in excess of cost as time goes by. Our implementation started in 1980. Based on our experience and that of other states, we know PMSS is still in its infancy and its full potential will only be realized with time and use.

Idaho Transportation Department Project Development Management Scheduling and Control System

HUGH F. LYDSTON

The Idaho Transportation Department uses a commercial computer program, the Management Scheduling and Control System (MSCS), to schedule project-development work activities, forecast project completion dates, and forecast required staff within the 10-year construction planning schedule. The MSCS program is available from MCAUTO, a McDonnell Douglas company. Idaho has been forecasting and scheduling project development with MSCS since 1975. Idaho operates MSCS in a resource-constrained, multiproject mode against all projects simultaneously. MSCS calculates activity start and finish dates, extends project completion dates, splits activities, and sets priorities for resource allocation according to project start dates, project networks, personnel limits, and management priority for relative importance among projects in the same fiscal year. Management uses the personnel forecasts to determine five-year personnel complements. One person operates the system for 400-700 projects. New projects are modeled in 4-6 min/project from computer libraries of various networks. Activity durations and resource quantities are selected from the libraries according to the elements and complexity of each project. Bimonthly updates are transmitted to headquarters from six district minicomputers via telephone lines. The Idaho Division of the Federal Highway Administration has accepted Idaho's use of MSCS as the monitoring and reporting system for project development. This acceptance has eliminated written monthly reports and other proofs of monitoring required by FHWA under certification acceptance. Due to MSCS communication and scheduling, internal project action correspondence has been reduced by 70 percent. The information in this report is current to 1982.

The Idaho Transportation Department has been forecasting and scheduling project development with the Management Scheduling and Control System (MSCS) since January 1975. MSCS is a product of the McDonnell Douglas Automation Company (MCAUTO).

Idaho operates MSCS in a resource-constrained multiproject mode against all projects simultaneously. The MSCS program calculates activity start and finish dates, splits activities, sets priorities for resource allocation, and extends project completion dates according to project start date, network sequence, available personnel limits, and management priority. Personnel needs are also forecast by MSCS and are used by management in budgeting and setting personnel complements. MSCS provides a schedule of services by activity start and finish dates, provides ready-to-advertise dates for the 10-year construction program and through the administrator's report, and provides for reporting of the exceptions via staff comments. The Federal Highway Administration (FHWA) has accepted Idaho's use of MSCS as the monitoring and reporting system for all project development functions. This acceptance has eliminated a multitude of written monthly reports and other proofs of action and monitoring that were otherwise required by FHWA under certification acceptance.

The state highway administrator requires all federal aid and state projects to be on MSCS except for stockpiles, areawide pavement marking or signing projects, and buildings. All Division of Highways projects under consulting engineering contract are reported on MSCS.

The state highway administrator uses the forecast of ready-to-advertise date for each project to determine the not-earlier-than date for program fiscal year of construction in the 10-year program. If a project is not updated and, as a result, it slips two months with each two-month update reporting period, it will soon slip into the next fiscal year of the program. The state highway administrator requires MSCS to

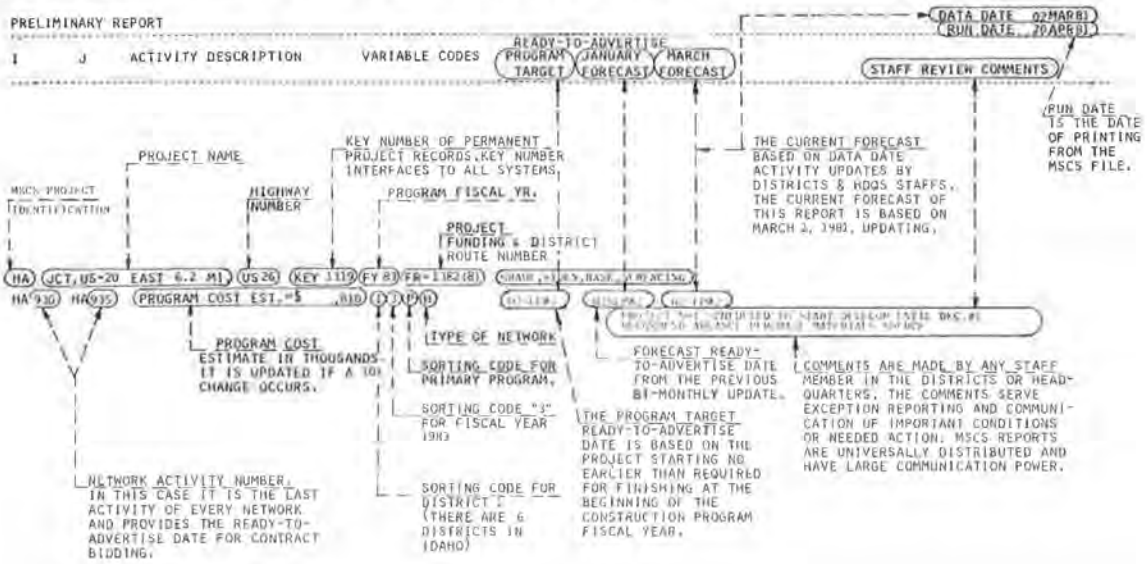
1. Provide forecast ready-to-advertise dates for scheduling the 10-year construction program;
2. Provide a schedule of project activities for each section supervisor, group leader, or lead technician with project responsibilities in the districts;
3. Provide activity scheduling for headquarters project development services; i.e., bridge, right-of-way, materials, traffic, utilities, railroad agreements, environmental, and program control;
4. Provide statewide project development communication whereby all involved personnel see the same information at the same time on any given project;
5. Provide current and future resource requirements for personnel forecasts and provide analysis of available resources versus need for consulting engineering on projects by one district for another district or by outside private consulting engineering firms;
6. Provide exception reporting for management to detect delays on specific actions and project slippage versus the program target; and
7. Provide trial testing of program scheduling and project priority decisions before they are implemented by management.

REPORTS

The state highway administrator uses the program administrator's report (Figure 1), which contains all projects in the 10-year program, for determining the earliest letting dates when adjusting the 10-year construction program. The administrator's report is also used to determine exceptions via the staff comments. The state highway administrator has directed the format of a gain-slip report that shows the gain or slip of a project in relation to the program.

