human talents also takes place. The ten, nine, eight, and so on talents that people possess are suppressed in order to insure freedom from error....
>
> People were thought to be delighted with the fact that they did not have to make decisions. Management believed that those people were happy workers who did not have the responsibilities of management. The concept of the idyllically happy worker attuned to the factory system in which all decisions were made for him was as erroneous as the Rousseauan myth of the Noble Huron.

Herzberg's study of the satisfied and dissatisfied employee shows that the satisfied employee (a) has a job worth doing (in the employee's estimation), (b) has the opportunity for achievement in the task he is doing, (c) is given recognition for achievement, (d) has an opportunity for advancement (growth), and (e) has responsibilities. These five common satisfiers are motivators that all relate to the task an employee is given to do. EDS attempts to provide these motivators. Advancement will be accomplished as the employee develops both himself and his job.

McGregor (4) developed generalizations, which provide a basis for new theory with respect to the management of human resources. He states that managers who make the following assumptions will allow employees to satisfy their needs for esteem and self-actualization at work.

1. Expenditure of physical and mental effort in work is as natural as it is in play or rest.
2. External control and threat of punishment are not the only means of bringing about effort toward organizational objectives. Man will exercise self-direction and self-control in the service of objectives to which he is committed.
3. Commitment to objectives is a function of rewards associated with achievement of objectives.
4. The average human being learns, under proper conditions, not only to accept but also to seek responsibility.
5. The capacity for exercising a relatively high degree of imagination, ingenuity, and creativity in organizational problem solving is widely distributed in the population.
6. In modern industrial life, the intellectual potential of the average human being is only partially utilized.

Using these assumptions, a manager will allow an employee to achieve his own goals by directing his efforts toward the objectives of the enterprise. McGregor identified four steps of the strategy: clarification of broad job requirements, establishment of specific "targets" for a limited time period, use of a management process during the target period, and appraisal of results. In EDS an attempt is made to use this strategy.

The training staff of Wisconsin DOT developed EDS, which was built on three activities: delegation, opportunity to perform, and evaluation. Each activity comprises several steps. Success of EDS depends on accomplishment of each step of the system. Some steps must be accomplished by the supervisor; some by the employee, and some by the combined effort of the supervisor and employee.

DELEGATION

In delegating responsibilities, the employee and the supervisor first review the employee's job description. In reviewing this job description, they must try to understand the efforts of all individuals toward goal accomplishment. They can get a better perspective of the functions of an individual employee by looking at a cross section of functions performed at several levels in the organization. If the functions carried out by all individuals in the organization were placed in a cylindrical file, a cross section could be viewed at the position of a worker, a supervisor, or a manager (Fig. 1).

The functions of a worker can vary greatly. Functions of the supervisor and the manager also vary over a large range. For reasons of example the function of a typical worker, a typical supervisor, and a typical manager will be reviewed.

The functions of a typical worker (Fig. 2) are broken into three categories: production, supervisory, and managerial. Most efforts of the worker are related to producing an item or a service at or below a specified cost (time, money, and materials) and at or above some quality standard. In addition to these production efforts, he is involved in several supervisory functions: He tries to improve methods of performing his production function, is trained and trains others to do his job, and may be coached by his supervisor or coach helpers or co-workers. He also directs some of his efforts to managerial areas. He tries to influence the organization through suggestions and discussion on items such as planning and organizing and attempts to influence the methods and amount of control the organization has on him and his environment. Even though he is not an official representative of the organization, he represents it in his contacts with the public both while at work and during nonworking hours. Many managers see the only function of a worker as production. This is a shortsighted view of the worker's function and ability.

