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Scheduling for Cost-Plus Construction Projects, Volume I: Lessons Learned and PROMAN User's Guide

by
E. William East

In cost-plus fixed fee contracts, the contractor is paid based on the actual costs incurred plus some graded incentive fee, rather than on a fixed bid. The larger the project, the more critical it becomes to ensure that the impact of all schedule changes be efficiently analyzed, so that the contractor can complete intermediate milestones as well as the entire project on time. Commercially available scheduling software does perform many of the necessary analyses, but cannot filter data in ways that are useful to schedule reviewers. In planning large projects, there is an acute need for supplemental software that can process scheduling data to make it immediately useful to schedule reviewers. The PROMAN (PROject MANagement) microcomputer-based schedule analysis software was developed by the U.S. Army Construction Engineering Research Laboratory (USACERL) to provide several tools to help evaluate progress of the construction project, to assess the impact of schedule changes upon the project, and to provide other assistance in construction schedule management.

In this study, PROMAN was employed on a large cost-plus project undertaken by the Corps of Engineers in the construction of the National Test Facility (NTF) in Colorado Springs, CO. USACERL provided regular consulting services to NTF, to monitor the contractor's progress schedule and to identify requirements for additional schedule analysis tools. Volume I of this report includes specific recommendations for the National Test Facility Resident Office and future cost-plus projects to assist in evaluating progress schedules and documentation to guide in the installation and use of PROMAN scheduling software. Volume II includes source code for the PROMAN software. The results of this study apply to all cost-plus construction projects and may also be applied to other large Corps construction projects.

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In cost-plus fixed fee contracts, the contractor is paid based on the actual costs incurred plus some graded incentive fee, rather than on a fixed bid. The larger the project, the more critical it becomes to ensure that the impact of all schedule changes be efficiently analyzed. In planning large projects, there is an acute need for supplemental software to process scheduling data to make it immediately useful to schedule reviewers. The PROMAN (PROject MANagement) microcomputer-based schedule analysis software was developed by the U.S. Army Construction Engineering Research Laboratory (USACERL) to provide several tools to help evaluate progress on Corps construction projects, assess the impact of schedule changes on the project, and provide other schedule management assistance.

PROMAN was employed in the construction of the National Test Facility (NTF) in Colorado Springs, CO. Volume I of this report includes recommendations for the NTF Resident Office and future cost-plus projects to help evaluate progress schedules, and documentation for the installation and use of PROMAN. Volume II includes source code for the PROMAN software. The results of this study apply to all cost-plus construction projects and may also be applied to other large Corps construction projects.

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FOREWORD

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SCHEDULING FOR COST-PLUS CONSTRUCTION PROJECTS, VOLUME I: LESSONS LEARNED AND PROMAN USER'S GUIDE

1 INTRODUCTION

Background

Cost-plus fixed fee contracts differ from traditional construction projects in that the contractor is paid based on the actual costs incurred plus some graded incentive fee, rather than on a fixed bid. The larger the project, the more critical it becomes to ensure that the impact of all schedule changes be efficiently analyzed, so that the contractor can complete intermediate milestones as well as the entire project on time. The cost and time control required for cost-plus projects presents many problems that respond well to the application of microcomputer-based scheduling systems. While commercially available scheduling software designed for such systems does perform many of the necessary analyses, there is a need, especially in planning large projects, for supplemental software that processes scheduling data to make it immediately useful to schedule reviewers. The PROMAN (PROject MANagement) microcomputer-based scheduling software was developed by the U.S. Army Construction Engineering Research Laboratory (USACERL) to provide the needed additional tools to help evaluate progress of the construction project, to assess the impact of schedule changes upon the project, and to provide other assistance in construction schedule management.

Objectives

The objectives of this study were (1) to demonstrate the application of PROMAN to a cost-plus project, (2) to introduce needed PROMAN modules that provide schedule analysis tools suitable to an existing cost-plus project, (3) to make specific recommendations for the Corps' future cost-plus projects that will help Resident Office personnel to analyze the Contractor's progress schedule more rapidly and effectively, and (4) to develop documentation for the installation and use of PROMAN scheduling software. Volume II contains the source code for the PROMAN software.

Approach

PROMAN was first applied on a large cost-plus project undertaken by the Corps of Engineers in the construction of the National Test Facility (NTF) in Colorado Springs, CO. The construction at NTF consisted of two multistory buildings, two single-story buildings, and significant mechanical and electrical extensions at Falcon Air Force Station, in Colorado Springs, CO. This large cost-plus project provided an ideal environment to demonstrate PROMAN's ability to assist Resident Office personnel to rapidly review the contractor's progress schedule, to make specific recommendations for the scheduling of future cost-plus projects, and to document PROMAN schedule analysis programming techniques.

USACERL researchers provided regular consulting services to the National Test Facility cost-plus project, initially to review the contractor's progress schedule, and later to identify requirements for additional schedule analysis tools. Once these requirements were established, PROMAN schedule analysis software was developed and installed, and the corresponding documentation was written.

Scope

This study applies, but is not limited, to all cost-plus construction projects. Many of the findings of this report may also be applied to other large Corps of Engineers construction projects.

Mode of Technology Transfer

The PROMAN software package developed for this study will be made available from the Construction Automation Software Library through the Construction Automation Support Center (CASC), 1408 W. University Ave., Urbana, IL 61801 (toll-free 1-800-428-4357).

2 LESSONS LEARNED

Microcomputer-based scheduling systems have unique application to cost-plus projects. This chapter briefly identifies several of the features related to scheduling and planning that District and Construction Field Offices should consider before beginning a cost-plus project.

Coordination of Design and Construction

From the start of a design-build project, the coordination of design completion and construction is essential to the timely completion of the project. At the beginning of the project, the way to accomplish this coordination is to require the Architect/Engineer (A/E) to furnish a design project schedule.

To develop the design project schedule the A/E must first list all activities needed to complete the design. These activities consist of "work packages." An individual work package is defined by a description of the scope of work to be designed, and by the specification sections and drawing numbers required for its completion. In addition to A/E activities, all building occupants' requests for any work packages must be identified as separate activities.

A good A/E schedule does not show activities as bars on a chart but logically links them to related activities in the project. Adding these relationships to the list of activities creates a Network Analysis System (NAS), described in detail in Engineering Pamphlet (EP) 415-1-4.[1] Unless the NAS approach is used, the impact of delays in the design schedule, changes in the user's design criteria, variances in funding, and other problems cannot be projected.

The ripple effect of design schedule changes, from groundbreaking through project completion, is an often overlooked aspect of many design criteria changes. The A/E NAS allows the user to evaluate changes and design delays, based on the total cost-plus construction process. Even though the contractor may have design completion activities in the schedule (often to cover later claims), the contractor cannot be responsible for design project management. The designer of the project must identify and solve design problems that could result in major expenses after construction begins.