The gain-slip report was specified by the state highway administrator for the purpose of reviewing the state-sponsored federal-aid projects in the first three program years. The gain-slip report provides simple and direct indication of the progress being made in project development on the federal-aid program. Since larger projects will

Figure 1. Idaho Transportation Department program administrator's exception report.



vary substantially in gain or slip as work goes on, slippage of more than three months (60 working days) is cause for management to request status evaluation.

The gain-slip report excludes the following categories of projects:

1. Environmental and location-only projects,
2. State maintenance projects,
3. State safety and rehabilitation projects,
4. All locally sponsored projects,
5. The six-year source acquisition program, and
6. All projects scheduled for construction beyond fiscal year (FY) 1983.

The gain-slip report includes all state-sponsored federal-aid projects programmed for FY 1981, FY 1982, and FY 1983.

Gain or slip is shown by program plus or minus working days. The July forecast is subtracted from the program target finish date. If the July forecast is earlier than the program, the working days are a plus (+) gain. If the July forecast is later than the program target finish, the working day difference is a minus (-). When the September update arrives, the September forecast will be the date subtracted for each project.

The program target is the model of the project set to finish on October 1, the beginning of the program fiscal year approved by the transportation board. If a project has been reprogrammed due to slippage from the original program year, the original program year is still the program target. If reprogramming occurs due to funding shifts or priority or need decisions, the program target model is shifted to meet the new program fiscal year. Program targets are only changed with the approval of the state highway administrator.

The gain-slip report is distributed with the regular MSCS administrator reports. An example report is shown in Figure 2. The state highway administrator feels that this report provides the necessary management control of project development.

The Idaho Transportation Department Director uses a special program administrator's report that shows public hearing and environmental clearance forecast dates in addition to predicted bid advertising dates and staff exception comments.

Any report can be revised or created for content or format at the request of the user. Report creation and generation requires about 45 min. Although all sorts of special analysis reports can be devised, the two usual categories of reports are staff reports and management reports.

Staff reports are activity reports selected on activities desired by the individual and needed for updating. The activity reports provide scheduling of start and finish dates, duration of original activity, and duration remaining for activities in progress. A sample staff report, a bridge group leader report, is shown in Figure 3, with updating marked by that group leader.

Management reports usually are selected on event activities--i.e., those that do not have substantial duration in working days and do not have assigned resources.

START DATES

Project start dates are selected so that predicted ready-to-advertise-for-bids dates fall on or near the October 1 beginning of the federal fiscal year. Start dates are adjusted to an earlier date in the operating MSCS file if resource limitation causes the project forecast to slip past the program target finish date. Projects that must start immediately in order to meet their program year do not have an entered start date. MSCS automatically starts a project on the current date if a late start date has not been used.

ENTERING NEW PROJECTS, UPDATES, COMMENTS, CHANGES

The Idaho Transportation Department's data-processing computer center uses Remote On-System Conservation Entry (ROSCOE) software for handling all computer entry data and submittal of computer jobs to the main machine processing queue. ROSCOE's application to operation of MSCS is the tool by which we are able to maintain precoded network activities and resources and build data sets of updates, corrections, new projects, and report requests for submittal to the MSCS file. MSCS operation commands and report requests are also stored in ROSCOE for selection in operating the MSCS program.

Rather than using the planning value and additive methodology, we have precoded all types of networks with activity durations and resources and stored

Figure 2. Sample gain-slip report.

```
                                IDAHO TRANSPORTATION DEPARTMENT                                    PAGE    6
GAIN/SLIP-1ST 3 PROG YRS        STATE HIGHWAY ADMINISTRATORS EXCEPTION REPORT                  DATA DATE  01JUL81
                                                                                               RUN DATE   3AUG81

                                                READY-TO-ADVERTISE                                      PROGRAM
          ACTIVITY DESCRIPTION                  PROGRAM     MAY        JULY      STAFF REVIEW COMMENTS  PLUS
                                                TARGET      FORECAST   FORECAST                          MINUS
-------------------------------------------------------------------------------------------------------------

 4I  LEW.INT.BR.I.C.INT     US12-X-KEY2268,FY82,F 4114(601),,URBAN,KEY2267/M 7C54(001) EACL

                PROGRAM COST EST.=$ 1,180          23FEB82   30JUN82   24AUG82                              12M.0-
                                                                     NEED RAILROAD AGREEMENT FOR TRACK RELOCATION
                                                                     PRIMARY PROJECT IN STATE SAFETY&REHAB PROGRAM

 4I  PARADISE CREEK  MOSCOW SH8 -N-8871891,FY83,BRM-7744(1),1-STRUCTURE

                PROGRAM COST EST.=$ 1,460          14OCT82   07DEC82   25OCT82                               7.0-
                                        FY SHIFT JAN 81                C

 4   RESERVE CR  ROSE LAKE IC190-A-8EY2255,FY83,I-90-1(129)29,MP29.21-35.09,MON,G.RAIL,SURF

                PROGRAM COST EST.=$ 6,420          07SEP82   17NOV82   08NOV82                              43.0-
                                                                     ACCESS CLOSURES RESOLVED LETTER  3/10/81
                                                                     NEED MATERIALS RPT&FIELDWORK FROM DIST 5
                                                                     COMB LOC/DES HRNG PLANS HAVE BEEN SENT TO DIST 5

 0C  21ST&G ST. LEWISTON    US12--KEY2504,FY83,HHS-4114(83), INTERSECTION IMPROVEMENT

                PROGRAM COST EST.=$ 1,160          07OCT82   30DEC82   22NOV82                              30.0-
                                                                C

 KZ  GROFINO-GREER          US12--KEY1540,FY83,F FR 4201(36),WIDEN&SHOULDERS & OVERLAY

                PROGRAM COST EST.=$ 1,100          27SEP82   07OCT82   27SEP82                               0.0
                                                                C

 4M  ARROW-CHERRY LANE BR.  US12-X-KEY2630,FY83,F-FR-4201(46),MON,OVLAY,MP 15.824-21.15

                PROGRAM COST EST.=$   740          23OCT87   13OCT87   09OCT87                              10.0
                                        FY SHIFT JULY 81                THIS PROJECT SHOULD BE EXCHANGED WITH KEY 259 WHICH
                                                                        IS CURRENTLY IN FY82

 4L  DEARY-YALE (STAGE 2)   SH9-N-KEY2457,FY83,SR-RS-4808(8),GR,DR,BS,SURF,MP.7.245-3.63

                PROGRAM COST EST.=$ 1,000          17SEP82   08JUL81   04SEP81                             260.0
                                                                     READY FOR FINAL DESIGN REVIEW
```