Figure 3 shows the functions of a typical supervisor. In the production process, he assists subordinates in the unusual or more difficult tasks. Much of his time is spent in developing production methods, training and being trained, and coaching and being coached. He reports to management and receives reports from workers and other supervisors and participates in three functions that are not performed by the workers: the budget process, cost analysis, and production quotas. He coordinates the work of the worker, selects workers to do each task, and may be involved in choosing new employees. In discussions with management about planning and organization, he may recommend policies and procedures for control of the enterprise. He represents the organization to the worker and to the public formally and informally. The supervisor is involved in more functions than any person in the organization, and yet he probably has less background to accomplish his functions, when entering his supervisory job, than any other person in the organization.

The manager's job (Fig. 4) requires a considerable change in direction of effort from that of the supervisor. He is still involved in coaching and being coached, training and being trained, staffing, determining the best production methods, and reporting on the activities of the organization and on outside influences on the organization. He coordinates the work of several supervisors and devotes energy to the budget process. However, he must develop more sophisticated methods for handling the managerial processes of planning, organizing, controlling, and representing the organization. The manager does not get involved in the production process.

A careful analysis of the functions of the individual must be made to determine where his job is located in this imaginary file. Job description and job functions must coincide. After the worker and his supervisor determine the employee's function and review his job description, the first step of the delegation process can be taken. A listing of job responsibilities can be made jointly by the employee and his supervisor so that there is a mutual understanding of the job responsibilities. Figure 5 shows a typical job responsibility form. These statements are written in the action mode to ensure an understanding of the action to be taken by the supervisor and the employee. The employee will generally view this process of mutual agreement as one that gives him more control over his environment. The process goes a long way toward satisfying his need for job security and provides some feeling of belongingness for him.

In the next step in the delegation process, the employee and his supervisor develop specific objectives to be met. The objectives should meet the following criteria:

1. They must be listed so that the specific accomplishment is well-defined.
2. They must be measurable units (i.e., parts per hour or per week, complaints per month, or deadlines).
3. They must be realistic, achievable goals. Objectives that cannot be achieved will only defeat the delegation process and lessen the employee's motivation. If the objectives are too easily attained, the process will do little to help the employee motivate

Figure 1. Job function file.

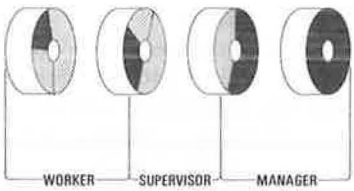


Figure 2. Worker job functions.

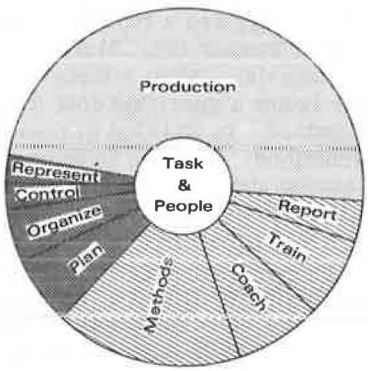


Figure 3. Supervisor job functions.

Figure 4. Manager job functions.

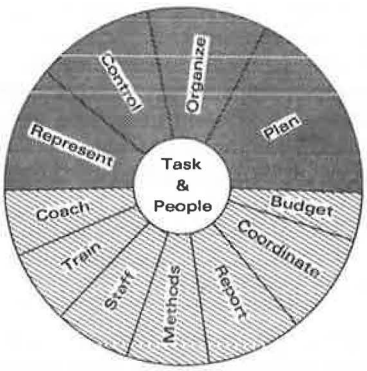


Figure 5. Job responsibility form.

EMPLOYEE DEVELOPMENT SYSTEM

Name	Title	Date
John Doe	Insurance Specialist	May 13, 1972

Job Responsibilities

State specific areas for which the employee is responsible.

List the functions performed under his command.

Supervisor and Employee must work together in developing these job responsibilities.

1. Obtain insurance for all vehicles owned by the Department of Transportation.
2. Recommend insurance coverage requirements of all Department of Transportation equipment.
3. Negotiate settlement of D.O.T. damage claims on members of the public.
4. Etc.

himself. As a general rule it is better to have objectives that can be accomplished easily than to have objectives that cannot be reached at all. This is especially true over short periods of time.