Scheduling Personnel

Every construction field office must face the often conflicting goals of cost, time, and quality management. For design-build projects the issue of timely completion becomes more critical than in some other types of contracting methods. The best tool to assess progress is the schedule; therefore, the Area/Resident Office should provide a full-time scheduler from the beginning of the project. This should be a GS-12 with several years' experience in both microcomputer scheduling and construction inspection.

A variety of microcomputer scheduling courses are offered by individual software vendors, university extension services, and private interests. A scheduler without microcomputer scheduling experience should receive a two-phased training program. The first phase should be a hands-on session with a software vendor to learn how to operate the Area/Resident Office's scheduling software. The

[1] *Network Analysis Systems Guide*, EP 415-1-4 (U.S. Army Corps of Engineers, 31 August 1986).

second phase should be provided by a private firm specializing in the use of microcomputer scheduling systems for project management. This second part should teach how to use microcomputer-based scheduling effectively on the project. The Project Sponsored Engineer Corps Training Program (PROSPECT) NAS course should be a prerequisite for any scheduler being considered. The book *A Guide to Computerized Project Scheduling*[2] may also assist in training.

Contractor Grading

From the contractor's point of view, determining a contractor's incentive fee is one of the most important tasks of the Area/Resident Office. One aspect to creating a useful and defensible grading scheme is to use an appropriate level of detail. One example of a detailed criterion is:

> Fewer than 5 percent of construction activities scheduled to start in the next 6 weeks have durations that exceed 20 days.

This criterion requires the scheduler to provide a detailed analysis. With sophisticated scheduling software, however, this criterion is easy to verify. The scheduler first obtains a list of all of those activities, selected by their early start dates. These early start dates should span the schedule's data date to 6 weeks in the future, identifying all activities starting within that period, and often the total number of activities selected. Next, the scheduler chooses those activities from the list that have a duration of greater than 20 days, and produces a list of activities and the total number of activities in the 20-day group. With the total number of activities to start within the next 6 weeks and the total number of those activities of over 20-day duration, the criteria may be successfully evaluated and defended if questions arise.

In evaluating contractor grading criteria, it may appear desirable to define some necessary items that cannot, based on the time required by the analysis, be fully justified. One such criterion is:

> At least 75 percent of construction materials and permanent equipment procurement . . . are identified in the NAS (construction progress schedule), PSSR (contractor's procurement tracking system), or the Submittal Register.

This criterion is difficult to evaluate for several reasons. First, the total of all construction materials and permanent equipment procurement must be agreed on by the Area/Resident Office and the contractor. Next, the reviewer must look in three separate systems to match the data. Comparing data between the systems is further complicated since each focuses upon different information. For example, the scheduling system is most concerned with delivery of materials and equipment; the procurement tracking system with the timely processing of contracts; and the submittal register with the timeliness of Government Approvals.

Another criterion difficult to evaluate revolves around the lack of initial agreement on the specific standards for grading the contractor. Such a criterion might be:

> All activities are coded consistently.

To meet this criterion there must first be some definition of a consistent coding scheme. Projects of over 1000 activities require activity coding to facilitate production of reports that target specific

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[2] E.W. East and J.G. Kirby, *A Guide to Computerized Project Scheduling* (Van Nostrand Reinhold, New York, 1990).

segments of work. Without activities codes the scheduler will have to review and transcribe each specific activity. The use of activity codes may save up to 50 percent of the scheduler's time.

Activity Coding

A coding scheme should allow the scheduler to select and sort activities in a construction schedule for specific schedule analyses. For example, to list all electrical activities, an activity code value (usually four letters) for the activity's specification section would be entered when the activity was created. The scheduler could simply select all electrical activities by this code. Other categories of activity codes are suggested by the following questions:

- Are all of the necessary activities included on the first floor of this building?
- Are all of the necessary activities included in the exterior closure of this building?
- Are all of the owner's approval activities in the schedule?
- Which activities where used to justify the time extension for a specific claim?

By selecting activities which meet more than one condition, very specific lists of activities can be generated. For example, to identify first floor electrical activities, activities are selected first by floor location and then further selected by electrical work. Other useful analyses that can be made by multiple selections are suggested by the following questions:

- Is there enough time to approve elevator submittals?
- When will the building be enclosed?
- What mechanical activities need to be finished in the next 2 weeks?
- Will concrete placement be delayed by weather?
- Will all necessary services be connected to the Heating and Air Conditioning (HVAC) prior to the testing of the system?

Activity coding is the most efficient way to check the accuracy or status of a construction schedule. Effective activity codes will reflect seriously considered activity categories. Table 1 provides a suggested minimum list of activity codes for a large construction project.

The difficulty in setting up an effective coding scheme is in achieving agreement, when the schedule is initially developed, between the contractor and Area/Resident Office on what should be coded and which values of codes should be used.

A useful activity coding scheme must include the types of information needed to monitor or control construction progress and verify schedule accuracy. There are three factors often overlooked in developing a useful list. First, activity codes should be easy to understand. For example, in the Responsibility Code,

the letter "P" may be used to refer to prime contractor activities and the letter "O" to refer to owner activities. Such one character codes can cause typographical errors and lost time in checking a code's definition in the code dictionary.

If possible, code values should be selected based on reasonable abbreviations rather than arbitrary letters or numbers. Table 2 illustrates a small portion of a poor activity coding dictionary from the NTF project. The activity code chosen for this example is a contractor-defined code called the Sort Code, which was intended to allow the scheduler to identify subparts of the project.

At first glance, the items seem to be listed by logical abbreviation. Unfortunately, since each person abbreviates differently, it is difficult to anticipate the code for a particular category. For example, it is unnatural to associate the code for dampproofing with the code value "CW." The code value for a cooling tower might begin with the letter "M" for "mechanical items." The actual code used, however, is "CT." Inconsistent codes force the scheduler to constantly refer to a code dictionary for every in-depth report. Consistent codes are essential to rapid development of ad hoc reports.