them in the ROSCOE utility library. By using a systematic index we call up copies of desired networks or parts of networks and assemble the project on the cathode ray tube (CRT) screen by using ROSCOE. The assembled project is stored as a submittal data set in another part of the ROSCOE utility library. The loading of a new project requires the usual project identification numbers, descriptive name of the project, intended fiscal year of construction in the program, and selection of the type of network, selected activity legs such as utilities and railroad, number of right-of-way parcels, and designation of each structure. With the exception of network selection and number of right-of-way parcels, all of this information is normally required for programming approval. An example of project input with network selections, right-of-way, and structures is shown in Figure 4. ROSCOE takes 4-6 min to assemble a project network with all modifications peculiar to that project and have it ready for submittal to the MSCS file.

NETWORKS

A few of Idaho's project-modeling networks are in Figures 5-7 and the MSCS program follows these networks in its calculation of start and finish dates. The networks are created by roadway design in cooperation with the districts and affected headquarters sections. District recommendations for network changes are used to make network revisions. The networks are models of the relation of activities in developing projects. As work procedures change due to new requirements or regulations, the networks on the ROSCOE library and project networks that exist on the MSCS file are changed to fit the new conditions by using computer commands that find networks and activities by defined characteristics.

External priority is used on management-selected projects where management has decided that a project is more important than other projects in the same year of the program. Priority is attached to the allocation of resources for the activities within that project. By attaching priority to the allocation of resources, all projects that use those same resources feel the effect of the prioritized project.

Each project has its own network. Individual activities or sections of networks can be linked between related projects so that the sequence of stage development can be controlled automatically. If one of the linked projects is moved in the program or if work lags, the subsequent stage projects automatically change dates. Linking of projects as a methodology with multiprojecting provides an automated monitor that reveals when sequenced projects require additional resources before the crisis develops. For example, the Wallace Interstate project consists of an historical relocation project, a major railroad relocation project, and three roadway and structures projects. The programming sequence spans five years. Each project has its own development network and networks are tied together according to many activity relations associated with the modeling of work. If the first project is moved in the program by management or if the project slips due to problems in development as reflected by updating by the production staffs, all of the subsequent-stage projects are adjusted automatically in the calculated finish dates by the MSCS program. The impact of the proposed programming decision on all of the project stages is automatically carried out due to a single start date entry. Further, the high resource priorities designated by management for the Wallace project have an automatic impact on all other projects in the program that use the same resource pools, and those projects, if affected, will have new start and finish dates calculated by the MSCS program.

Figure 3. MSCS bridge staff report for activity scheduling and update changes.

TARGET NETWORK REPORT /45 IDAHO TRANSPORTATION DEPARTMENT PAGE 10
SCHED-UPDAT REPRT DICK J PROJECT DEVELOPMENT MSCS DATA DATE 01MAY81
RUN DATE 3JUN81

I	J	ACTIVITY DESCRIPTION	VARIABLE CODES	ORIGINAL DURATION	REMAIN DURATION	SCHEDULED LEVELED START	SCHEDULED LEVELED FINISH	LEVELRES DEMAND
3F	CALD IS:STAGE 3CNN CONN 184-R-***Y 501,FY82,I IG BON 1177127, MAIN ROWY STRS,NR CONNYIC							
3F456 TITLE	CALDWELL SECTION	321	HF45PJ	0.0	0.0			
***Y 501,FY82, PROJ. I-80N-1177127 COMPLEXITY & INHOUSE		RED		I-80N OVER BOISE R.				
3F459 3F461	CONSULTANT CONFERENCE	321	HC45PJ	0.0	0.0	01MAY81	01MAY81	182.0
3F464 3F465	CONSULTANT CONFERENCE	321	HC45PJ	0.0	0.0	01MAY81	01MAY81	182.0
3F610 TITLE	CALDWELL SECTION	321	HF45PJ	0.0	0.0	01MAY81	01MAY81	2333.0
***Y 501,FY82, PROJ. I-80N-1177127 COMPLEXITY & INHOUSE		RED		I-80N OVERPASS, 10TH Ave. I.C.				
3F611 3F612	PRELIM LAYOUT&REQ FCUNDATCN	321	HF45PJ	0.0	0.0	01MAY81	01MAY81	56.0
3F613 3F614	CONSULTANT CONFERENCE	321	HC45PJ	0.0	0.0	01MAY81	01MAY81	56.0
3F615 3F615	PREPARE&CHECK FINAL LAYOUT	321	HC45PJ	0.0	0.0	01MAY81	01MAY81	56.0
RES	HT/00.2 9J/03.4 9K/06.4							
3F615 3F616	DES CALCS.SKETCH.&MCMPREACT	321	HC45PJ	102.0	15.0	01MAY81	21MAY81	56.0
RES	9J/03.4 9K/06.4							
3F616 3F618	DETAIL&CHECK PENCIL DRWGS	321	HC45PJ	82.0	40.0	22MAY81	20JUL81	56.0
RES	9J/01.2 9K/02.2 9L/05.3							
3F618 3F619	INK & PRCCF TRACINGS	321	HC45PJ	39.0	30.0	21JUL81	31AUG81	56.0
RES	9J/01.2 9K/01.6 9L/05.5							
3F619 3F620	QUANT.CCST.FINAL PLNS.SP'S	321	HC45PJ	37.0	37.0	01SEP81	23OCT81	56.0
RES	9H/00.1 9H/02.2 9J/00.6 9K/03.7 9L/06.5							
3F620 3F621	QUANTS&EST TO DIST & OTHERS	321	HC45PJ	4.0	4.0	26OCT81	29OCT81	56.0
RES	HT/00.2							