4. They must relate to job responsibilities. These criteria will remove the artificial barriers frequently placed between the employee and the accomplishment of his task. As the employee and supervisor develop and then review the list of objectives, all objectives that do not relate to the job responsibilities should be removed, or the job responsibilities should be changed. For example, in Figure 5 an objective to attend the annual highway construction conference is unrelated to the job responsibilities. This objective only results in another item interfering with the accomplishment of the other objectives.

5. They should include at least one area of growth. This will allow the employee to do a maximum job in his present position or prepare himself for advancement to more challenging positions. To define growth areas requires that caution be taken to outline only small amounts of development at a time. A small growth increment during short time spans is more successful than taking large growth steps over long time periods.

Figure 6 shows some of the objectives developed for the insurance specialist. Objectives 1 through 4 relate to the first job responsibility (Fig. 5). They specify, in measurable terms and with time limits attached, the job to be done. Objective 4 results in establishment of a method to measure attainment of the first three objectives. Objectives 5, 6, and 7 relate to the second job responsibility. The sixth objective is an item of self-development or growth and requires that additional knowledge be gained. All of these objectives are a result of in-depth discussion between a supervisor and an employee.

Many supervisors fail in the final step in the delegation process. The definition of job responsibility and the setting of job objectives will be of no value unless the employee is given resources to accomplish the task. This resource review process requires that the supervisor discuss with the employee at least 10 resource items that may be needed in reaching his objectives (Fig. 7). If the necessary resources are available to the supervisor, he can make a selection and furnish them immediately or when required. If the resources are not available, the supervisor may have to request the appropriate resources from his superior. The supervisor must inform upper management of the resources required by the worker. Lack of this communication will result in less efficient operations: Management will not be able to act because of the unknown problems. Many employees have been frustrated in their efforts to perform their task by the absence of the necessary resources. If the enterprise cannot furnish a necessary resource, the employee should not be expected to accomplish the task. Either an alternate means for accomplishing the task must be identified and resources made available, or the employee must be relieved of the responsibility for task accomplishment.

Discussions between the supervisor and worker usually generate information and ideas that are useful to management in streamlining or economizing the work of the enterprise. The supervisor will also obtain information on the work environment and the employee's attitudes on company policy and administration. After working with each employee in this delegation process, the supervisor can provide management with information otherwise not easily obtained from the work force.

OPPORTUNITY TO PERFORM

The delegation process identifies job responsibilities and specific job objectives and provides the resources required to meet these objectives. The employee must now be given an opportunity to perform his work. This opportunity should be coupled with an effort on the part of the supervisor to observe, assist, coach, and train the employee. These supervisory functions are essential to employee growth and development.

The supervisor can observe the employee from several perspectives. Many methods may be used and should be used in accordance with the task being performed.

1. Review the reports of the employee, and look for strengths and areas for improvements.

Figure 6. Work objective form.

EMPLOYEE DEVELOPMENT SYSTEM

Name	Title	Date
John Doe	Insurance Specialist	May 13, 1972

Work Objectives

State the objectives in measurable quantities.

Supervisor and Employee must work together in developing these work objectives.

1. Obtain insurance on all vehicles purchased by the D.O.T. prior to delivery of the vehicle.
2. Obtain insurance renewals on all vehicles owned by the D.O.T. prior to cancellation of old policies.
3. Terminate insurance coverage on D.O.T. vehicles at the time of disposal of the vehicles.
4. Maintain a list of vehicles owned by the D.O.T. which includes: Date of purchase, date of first insurance coverage, length of coverage, dates of renewals, date of termination of coverage and date of disposal.
5. Complete a study and submit a report of insurance requirements for all D.O.T. equipment by October 10, 1972.
6. By June 15, 1972, obtain a working knowledge of recent changes in the Wisconsin insurance laws which will go into effect on January 1, 1970.
7. Present a report proposing changes in our present insurance coverage by August 15, 1972.
8. Etc.