Table 1

Suggested Activity Codes

Activity Code	Definition
Responsibility	Designation for the trade or subcontractor who is responsible for the work in an activity
Work area	Designation for a particular area of the work such as floor number or phase of work relating to an activity
Type of activity	Designation for type of an activity, such as: submittal, approval, delivery, installation, test, etc.
Specification	Designation for construction contract specifications relating to an activity
Building system	Designation for the building system relating to an activity
Weather sensitivity	Designation showing if an activity is weather sensitive
Mod/claim number	Designation for the change order or claim relating to an activity
Cost code number	A code relating the activity to a specific cost item within the cost accounting system

Table 2

Poor Subarea Code Value Definition

Code Value	Definition
AA	Partitions
AD	Drywall
AF	Firewall
AM	Architectural - misc
AP	Precast
AW	Windows/window walls
CC	Concrete
CE	Earthwork
CF	Concrete floors
CMU	CMU Walls
CS	Storm drains/culverts
CT	Cooling tower
CW	Dampproofing
DEMO	Demolition
DW	Domestic water
EC	Conduit and cable tray
ED	Duct bank
EE	Electrical equipment
EF	Electrical fixtures
EG	Underground electrical
EL	Lighting
ELEV	Elevators
ELP	Parking lot lighting

A second problem occurs with activity coding dictionaries when several different codes refer to the same information. When this occurs, it is impossible to determine which code actually refers to the desired data. In the NTF project, Sort, Responsibility, and Levels codes all contain a specific value for testing. Since the testing value was not consistent between different schedule versions, the scheduler was forced to complete several sorts to check all possible subsets of activities. Such inconsistent coding undermines not only efficiency, but confidence in the accuracy of the network.

For large projects, it is critical to designate independent categories for activity codes. If a project spans several years, the ad hoc coding schemes will become difficult to maintain. After only 6 months, even persons who developed an ad hoc coding scheme may not be able to explain why certain codes were originally used.

Finally, when using codes that relate to specification sections or building systems, schedulers should provide sufficient levels of detail for each activity. The depth of the activity coding dictionary is very important for large projects. A "deep" code such as the Construction Specification Institute[3] (CSI) Master

[3]Construction Specification Institute, 601 Madison St., Alexandria, VA 22314.

Format will, for example, allow the differentiation between structural steel and steel pan forms for concrete slabs. A "deep" systems code such as the Building Systems Index (BSI)[4] will, for example, allow the differentiation between windows used for exterior closure and casefronts used to separate interior offices. While the detailed coding of all of the activities in the schedule may at first appear to be a large effort, the schedule data becomes effective project information only when it differentiates between types of activities. On large projects, the depth of hierarchical codes will largely determine the depth of the project monitoring and control tools available to the Area/Resident Office.

The final problem encountered in using a complex coding scheme is the need to add new codes after the project has begun. To accomplish this, the user must add the new code(s) to each version of the schedule, and also manually add all the corresponding data into each activity. Often the need for more detailed analysis occurs when a project that appears to be rather straightforward turns out to be quite complicated. Adding new codes after a project is under way should be avoided; in the long run, it is much better to specify a large number of codes that would be useful for the life of the project.

Activity coding is a critical element in creating an effective construction schedule. The coding scheme built into a schedule determines the speed with which reports can be produced and the depth to which schedule analysis may be performed. Since time for schedule analysis is limited, activity coding determines the level of analysis, and therefore the amount the schedule will be used to manage the job. If a consistent, independent coding scheme is not developed at the beginning of a project, then the scheduler will spend much time compensating for poor coding and adding new coding into the schedule. On a large project the scheduler could easily waste 4 hours a week extracting information from a scheduling system with bad activity coding.

Integration of Automated Systems

In construction, a wide variety of specialists combine efforts to create a working unit that is larger than the sum of its parts. Each architect, engineer, contractor, tradesman, supplier, attorney, accountant, and estimator views the project from a different perspective. Since the advent of microcomputers, firms have developed specialized software to reflect the view of each construction specialist. Unfortunately for the contractor's Project Manager or the Area/Resident Engineer, specialized software does not reflect a viewpoint of the total project. This section describes two areas in which data from various software systems may be combined to reflect a larger project picture. These two areas are cost and productivity control, and procurement process control.

Cost and Productivity Control

One of the key concerns in any cost-plus project is measuring the productivity of workers on the job. Early warning of low productivity is essential since, on cost-plus work, the Corps pays contractor costs directly. Integrating cost accounting and data scheduling should therefore be a primary concern when specifying a project control system. This integration is difficult because accounting requires a different level of detail than does scheduling. For example, an accounting system breakdown may identify an entire carpentry crew as a single work unit, while a scheduling system must identify specific actions of this carpentry crew in detailed building locations.

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[4] *CWCES System Manual* (U.S. Army Corps of Engineers, Huntsville Division, 30 September 1988).

A scheduling system's activity codes may unify the incompatible views of the accounting and scheduling systems. Cost accounts typically have some specialized coding scheme. Activity codes correlate scheduled activities to cost coding schemes usually through the CSI Master Format or the cost code fields. Since accounting systems frequently use the CSI to provide a work breakdown, this field may be selected to assist in productivity analysis. If the CSI is not used, then a different cost code field should be employed.

Once all schedule activities have been coded to reflect their cost accounts, specific items of payment requests may be coded to individual activities. Most contractors use general cost codes rather than cost codes of specific activities. These specific costing activities require detailed contract requirements, but once compiled, totals required for cost coding the scheduling system can provide a summary of all activities with similar cost codes. Integrated schedule and cost control systems are not typically specified, but should be required on cost-plus projects. A direct correlation between accounting and scheduling systems is essential to determine if cost and time schedules are keeping step.

Another method to correlate cost and schedule systems is to allocate specific crews and equipment to particular activities. In this method, the number of manhours, like cost accounts and equipment hours to complete the work, is entered for every activity. This creates additional work, in that manhours are not usually posted for schedule activities. However, if the schedule is updated with cost data for each activity, then manhours and equipment utilized will be available for direct input to the network.

Procurement Control

A frequent construction problem is late delivery of materials. The goal of an integrated procurement system is to directly identify those construction activities that may be delayed by problems in the procurement process. The procurement process is usually automated in three separate parts. First, a contractor's procurement tracking system monitors bid packages and material deliveries. Second, the submittal log monitors timely government approvals. Finally, the scheduling system directs specific procurement activities.

When the schedule is the top-level time control tool, a procedure may be developed to properly coordinate the schedule with the contractor's procurement system and the submittal register. The effective way to use these systems is to require that all bid packages and material deliveries have specific activity numbers associated with them. Delivery dates of procured items may then be checked against schedule activities and those delivery dates that will delay schedule activities may be identified in advance.

Computer Hardware

A key element of efficient schedule analysis for large construction projects is adequate computing power. Computer equipment reserved for scheduling. Due to the large size of the schedules to be processed, computer hardware for large projects should be fast (20 MHz minimum) with large (40 MB minimum) hard disk storage. A fast 80386 machine with a math coprocessor should decrease the time spent for schedule calculations, selecting and sorting activities, and generating report files and printouts by an average of 20 percent over typical AT class machines.

Printers, another critical hardware need, should be as fast and as quiet as possible. The printer should provide a 132-character-wide carriage with options for condensed and double-strike characters.