Bridge Group Leader

TARGET NETWORK REPORT /45 IDAHO TRANSPORTATION DEPARTMENT PAGE 19
SCHED-UPDAT REPRT DICK J PROJECT DEVELOPMENT MSCS DATA DATE 01MAY81
RUN DATE 3JUN81

I	J	ACTIVITY DESCRIPTION	VARIABLE CODES	ORIGINAL DURATION	REMAIN DURATION	SCHEDULED LEVELED START	SCHEDULED LEVELED FINISH	LEVELRES DEMAND
FC HARISN,ENTERFARMER CANALS48+X-KEY 386,FY82,8R FS 6742(15),HARSN+ENTERPRISE+FARMERSFRIEN								
FC633 TITLE	HARISN,ENTERFARMER CANALS 48	625B D	I J	0.0	0.0	01MAY81	01MAY81	2333.0
KEY 386,FY82,ST-6742(516)				COMPLEXITY 1,INHOUSE		HARRISON CANAL	,MP 22.82	
FC634 FC635	PRELIM LAYOUT&REQ FCUNDATCN	625B D	I J	0.0	C.0	01MAY81	01MAY81	18.0
FC636 FC638	PREP&REQ&CHECK FINAL LAYOUT	625B D	I J	16.0	~~16.0~~ 0000	31MAY81	22MAY81	18.0
RES	HT/00.1 9J/03.C 9K/05.D							
FC638 FC639	DES CALCS.SKETCH.&MCMPREACT	625B D	I J	30.0	~~30.0~~ 0000	26MAY81	07JUL81	18.0
RES	9J/03.0 9K/05.E							
FC639 FC641	DETAIL&CHECK PENCIL DRWGS	625B D	I J	20.0	~~20.0~~ 5	08JUL81	04AUG81	18.0
RES	9J/01.3 9K/02.E 9L/C5.5							
FC641 FC642	INK & PRCCF TRACINGS	625B D	I J	20.0	2C.0	05AUG81	01SEP81	18.0
RES	9J/00.8 9K/01.6 9L/05.5							
FC642 FC643	QUANT.CCST.FINAL PLNS.SP'S	625B D	I J	10.0	1C.0	02SEP81	16SEP81	18.0
RES	9H/02.3 9K/00.6 9L/04.5							
FC643 FC630	QUANTS&EST TO DIST & OTHERS	625B D	I J	4.0	4.0	17SEP81	22SEP81	18.0
RES	HT/00.2							
FC644 TITLE	HARISN,ENTERFARMER CANALS 48	625B D	I J	0.0	0.0	01MAY81	01MAY81	2333.0
KEY 386,FY82,ST-6742(516)				COMPLEXITY 1,INHOUSE		ENTERPRISE CANAL	,MP 23.58	
FC645 FC646	PRELIM LAYOUT&REQ FCUNDATCN	625B D	I J	0.0	C.0	01MAY81	01MAY81	18.0
FC647 FC649	PREPARE&CHECK FINAL LAYOUT	625B D	I J	16.0	16.0	31MAY81	22MAY81	18.0
RES	HT/00.1 9J/03.C 9K/05.D							
FC649 FC650	DES CALCS.SKETCH.&MCMPREACT	625B D	I J	~~10.0~~ 40	2C.0	26MAY81	07JUL81	18.0
RES	9J/03.0 9K/05.E							
FC650 FC652	DETAIL&CHECK PENCIL DRWGS	625B D	I J	~~20.0~~ 30	20.0	08JUL81	04AUG81	18.0
RES	9J/01.3 9K/02.E 9L/C5.5							
FC652 FC653	INK & PRCCF TRACINGS	625B D	I J	20.0	2C.0	05AUG81	01SEP81	18.0
RES	9J/00.8 9K/01.6 9L/05.5							
FC653 FC654	QUANT.CCST.FINAL PLNS.SP'S	625B D	I J	10.0	10.0	02SEP81	16SEP81	18.0
RES	9H/02.3 9K/00.6 9L/04.5							
FC654 FC603	QUANTS&EST TO DIST & OTHERS	625B D	I J	4.0	4.0	17SEP81	22SEP81	18.0
RES	HT/00.2							
FC655 FC656	DIST TO INFOSUB 210 TO BR	625B D	I J	10.0	10.0	01MAY81	14MAY81	0.0
RES	9M/03.0 9R/02.C 65/02.0							
FC655 TITLE	HARISN,ENTERFARMER CANALS 48	625B D	I J	0.0	C.0	01MAY81	01MAY81	2333.0
KEY 386,FY82,ST-6742(516)				COMPLEXITY 1,INHOUSE		FARMERS FRIEND CANAL,MP 24.10		
FC657 FC658	MOD PUBLISH PHASE 4 REPORT	625B DP1	J	8.0	8.0	15MAY81	27MAY81	0.0
FC658 FC660	PREP&REQ&CHECK FINAL LAYOUT	625B D	I J	16.0	16.0	28MAY81	18JUNE1	0.0
RES	HT/00.1 9J/03.0 9K/05.D							
FC660 FC661	DES CALCS.SKETCH.&MCMPREACT	625B D	I J	30.0	3C.0	19JUN81	31JUL61	0.0
RES	9J/03.0 9K/05.E							
FC661 FC663	DETAIL&CHECK PENCIL DRWGS	625B D	I J	20.0	2C.0	03AUG81	28AUG81	0.0
RES	9J/01.3 9K/02.E 9L/05.5							
FC663 FC664	INK & PRCCF TRACINGS	625B D	I J	20.0	2C.0	31AUG81	28SEP81	0.0
RES	9J/00.8 9K/01.6 9L/05.5							

Figure 4. MSCS precoded project development networks.