Figure 7. Resource review form.

EMPLOYEE DEVELOPMENT SYSTEM

Name	Title	Date
John Doe	Insurance Specialist	May 13, 1972

Resource Review - Relate resources to work objectives.

1. **Staff Requirements** – Present staff of 2 can handle only Division of Highways equipment. Two additional staff members will be required by September 1, 1972.
2. **Space Requirements** – Present space is sufficient for present staff. Space for four staff members should be supplied on the fifth floor.
3. **Furniture Requirements** – Present furniture sufficient for present location. Two desks, chairs, tables, bookcases and file cabinets will be required on fifth floor.
4. **Machinery Requirements** – None
5. **Tool Requirements** – None
6. **Supply Requirements** – Present sources are sufficient.
7. **Communications System Requirements** – Present system is sufficient.
8. **Personal knowledge, skills and abilities review** – Take course in 1972 Insurance Law Changes at U.W. Extension May 28, 29 and 30. Attend Management Course in Effective Writing.
9. **Sources of Information** – Present periodicals and bulletins are sufficient.
10. **Types of Communication to be received** – List of purchases, organizational changes, lists of disposals.
11. **Budget** – Present budget is sufficient.

2. Read copies of the employee's memos or letters (preferably after and not before they are delivered).
3. Discuss the employee's work with him.
4. Allow the employee to lead discussions in the supervisor's presence.

The data collected in this observation process will be useful in the employee evaluation process. Effort should be made to see the employee from the viewpoint of peers, subordinates, and customers.

The supervisor should assist the employee in the accomplishment of his task by

1. Supporting him in decisions he has made,
2. Supporting him in discussions concerning task performance,
3. Introducing him to persons who can help him accomplish his tasks, or
4. Performing tasks when the employee needs assistance or is unable to perform the task because of lack of skill or knowledge.

These and other methods of assistance will help to satisfy the employee's belonging needs. And the supervisor must coach the employee in the same way as a sports coach handles a team.

Operate From the Sidelines

The supervisor should stand far enough (physically and mentally) from the task being performed to see not only the task of the individual but also the action surrounding the job, i.e., the conditions under which the task is being performed.

Encourage Learning by Doing

Supervising is not peering over the employee's shoulder until he is afraid to raise his arm for fear of hitting the supervisor in the head. Supervising is picking the proper task to give the employee the experience he needs and then letting him do it. It is providing the right conditions for doing and then making the doing meaningful.

Hold to a Known Standard

An employee must know what satisfactory performance is and how it will be measured before he can be expected to perform effectively.

Earn Respect

A supervisor may be respected for his experience, his influence with the boss, his superior knowledge, his broad understanding of the business, or his maturity of judgment. But he must also be respected for his ability to coach.

Create a Climate of Confidence

A supervisor must show that he believes in his subordinates and in their capacity to improve. He must approve of them as people and believe in their ability to grow.

Use Demonstrations Wisely

Before a supervisor gives a demonstration, he should discuss with the employee what he is expected to observe. After the demonstration, the supervisor should determine what the employee did observe.

Allow for Individual Differences

A coach takes the natural material he finds and tries to improve it, but he does not try to change the employee. A supervisor should capitalize on individual differences and help each employee with his particular strengths and weaknesses.

Let People Know Where They Stand

A supervisor should frequently discuss performance with his subordinates.

Ask Questions to Encourage Thinking

A supervisor helps his subordinates think through their problems, analyze their successes and failures, and plan more effectively for the future.

Take Time and Have Patience

By demonstrating patience and determination and by providing encouragement, a supervisor can inspire people to persevere until their goals have been reached.

Work on One Thing at a Time

If a supervisor attempts to work on several phases of performance at the same time, he will only confuse the workers, create unnecessary frustration, and destroy the employee's confidence in his ability to improve.