Schedule Analysis Tools

Schedule analysis on large projects is very time consuming, due largely to the types of tools that software developers provide. Often commercial software does not provide the capabilities needed for the analysis of large projects. One clear example of the gap between software capability and user requirements occurs when there is a need to reconcile changes between two schedules. Two typical schedules might be the previous month's schedule and the current schedule update that shows new progress. Current software systems do not verify that all approved and appropriate changes have been included in the updated schedule.

Current commercial systems can match activities in two schedules to compare changes in start dates and to identify floats. Unfortunately these same systems may not identify added or deleted activities in the current schedule, changes in logic, or changes to lags between precedence activities.

Based on the work first accomplished at the Corps of Engineers' Fort Drum Construction Office, Watertown, NY, USACERL initially developed PROMAN as a schedule comparison program which identified all additions, deletions, and logic and lag changes. This program clearly identified typical contractor schedule changes that hide float or change logic. With this program, a contractor could no longer alter a schedule by changing the logic of activities as the project progresses. At their outset, many project activities have finish-to-start relationships with other activities and several weeks of lag duration. If the project falls behind the required finish date, a contractor cannot reduce these lag durations, the finish-to-start relationship to a start-to-start relationship, or reduce the lag on the start-to-start relationship, without discovery. (Sequential activities cannot be given a parallel appearance.)

Without the assistance of the schedule comparison program, a scheduler would have no time to show that this transformation had occurred throughout the schedule, reflecting a concerted effort to squeeze more and more work into less and less time.

To complement the (unmodified PROMAN) schedule comparison program, an expanded set of schedule analysis tools was developed for the NTF Office. These tools provide coordination between procurement and submittal systems, rapid identification and analysis of the critical paths through the schedule, analysis of the variance between groups of schedule activities by cost, time, and manhours, and several other features. These tools, developed under a contract with the Construction Automation Support Center,[5] were packaged into a program called PROMAN (PROject MANagement). The next chapter contains a guide to the use of PROMAN.

[5]A construction software research facility associated with Resource Center Enterprises, 1408 W. University Ave., Urbana, IL 61801.

3 A GUIDE TO PROMAN

Introduction

The PROMAN software package provides a collection of programs which generate detailed management reports for project managers. The database structure is that of dBase III PLUS. The programs included in PROMAN provide for integration of procurement, submittal, and scheduling systems. This chapter discusses installation and use of the modules of Version 1 of the PROMAN collection.

The program is written so that any or all reports can be run in real time or as a batch process. This means that the modules can be set to run in sequence from start to finish, thus saving the operator from monitoring the computer for the duration of the run. Version 1 of the program supports printing to the HP Laserjet Plus printer, an EPSON Wide Carriage Printer or compatible, or directly to a disk file. To facilitate the unmonitored operation of the program, it is possible to generate a report file with the printer codes in place for any of the supported printers. In that way, the prints can be run after all the desired reports have been generated.

Program Installation

PROMAN is provided on low density diskettes. It is recommended that the program be run on a fast (20 MHz minimum) 80286 or 80386 microprocessor-based DOS machine. A hard drive with at least 15 to 20 megabytes of free space is recommended; a minimum total capacity of 40 megabytes will be needed. There must be space for the PROMAN programs, the PROMAN output files, and Primavera Project Management System. Enough space is also needed for dBase III PLUS if the noncompiled version of PROMAN is being used. In the instructions below, it is presumed that the software is installed on the C drive. If the software is to be installed on a different drive, change the letter designator to that drive.

To install the program, use the following steps:

1. Make a subdirectory on the root directory for the program by entering: **MD C:\PROMAN**.
2. Place the first distribution diskette in the A: drive of the computer.
3. At the prompt, type the following: **COPY A:*.* C:\PROMAN**.
4. Repeat steps 2 and 3 for each of the diskettes.
5. Remove the distribution disks and store them as backups for the loaded programs.
6. Ensure that the config.sys includes the settings: Files = 20; Buffers = 25.

Preparation of PROMAN Input Files

Initial attempts to rapidly develop and deploy PROMAN for the NTF office required that the automated systems in use at the NTF office be used, as much as possible, to provide the required data. The NTF office used the Primavera scheduling software, a submittal register built on the dBase III PLUS data base management system, and a proprietary procurement system used by Kaiser Engineers. PROMAN source code can (and must) be altered to accommodate other computer configurations.

Before using PROMAN, you must identify and export the correct input files from the Primavera Project Management Software 3.0 package by following these steps:

1. Change to the subdirectory containing the Primavera system files, and at the DOS prompt, type **P3**. The introductory Primavera screen, "Primavera Utilities," will list, among other things, the available projects (Figure 1). Choose **1** to select a particular project from the UTILITIES menu. A prompt line appears, requesting the project title. After entering the desired title and pressing **Enter**, advance to the file confirmation screen.

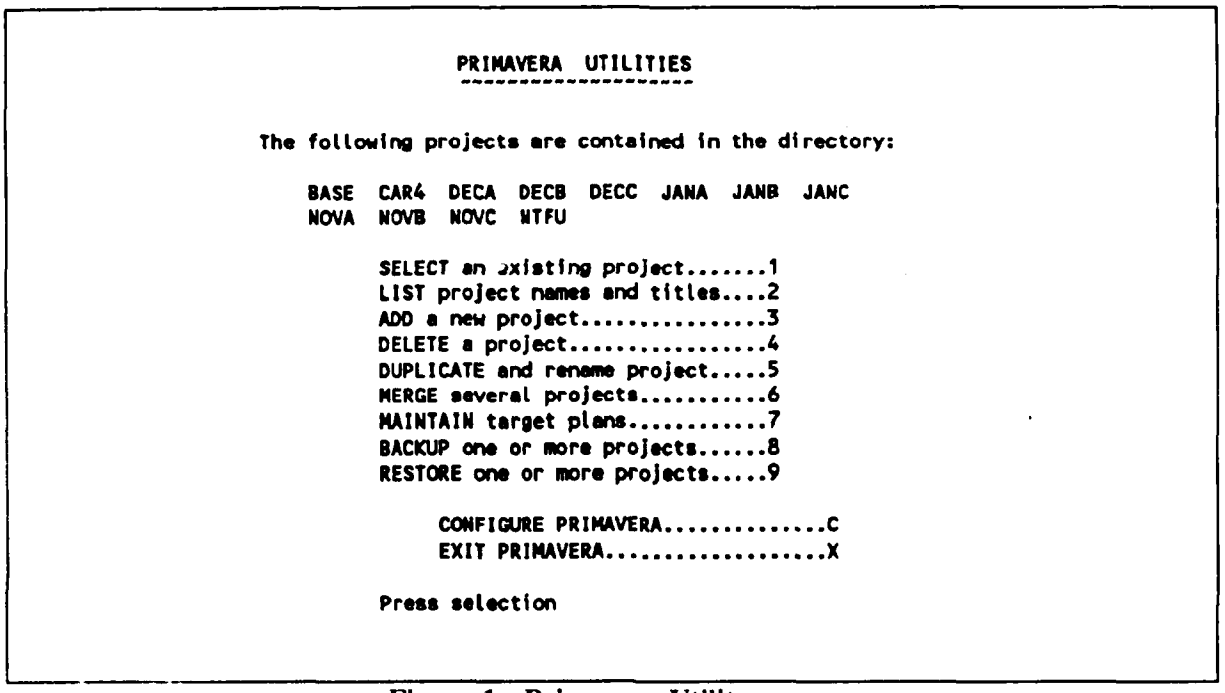

Figure 1. Primavera Utility menu.