PROJECT TITLE: DEVILS ELBOW(MILE 8.8-9)US95 — HWY NO: 3AP — DIST: — CY: — FUND: — START DATE: M.03.01.82 — COST (IN THOUSANDS): $2,300

K.E.Y 3267, F.Y 84, F-3322(42), GRADE, DRAIN, ALIGNMENT IMPROVEMENT.

TYPE OF NETWORK (CHECK ONE)
- A ☐ URBAN MAJOR **
- B ☒ RURAL MAJOR **
- C ☐ MEDIUM DESIGN
- D ☐ MOD. NEG. DESIGN
- O ☐ LOCATION NETWORK
- S ☐ SHORT DESIGN
- L ☐ LOCAL SPONSOR
- E ☐ INTERSECTION IMP'M'T & SIGNALS
- F ☐ SIGNAL & MARKINGS (HOWY OR RR)
- K ☐ SOURCE ACQUISITION
- H ☐ OVERLAY
- J ☐ SEAL

ATTACHMENTS (CHECK THOSE NEEDED)
- ☐ COMBINED HEARING
- ☐ CATEGORICAL EXCLUSION ENV
- ☒ F.O.N.S.I. ENV.
- ☐ EIS ENV.
- ☒ UTILITIES
- ☐ R.R. ENCROACHMENT
- ☒ FAG AND 404 PERMIT
- ☐ AIR PORT CLEARANCE
- ☐ R.C. & M. AGREEMENT

16 NO. R/W PARCELS
NONE NO. RELOCATIONS

STRUCTURE

C O D E	ACTIVITY I NODE	ACTIVITY J NODE	A/I CD	STRUCTURE NAME OR IDENTIFICATION	HWY NO
A	.4.0.0	T.I.T.L.E	7	BIRCH CREEK(MILE 90.3) US95	
M	.4.0.0	T.I.T.L.E		K.E.Y 3267, F.Y 84.	
M	.4.0.0	T.I.T.L.E		COMPLEXITY 2, INHOUSE, SINGLE SPAN	

UCT

C O D E	ACTIVITY I NODE	ACTIVITY J NODE	A/I CD	STRUCTURE NAME OR IDENTIFICATION	HWY NO
A	.4.1.7	T.I.T.L.E	7	VALLEY CREEK(MILE 91.4)US93	
M	.4.1.7	T.I.T.L.E		K.E.Y 3267, F.Y 84.	
M	.4.1.7	T.I.T.L.E		COMPLEXITY 3, INHOUSE, DISTRICT PROPOSES VOIDED SLAB	

URES

C O D E	ACTIVITY I NODE	ACTIVITY J NODE	A/I CD	STRUCTURE NAME OR IDENTIFICATION	HWY NO
A	.4.3.0	T.I.T.L.E	7		
M	.4.3.0	T.I.T.L.E		K.E.Y. . . . . F.Y.	
M	.4.3.0	T.I.T.L.E		COMPLEXITY . . INHOUSE	

** MAJOR INCLUDES PRE-CODED HEARING
NOTE: USE DH-2280-B FOR ATTACHING ADDITIONAL STRUCTURES

1. F.O.N.S.I. = FINDING OF NO SIGNIFICANT IMPACT (FORMERLY NEG. DEC.)
2. CATEGORICAL EXCLUSION (FORMERLY NON-MAJOR)

Figure 5. MSCS design or combined location and design control network.