Repeat Coaching

A supervisor can never be satisfied with a "once and done" coaching job.

Training

The supervisor must train the employee to perform his job in the most effective way possible. The capacity to learn is the central feature of human life, but some methods allow for faster learning than others. Testing has shown that 83 percent of what we know was learned through sight. Visual processes and demonstrations are essential to the learning processes. Although we remember only about 30 percent of what we see, we remember about 90 percent of what we say and do. Efforts should be made in the training process to have the employee explain and do the processes for the supervisor.

A supervisor should build into this training process "see, say, and do" procedures and methods of using repetition, arousing curiosity on the part of the employee, and offering training in areas that the employee perceives as important. Increased learning can be accomplished by creating competition among employees in the learning situation or competition of an employee against himself. (The job instruction training processes developed by the armed services are a good guide.)

Although the supervisor is not expected to be a professional trainer he should try to learn, as part of his self-development, as much as possible about the principals of learning and habit formulation. A study of these principals will go a long way toward understanding human nature and the motivation drives of employees.

EVALUATION

The employee now has a job delegated to him, and he has had an opportunity to perform the job while the supervisor observes, assists, coaches, and trains. It is now possible to evaluate the performance of the employee. The evaluation process should be made in three steps: The employee should report on his progress, the supervisor should check that progress, and they should be built into the job so that reporting is done as all other parts of the job responsibilities are accomplished.

The supervisor must collect information about job performance during the period the employee is performing the task. Production records, data relating to services performed, or complaints received should be gathered on a continuing basis. This information and the data presented by the employee can then be used to check on the progress of the employee.

The employee and supervisor together should then look at the data collected and reported to measure the progress against the objectives established during the delegation process. The objectives were originally written to indicate the quality or quantity of work to be done and a deadline by which the work should be done. The objectives and the data should now be compared. Comparisons should show both positive and negative factors relating to progress (Fig. 8).

In filling in the progress check, the employee and the supervisor must openly discuss

the accomplishment of the tasks and the obstacles encountered in accomplishing these tasks. Part of the negative factors may be a listing of these obstacles. The positive factors and negative factors probably will also reflect the timeliness of the supervisor's providing the necessary resources that were identified in the resource review. After a discussion of each of the objectives and the listing of these factors, the employee and the supervisor should record the number of objectives established and the number accomplished.

The final step in this evaluation process is the listing, by the supervisor and employee, of the major strengths of the employee and areas for improvement. These statements should be based on the objectives met and the positive and negative factors noted. - This final step of the evaluation process is based on a completely positive view of the employee. No negative statements are made. The areas for improvement should be used during the next delegation process to see that the objectives, job assignments, and resources are arranged to provide this improvement. The supervisor will again, as in the delegation process, obtain information useful to management on the attitudes and ideas of employees. This results in the supervisory staff, at all levels, being more valuable as a resource for planning, organizing, and controlling the enterprise.

RECYCLING

After this evaluation, the entire process should be repeated. The job responsibilities should be reviewed and if necessary modified. New objectives should be developed (employees will generally set higher objectives each succeeding time this is done) and resources allocated to the employee. The employee should again be allowed to perform the task while the supervisor observes, assists, coaches, and trains. And the supervisor and employee should once again evaluate the progress by reporting progress, checking progress, and measuring performance against the objectives.

This cycle should be repeated at intervals that meet the needs of the employee. Some employees require a very short time interval of only a month or two. Other employees may require the process to be repeated only once a year. It is suggested, however, that the first cycle never be longer than 4 months and adjustments in cycle length be made after the first round.