2. Press **A** from the "Confirm Selection" menu (Figure 2) to verify the selection and to advance to the next screen.

3. Select **9** (Reports Specification) from the "Project Data Menu" (Figure 3), to advance to the "Types of Reports" menu (Figure 4).

4. Selects **6** (Export Data Files) from the "Types of Reports" menu, to advance to the "Export Data Files" list menu (Figure 5).

5. In the "Export Data Files" list menu, you will see a listing of the Export Report routines which, after the initial setup of the export routines, will be predefined as "EX-01" and "EX-02". "EX-01" creates the "Activity Data" dBase file, which contains information specific to each activity (start dates, finish dates, codes, etc.), and which is named "SCHEDULE.DBF" by default. "EX-02" creates the "Logic" file, which contains information about the order of activities in a particular project, which is named "SUCCESSOR.DBF" by default. You can assign names to these files by selecting the "Edit" option from this menu. However, it may be simpler for users unfamiliar with Primavera to keep the default filenames (after first making sure that there are no *existing* filenames with the same names that will be overwritten), and later to change the filename after exiting Primavera.

```
                    CONFIRM selection
                    -----------------

                  Project name is DECA


Project Title:  National Test Facility
 Company  Name:  Kaiser Engineers, Inc.

Report Center Heading:  December Schedule Update, Areas 1,2,5,7,8,9

Project Start Date:  16FEB88     Project must Finish no later than:

Early Finish Date:    4APR90

Network Type (PDM or ADM):  PDM              5  Workdays Per Week

Schedule data date:  27DEC88                 Start Day of Workweek:  MO

                TARGET #     TARGET PROJECT     DATA DATE
                --------     --------------     ---------
                   1              NOVA           12DEC88
                   2

-------------------------------------------------------------------------

Commands: Advance   Edit    Help    Return
```

Figure 2. Confirm selection menu.

```
                    PROJECT DATA MENU                          DECA
                    -----------------

          Project data:
               Calendar.....................1
               Activity data................2

          Dictionaries:
               Activity codes...............3
               Resources....................4
               Cost accounts................5

          Calculations:
               Scheduling...................6
               Leveling.....................7

          Reports:
               Execution....................8
               Specification................9

                    Return to PRIMAVERA utility menu.....R

                    Exit PRIMAVERA.......................X

        Press selection
```

Figure 3. Project Data Menu.

6. Selects N (Next) from the "Export Data Files" menu to select the report file to be processed. At the bottom of the screen, a prompt line will appear, requesting the "Ref. No." (reference number) of the desired file. After entering **EX-01** and pressing **Enter**, the file "EX-01" may be processed by pressing

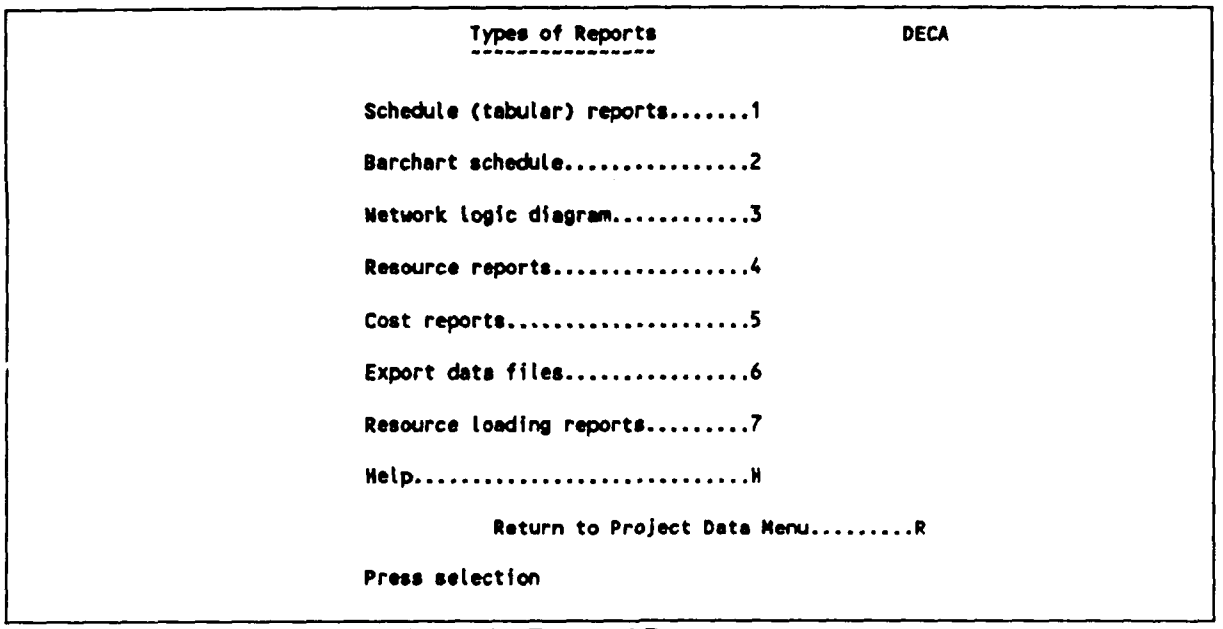

Figure 4. Types of Reports menu.