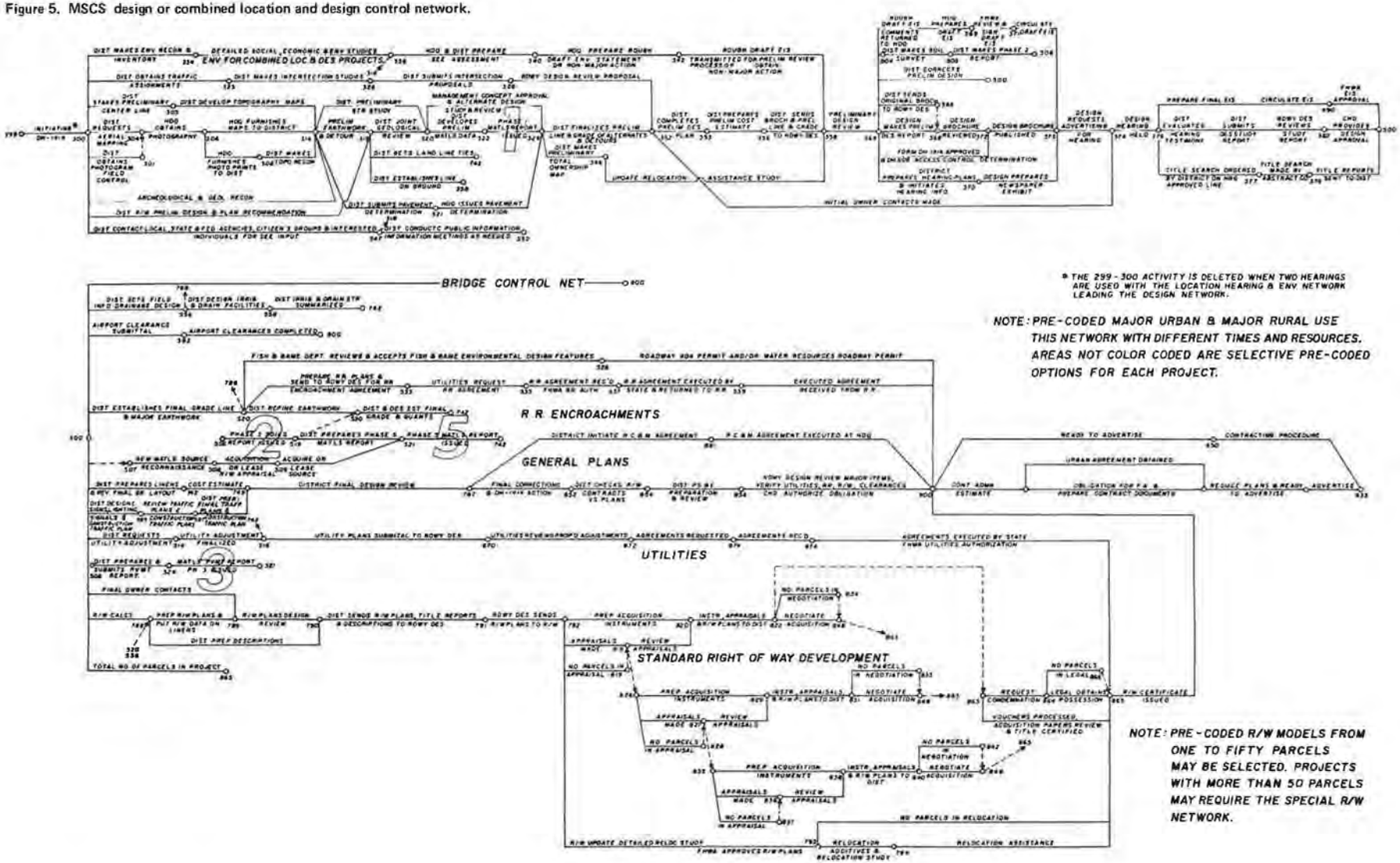


Figure 6. MSCS bridge design control network.

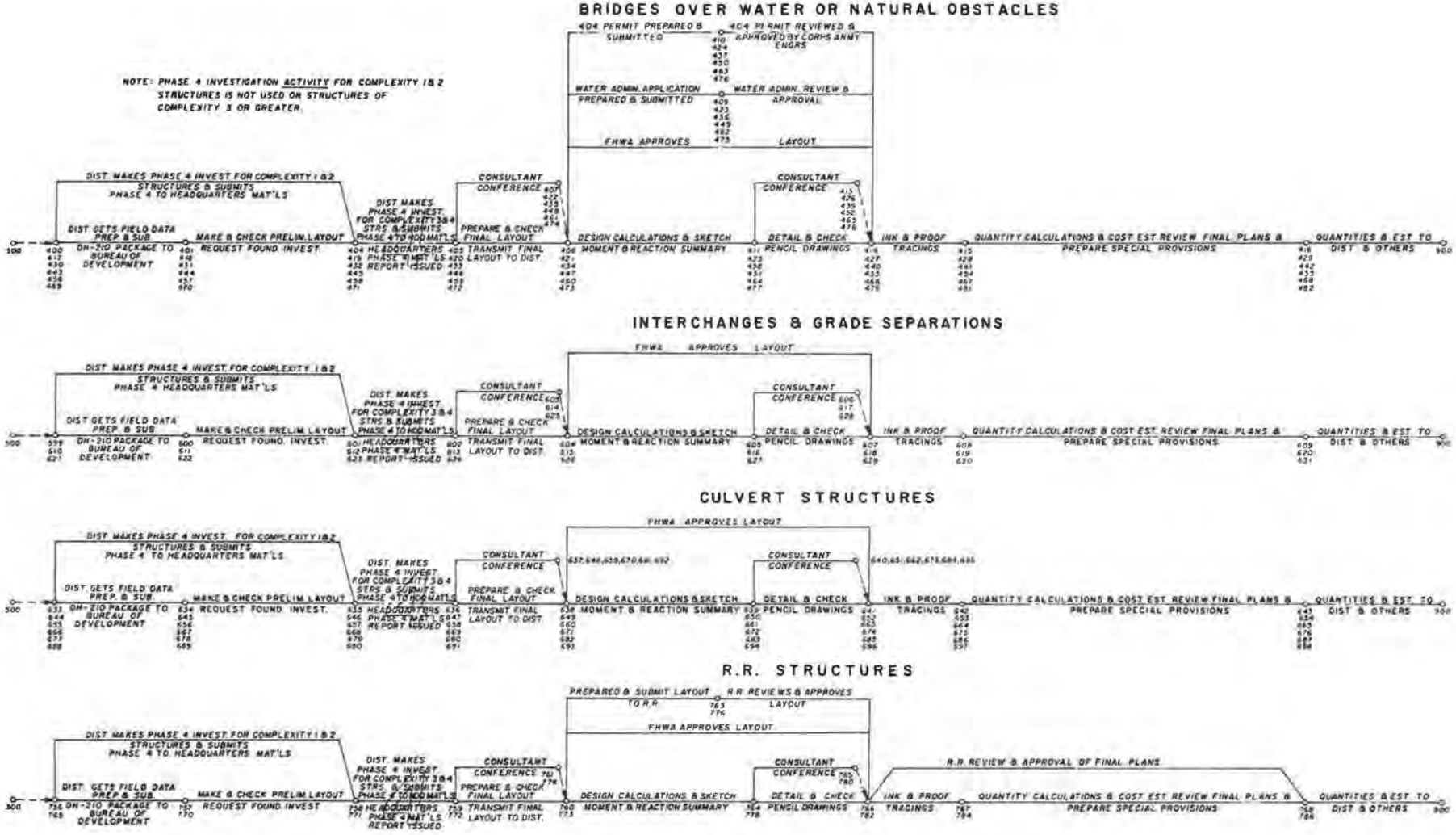
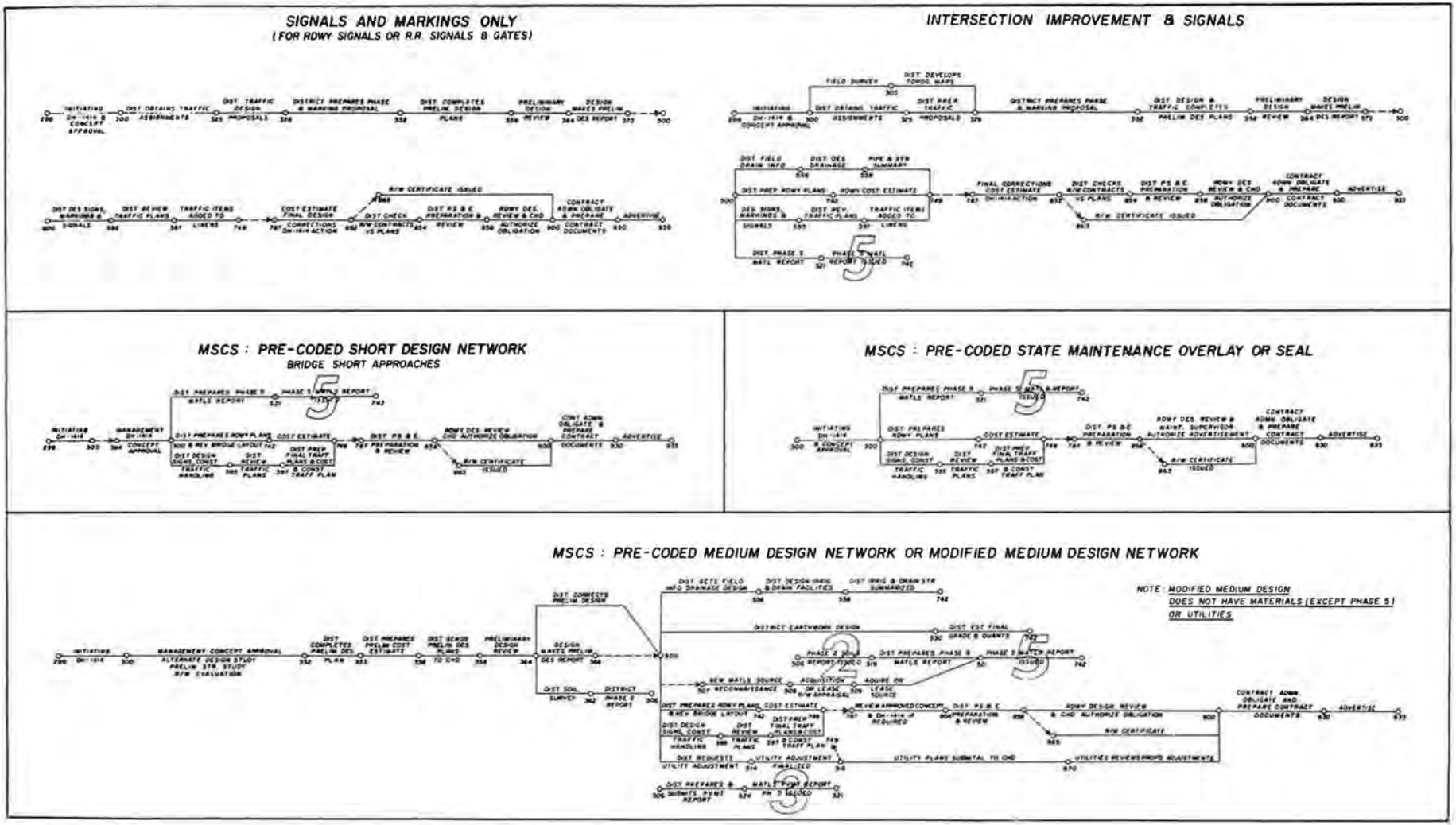