CONCLUSIONS

This process was developed and first used in the training and safety section of Wisconsin DOT. An experiment was developed to test the system, and we felt the experimental use of the process would best be done with a problem employee. At the time we had an employee working on a limited-term basis in our mail and supply room who was having some difficulty adjusting to work requirements. The supervisor-employee relationship had become very strained, and the employee probably would have been let go. We had him transferred to the training and safety section where we had a vacancy for handling audiovisual (A-V) equipment. This job required the employee to check out equipment to department employees, maintain records on where the equipment was being used, maintain equipment, and assist the training officers in accomplishing tasks.

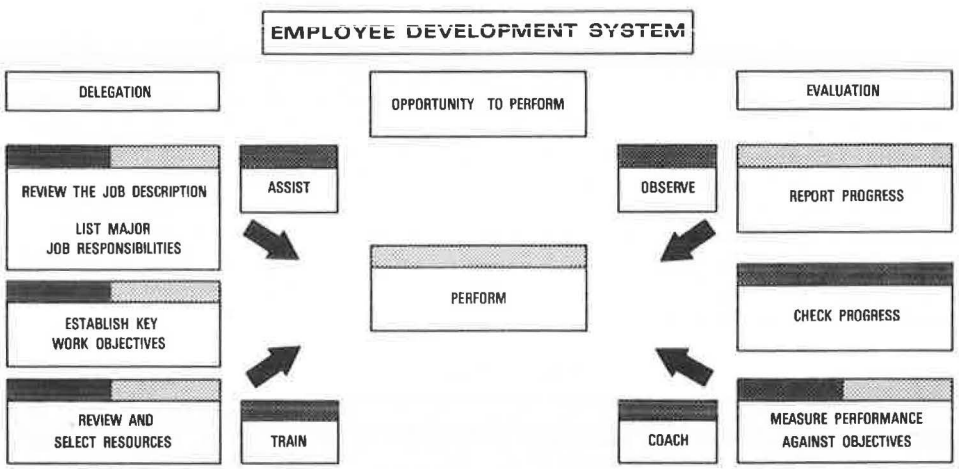
He was given individual tasks to accomplish and some general direction in handling A-V equipment. He was a problem and had difficulty doing anything right. Equipment was lost or did not operate properly, invitations to programs were sent for the wrong days or wrong programs, and services of the training and safety section dropped rapidly.

The employee and his supervisor then tried EDS. The first cycle used was for less than a month. Improvements in performance were seen immediately, and by the end of 6 months the employee had eliminated nearly all errors in the A-V equipment handling and had taken on, in addition to all other parts of his job, the job of coordinating 50 programs being presented around the state. This involved hiring the consultant trainer, arranging for training facilities, issuing invitations, introducing the trainer at sessions or arranging to have someone else introduce him, and doing an evaluation of the trainer and the training session. This was a much higher level of work than the employee had performed in the past.

Figure 8. Progress check.

	Positive Factors	Negative Factors
Accuracy of Work		
Quantity of Work		
Timeliness of Work		

Figure 9. Wisconsin DOT EDS.



Following this experiment, the system was presented to a group of supervisors for their evaluation. One of these supervisors, a materials engineer, implemented the system in his section and has been using the system for 2 years now. The results have not been so dramatic as in the case of the problem employee, but the materials engineer is most satisfied, and his section now has an outstanding record of success. (The process is now offered to any supervisor who wishes to use it.)

Employees who have been involved in EDS generally feel that they have more control over their job environment (security need). They acquire a feeling of being successful in accomplishing their objective (esteem need). They receive recognition for this accomplishment during the evaluation process (esteem needs). They feel that they are an essential part of the organization and that the accomplishment of their objectives is essential to the success of the organization (belongingness need). And they feel they have grown enough in their jobs to allow them to take on more responsibility (self-actualization).

The process shown in Figure 9 satisfies the needs outlined by Maslow and provides the satisfiers outlined by Herzberg. Use of EDS has resulted in employees with a high degree of motivation toward task accomplishment. EDS only works, however, when the supervisor believes in the ability of the employee to satisfy his own needs while satisfying the needs of the organization.

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