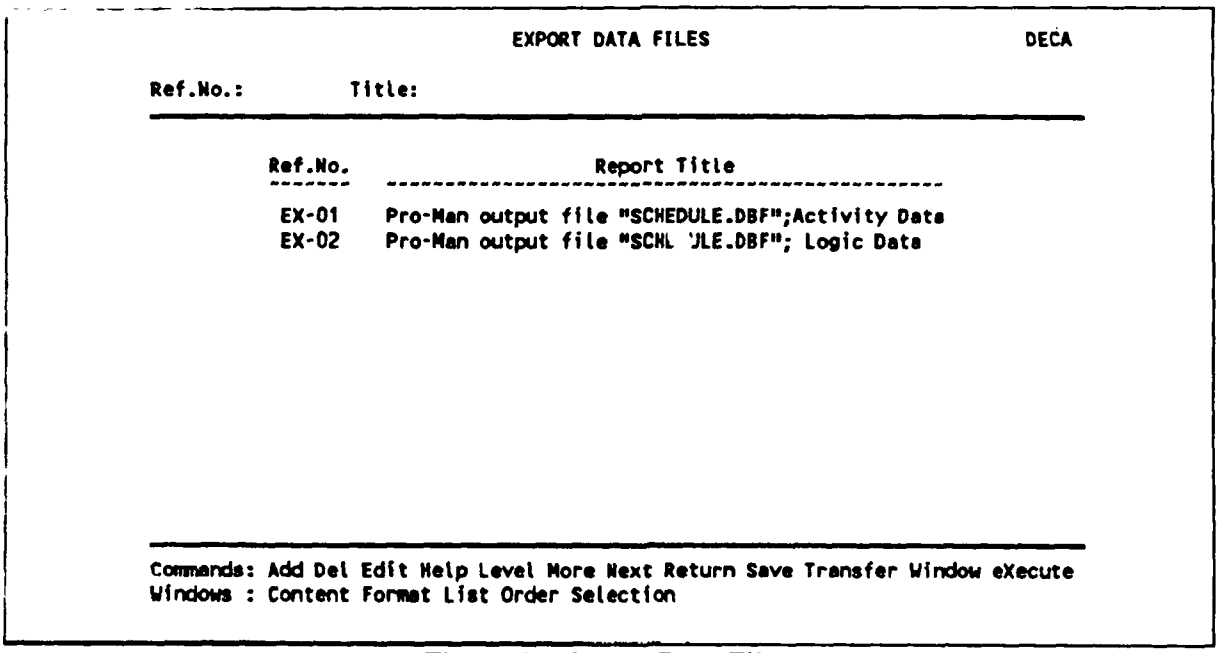

Figure 5. Export Data Files.

X (eXecute). While the file is processed for exportation, you will see various messages on the screen, followed by a "completed" message. Primavera will still be in the "Export Data Files" list menu.

7. From the "Export Data Files" list menu, press N (Next), and then at the filename prompt, enters EX-02 and **Enter**.

8. The "Export Data Files" menu includes four windows in addition to the "List" window: the "Content," "Format," "Order," and "Selection" windows, in which file parameters can be set. For "EX-02,"

you need to select the "Content" menu, and does so by pressing **W** (Window) and then **C** (Content). Primavera advances to all "Export Data Files" content menu (Figure 6).

EXPORT DATA FILES DECA

Ref.No.: EX-01 Title: Pro-Man output file "SCHEDULE.DBF";Activity Data

CONTENT:	Current Schedule	Target 1	Target 2	ASCII File Width 202	Current Schedule	Target 1	Target 2
Activity ID	1	0	0	Resources	0	0	0
Title (No. of char 48)	2	0	0	Cost Account	0	0	0
Early Start	3	0	0	Res/Cost Percent	20	0	0
Early Finish	4	0	0	Res/Cost Lag & Dur.	0	0	0
Late Start	5	0	0	Units Per Day	21	0	0
Late Finish	6	0	0	Earned Value (Units)	0	0	0
Actual Start	7	0	0	Budget Quantity	0	0	0
Actual Finish	8	0	0	Actual Quantity/BCWS	0	0	0
Total Float	9	0	0	Quantity to Complete	0	0	0
Free Float	10	0	0	Quantity at Completion	0	0	0
Original Duration	11	0	0	Earned Value (Cost)	22	0	0
Remaining Duration	12	0	0	Budget Cost	0	0	0
Percent Complete	13	0	0	Actual Cost/BCWS	0	0	0
ACT Code Field 2 - 7	14	0	0	Cost to Complete	0	0	0
Log Records 1 - 1	0			Cost at Completion	0	0	0

Commands: Add Del Edit Help Level More Next Return Save Transfer Window eXecute
Windows : Content Format List Order Selection

Figure 6. Export Data Files content menu.

9. From the "Export Data Files" content menu, enter **E** (Edit) to change one parameter by cursoring down to the bottom line ("Export successor relationships only, ignore Content window?"), to enter **Y** (Yes). After this single change, EX-02 can be executed by pressing **X**.

10. Once EX-02 has been processed, you can exit Primavera by "backstepping" through the menus by pressing **R** three times, to return to the "Project Data Menu" screen, and then by pressing **X** (eXit).

11. It should be noted that the "Export Data Files" content, order and selection menus (Figures 7 to 9) were not used to export files for default conditions. These window may be used to tailor Primavera files for other scheduling software.

After creating the files according to Figures 5, 6, 7, and 8, Export File parameters set in the "Content" or the "Format" Windows should *not* be altered; otherwise the size, type, and content of the fields in the Dbase files may be altered such that PROMAN may not recognize them.

Program Operation

The PROMAN software must be run from the C:\PROMAN subdirectory. If using a noncompiled version of PROMAN, the dBase III PLUS program must be present on the hard disk and its location must be in the path statement. Refer to a DOS manual for instructions on setting a path.

A list of the source codes for all PROMAN program modules is included in Volume II of this report.

```
                              EXPORT DATA FILES                              DECA

Ref.No.: EX-01   Title: Pro-Man output file "SCHEDULE.DBF";Activity Data
-------------------------------------------------------------------------------
FORMAT:
       Enter name of output file [without extension]:  NOVCACT

       Type of output file to be created: ASCII      [.PRN] (A)
                                          dBASE III [.DBF] (D)
                                          LOTUS 123 [.WKS] (L)   D

       Title each column in .WKS and .PRN files (Y/N)?  N

       Format dates as Calendar date or Workdays or Both (C/W/B)?  C

       Summarize or Detail each activity's resource/cost data (S/D)?  D

       For ASCII files, separate each field by  1 characters.
       And insert  0 characters each time the content sequence number skips.

       Export successor relationships only, ignore Content window (Y/N)?  N

-------------------------------------------------------------------------------
Commands: Add Del Edit Help Level More Next Return Save Transfer Window eXecute
Windows : Content Format List Order Selection
```

Figure 7. Export Data Files window.

```
                              EXPORT DATA FILES                              DECA

Ref.No.: EX-01   Title: Pro-Man output file "SCHEDULE.DBF";Activity Data
-------------------------------------------------------------------------------
ORDER(SORT) ACTIVITY DATA for presentation using schedule parameter codes:

   Sort by:  1.  ACT       2.            3.            4.

             5.            6.            7.            8.

             9.           10.           11.           12.

            13.           14.           15.           16.

            17.           18.           19.


    Schedule parameter codes: ACT PNO SNO DES ES LS EF LF AS AF TF PCT OD RD FFL
                              V1E V1L V2E V2L
                              S/C  RESP WAD  LVLS ID   SORT SUBS AREA SUAR TYPE
                              STND

-------------------------------------------------------------------------------
Commands: Add Del Edit Help Level More Next Return Save Transfer Window eXecute
Windows : Content Format List Order Selection
```

Figure 8. Export Data Files sort window.