Figure 7. MSCS precoded intersection design networks.



HISTORY

Idaho's MSCS became operational in January 1975. Operational means that the forecasts were used by top management for forecasting when a project would be ready and for detection of delays.

In December 1977, management required that 205 new projects be added to the six-year construction program. This new program configuration was based on a major increase in state funding as well as on a potential major increase in federal funding. The project modeling methods at the time required an average of four district person hours per project, with headquarters proofing, key punching, and correcting final errors added to the district time. The network activity and resource modeling of the 205 new projects was going to require at least two months in straight-line time. In addition to the immediate problem of 205 new projects, the following conditions had reached a crisis point in their own right.

1. The system operation had to be compatible with the time required for management programming decisions. These decisions included adding of new projects, switching of category of funding and fiscal year of construction, and changes in priority between projects of the same fiscal year. Total reshuffling of the six-year construction program for management trial runs could not have more than three-day turnaround for MSCS forecasting.
2. Production personnel did not have time for person-hour type of involvement in estimating activity durations or resource parameters for initial loading of a project into the forecasting system.
3. Production personnel demanded accuracy in the project models and direct correlation to reality. Only production personnel possessed the timely knowledge for accurate updating of a project. The districts agreed that, on any given project, relatively few activities had considerable variance, but these activities were not predictable on a systematic basis.
4. Management thought that all projects, except stockpiles and areawide striping projects, had to be on MSCS. This would encompass the effective total workload of project development.

Roadway Networks

MSCS operations were suspended in November 1977 and the roadway design assistant devised networks for the various types of roadway projects, complete with activity durations and resource quantities. By telephone and personal contact with the districts, the networks were verified and amended as they were devised. In consultation with the bridge design section, bridge design networks were devised in four configurations. For each of the configurations, four levels of complexity (variations in activity duration times and resource amounts) were coded.

The four configurations were arrayed in 17 structure design networks so that a single project could have up to 17 structures separately identified and forecast. The 17 networks were then coded in each of the four levels of complexity, for a total of 68 bridge design networks, complete with activity durations and resources. Three types of environmental action were precoded as network legs. Right-of-way was precoded in batches of subnetworks that could be selected by number of parcels. Utilities, railroad encroachments, 404 permits, and materials sources were set up as network legs, each with two levels of complexity so they could be attached to main networks if they were needed.

As the networks, their activity durations, and resources were completed, they were loaded on ROSCOE utility libraries in the main computer disc storage. At the end of four weeks the entire task was completed and we began loading the 205 projects based on information that the districts had already submitted for programming purposes. In six days all of the projects were on the MSCS file and all other project fiscal year adjustments had been entered. The MSCS file was then run against the MSCS program and reports for management were provided in one night.

All project loading since that time has been done by headquarters. Districts provide normal programming information plus network selection and number of right-of-way parcels.

Updating Screens

Updating screens for input into ROSCOE were devised in November 1977 so that district personnel could annotate their schedule reports with their updating notes and eliminate input forms. These reports are collected by the district design engineer and are turned over to a terminal operator for entry on the ROSCOE screens and transmission by telephone line to computer facilities at headquarters. Production personnel need change only the days remaining on activities that are in progress or they may change the future by changing the original durations for those activities that are known to have changed in complexity but are not yet in progress. Thus, on the same report production personnel can adjust the future activities that vary from the precoded model and show the progress on in-progress activities by just changing days of duration. Since the resources operate as a percentage of activity duration, the resource person-days are automatically adjusted by activity duration change.

CURRENT OPERATIONS

One production specialist handles all updates, new loads, corrections, and reports. Every day 40 new projects can be loaded by the one specialist. Normally, only a few new projects occur during the week. New projects are loaded from regular programming information with telephone confirmation with the district on network selection and estimated number of right-of-way parcels. A major reshuffle of the program for a management what-if situation can be run overnight. There have been a few daytime turnarounds when management deemed it necessary. As a rule, management takes more time to decide on proposed changes than the time it takes to make the changes and run the MSCS system.

Production personnel do not have to code new projects. After a new project appears on the network report, the district and headquarters service sections modify the network to fit the actual project conditions by changing activity durations where necessary and calling for additional network legs, such as utilities, if they were overlooked. Key punching and cards no longer exist since the production specialist assembles all project models on ROSCOE from the ROSCOE utility libraries where all precoded networks and special networks legs are stored. Updates are transmitted from the district datapoint 4530 minicomputers via telephone line direct to ROSCOE data set library space set up by the production specialist. After updating into the MSCS file, the temporary ROSCOE space is cleared.

Production personnel have the final authority on the file input data: activity durations, resource amounts, and resource pool limits. District section supervisors and headquarters section supervisors select the resource limits and have final author-

ity. Changes in the resource quantities on the precoded models as well as resource changes on the operating MSCS file cannot be made without district concurrence. Any change in resource pool constraints also requires district concurrence.

All projects except stockpiles and striping projects are loaded into MSCS.

Implementation and Guidelines for Current Operation

The district production staffs aided MSCS implementation. Perhaps the biggest reason for the willingness of production people to help create the MSCS operation was that it gave them the opportunity to communicate reality to management.

The original guidelines for implementation and operation have never changed.

1. The MSCS system is used by top management as the only source of earliest ready-for-contract forecasted dates. The other parameters such as funding, project need, geographic distribution, public demand, safety, and operation are involved in management's decision of priority and scheduling, but a project cannot be scheduled for contract earlier than the earliest MSCS forecast.
2. Information acquisition cuts across boundaries of authority but does not affect the chain of responsibility or authority. Information is accepted from anyone at any time by any method of communication. The system is not used as a whip and thereby contains true information to the best of the project development staff's knowledge.
3. The roadway designer is in sole charge of project development and has direct access to top management as far as MSCS is concerned. Production personnel are the final authority on time and resources.
4. The system is operated on the philosophy that the system conforms to the methods and desires of production personnel. Operation is constantly improved on suggestions from production personnel and all improvements must have least inconvenience to staffs and reduce the time required by production staffs. All reports are tailored to suit the preference of the users. Any request, question, or complaint by a production person is acted on immediately and solved to his or her satisfaction. Corrections or modifications are made for the user.

Resource Constraint Versus Unlimited Critical Path

During the first year of operation we found that it was important to answer the question, "What is the effect of resource constraint versus unrestrained resources on each activity?" MSCS, during its program operation, calculates the resource-unrestrained critical path start and finish dates and stores these dates on an internal file for use during resource allocation. Selection of command allows subtraction of the resource-leveled finish date from the resource-unrestrained critical path finish date. The result is shown as negative or positive working days.

We have chosen to name this number level resource demand because it is the number of working days after (-) or before (+) the critical path late finish that is needed to obtain resource availability for that activity. Thus, an activity that shows -42.0 in the LEVEL RES DEMAND column of a report has been delayed by 42 working days beyond the unresourced critical path late finish due to lack of available resources. All scheduling and update activity reports, such as the sample of the bridge group leader report in the exhibits, have been report-formatted to show the level resource demand value. Any production person or supervisor can see at a glance which activities will be in trouble due to lack of forces during that period of time.

MSCS Program Capacity

The most recent MSCS program improvement by MCAUTO allows 42 350 activity and resource records to be resource-allocated simultaneously under resource constraints in one file of projects. Each resource record can have 12 resources or work centers per activity. We have chosen to allow a maximum network size of 999 activities/project. This limits a single file of projects to 1296 projects. If we chose a limit of 99 activities, the theoretical limit would be 46 656 projects/file, which makes the resource allocator record limit of 42 350 records the controlling factor.

OPERATION COSTS AND PERSONNEL

Idaho purchased a paid up license for MSCS from McDonnell Douglas and remained in its 1700-member user group. The user group maintenance fee obtains requested enhancements and new, advanced versions of MSCS that are released periodically. The most recent release, version 9.0, reduced the space requirement for processing from 1400 virtual K to 640 virtual K, reduced the central processing unit time from 2.5 h to 35 min, and added more commands and options, including conditional change. The reduction in time is significant when 638 projects with 37 500+ activities are under resource constraint.

The total investment to date, including paid up lease, is approximately $56 000. The 1982 maintenance fee will probably increase from $3700 to $4500. In 1975 the maintenance fee was $1200. The personnel commitment and time required to operate project development MSCS with statewide updating every two months are described as follows: Six districts with 4-8 production personnel per district with updating responsibilities, for 52.2 person days/year. Also needed are a total of 9 headquarters personnel from bridge, utilities, environmental and mapping, local roads, and right-of-way who have updating responsibilities for 24.45 person days/year. Total production personnel time required for updating is 76.65 person days/year.

Along with the time of production personnel required for updating, system management and operation requires one full-time engineering systems analyst and one full-time data processing production specialist at headquarters. The total salary cost per year for updating, system management, and operation is $54 000, which at the loaded rate for benefits, translates to approximately $72 000.

It is difficult to quote meaningful costs for computer hardware and software use because it depends on cost-accounting procedure and in-house facilities that use an IBM 370-158 (VS-1). The ROSCOE software is the tool used to handle updating, creation of data sets, MSCS operation commands, and job control language commands in assembly and submittal to the main machine processing queue. Reports are printed on two 1200-line/min printers. The cost of ROSCOE, an Applied Data Research Corporation product, is not included in cost of MSCS operation because it is used departmentwide. ROSCOE is similar to TSO, CMS, and other data-handling software.