1. Select the drive (C:) where PROMAN is installed as the current drive by typing C: at the DOS prompt and pressing the ENTER key.

2. Change to the PROMAN directory by entering "CD\PROMAN".

3. Start the program by entering "**proman**" and pressing the ENTER key.

```
                              EXPORT DATA FILES                              DECA

Ref.No.: EX-01   Title: Pro-Man output file "SCHEDULE.DBF";Activity Data
-------------------------------------------------------------------------------
SELECTION CRITERIA:  Four successive levels of screening are available.

Level 1: Meet (All/Any)       selection criteria listed below:
-------------------------------------------------------------------------------
                     SPC         CC        LOW              (HIGH)
                     ---         --     --------------   --------------

        Select if          is
        Select if          is
        Select if          is
        Select if          is
        Select if          is
        Select if          is
        Select if          is
Sched. parameter codes (SPC): ACT PNO SNO ES EF LS LF AS AF TF PCT OD RD RES FFL
                              ED LD AD CON V1E V1L V2E V2L
                              S/C  RESP WAD  LVLS ID   SORT SUBS AREA SUAR TYPE
                              STND
         Criteria codes (CC): EQ NE GT LT WR NR

-------------------------------------------------------------------------------
Commands: Add Del Edit Help Level More Next Return Save Transfer Window execute
Windows : Content Format List Order Selection
```

Figure 9. Export Data Files selection window.

Using PROMAN

The first screen after entering the PROMAN program provides an explanation of database files used with PROMAN (Figure 10).

Users should not exit PROMAN by rebooting or powering down their system. Exiting during report generation may damage data files. Input files should remain intact, but other newly created files may have to be manually erased.

Main Menu

The PROMAN Main Menu provides six choices, numbered one to five, and nine. You may choose to: run batch reports (1); import a standard ASCII file (2); list database files (3); process new project files (4); change active project files (5); or exit PROMAN (9) (Figure 11).

1 - Run Batch Reports

By selecting "1," you can use PROMAN's ability to support batching of reports. After this selection, PROMAN will prompt you to select one or more entries from a list of reports to run against the downloaded data from the project management system (Figure 12). To make a selection, type in the letters corresponding to the desired reports.

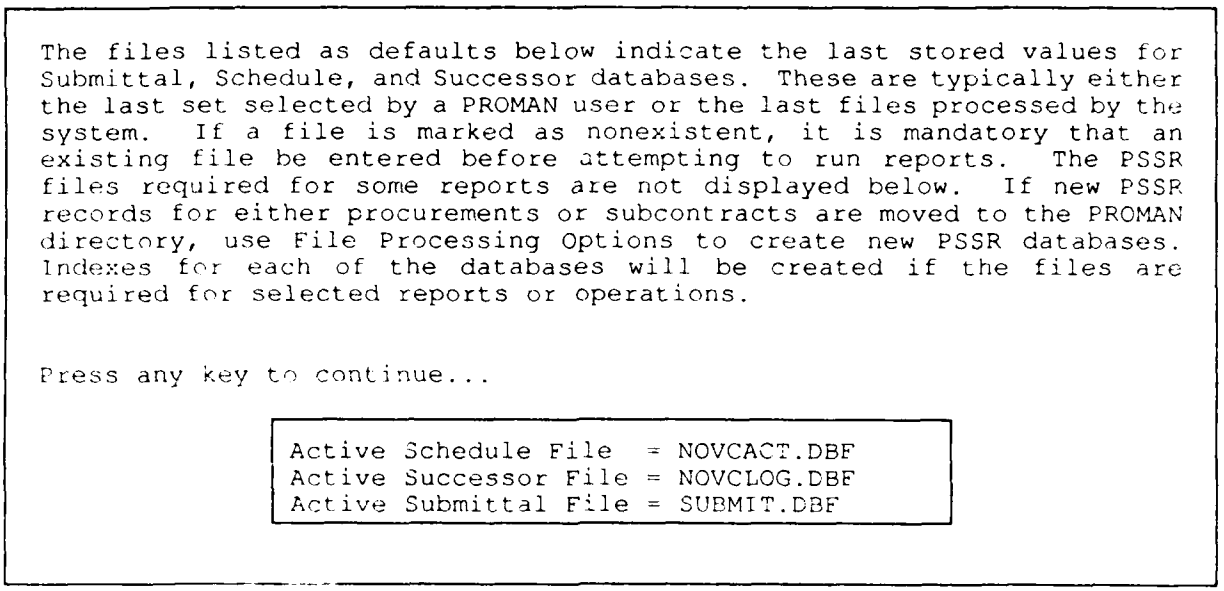

Figure 10. Initial PROMAN screen.

An asterisk (*) is placed beside each selected report. If a report has been chosen by mistake, or if you wish to make a change before running the reports, a report can be "unselected" by typing its corresponding letter again. After all reports have been correctly marked, press "1" to run the reports. Each report is described with examples in the last section of this document. To run batch reports at night it is recommended to send the output to a disk file rather than directly to a printer. It is also advisable to ensure that the hard drive contains adequate disk space (3 to 4 megabytes minimum) to hold the reports.

After running the batch files, it is possible to exit from the program. To exit PROMAN, enter a "9" as your choice from the Report Selection Screen or from the Main Menu.

2 - ASCII Standard File Import

By selecting "2" from the Main Menu, choose the "ASCII Standard File Import" utility (Figure 13), which converts a standard ASCII file of a specific format into the format required by the PROMAN program. Researchers for this study collaborated with software vendors to expand upon the Data Exchange Format[6] developed at USACERL to create this utility. Since the initial development of this interface, the standard format has changed. Furthermore, the construction codes used at NTF are not universal codes. Users whose hardware/software configuration does not support the configuration described in this study will need to write a formatting interface to suit their equipment.

3 - List Database Files

This utility lists database files located in the PROMAN directory (Figure 14). A similar option is available from the "Process New Project Files" menu. If the desired files are not listed, it is best to exit PROMAN, locate the files, and copy them into the C:\PROMAN directory.

---

[6] *Project Management Systems Data Exchange Format*, Draft Technical Report (USACERL, November 1989).

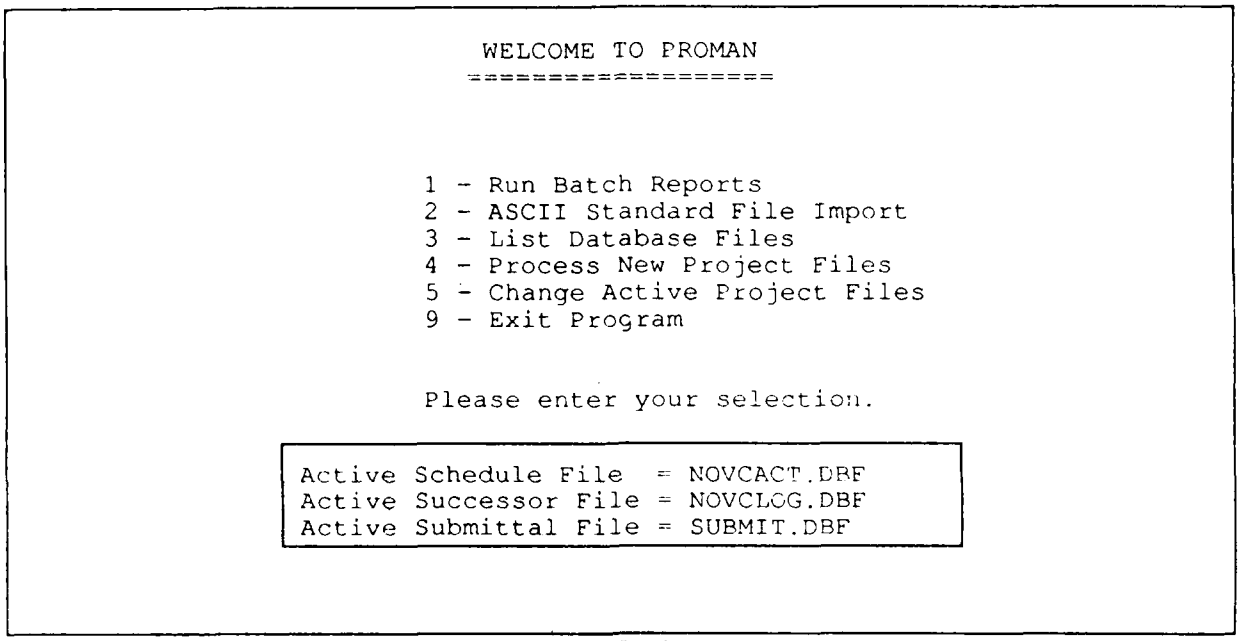

Figure 11. Main menu.

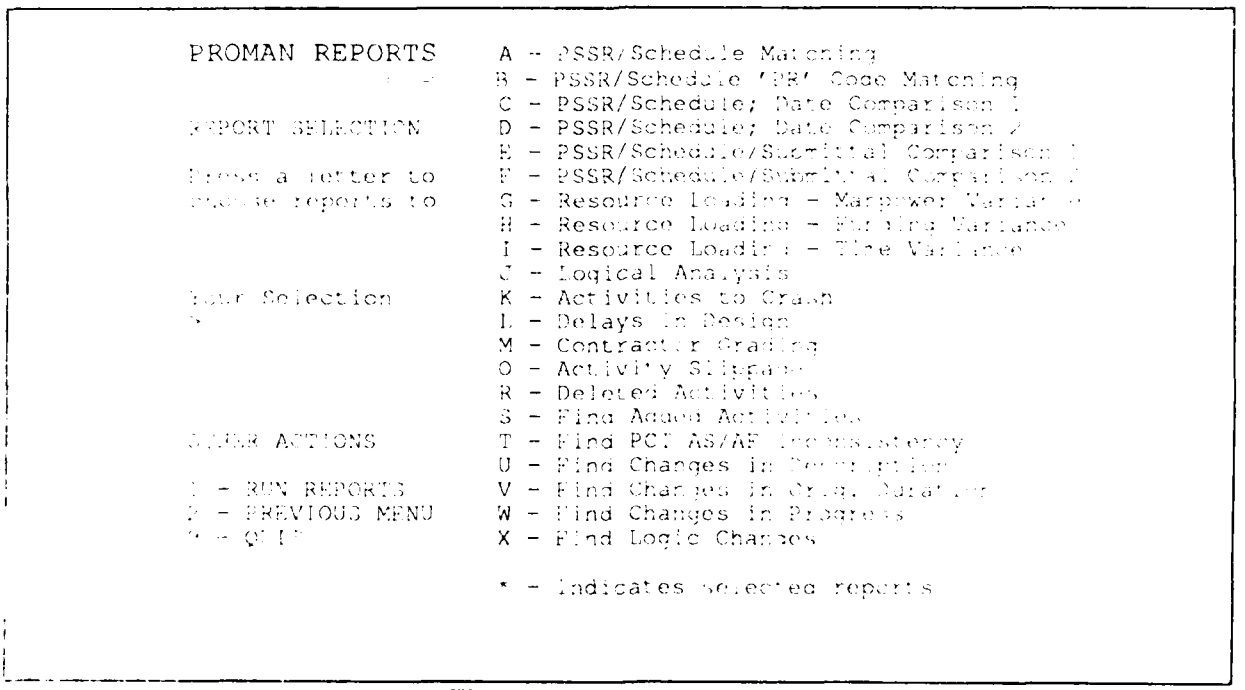

Figure 12. Reports menu.

```
Input the entire filename, including filename extension if present, of the
PSSR "Procurement" ASCII file to be compared against Schedule and/or
Submittal files.  In order to run Reports which require the PSSR data, a
filename MUST be input here.   (For specific information about the
necessary format for this file, please refer to the S.A.S. User's Manual.)

      INPUT PSSR "Procurement" FILENAME:PSSRS.ART

               VALID FILENAME

      Input a PSSR "SubContract" ASCII file?  Y


Input the entire filename, including filename extension if present, of the
PSSR "SubContract" ASCII file to be compared against Schedule and/or
Submittal files.  (For specific information about the necessary format for
this file, please refer to the S.A.S. User's Manual.)

      INPUT PSSR "SubContract" FILENAME:PSSRR.ART

               VALID FILENAME

Press any key to continue...
```

Figure 13. Example filename entry screen.

4 - Process New Project Files

Every database file to be used by the PROMAN program **must** be processed once through this menu option. Schedule files, successor files, submittal files, or subcontract and procurement files may be processed from this menu (Figure 15). Each type of file may be processed separately, or all types may be processed at once, depending upon the menu item chosen.

```
Database Files  #Records  Last Update  Size

SUBMIT.DBF      489       02/01/89     111616
FEBCACT.DBF     1023      04/20/89     211700
JANCACT.DBF     1015      04/19/89     210052
ACTIVITY.DBF    229       04/03/89     14328
FEBCLOG.DBF     2194      04/18/89     59400
PSSR_SC.DBF     268       04/21/89     60330
PSSR_PR.DBF     915       05/21/88     323455
GRADE1DEF.DBF   2930      03/31/88     556781
```

Figure 14. List database files option.

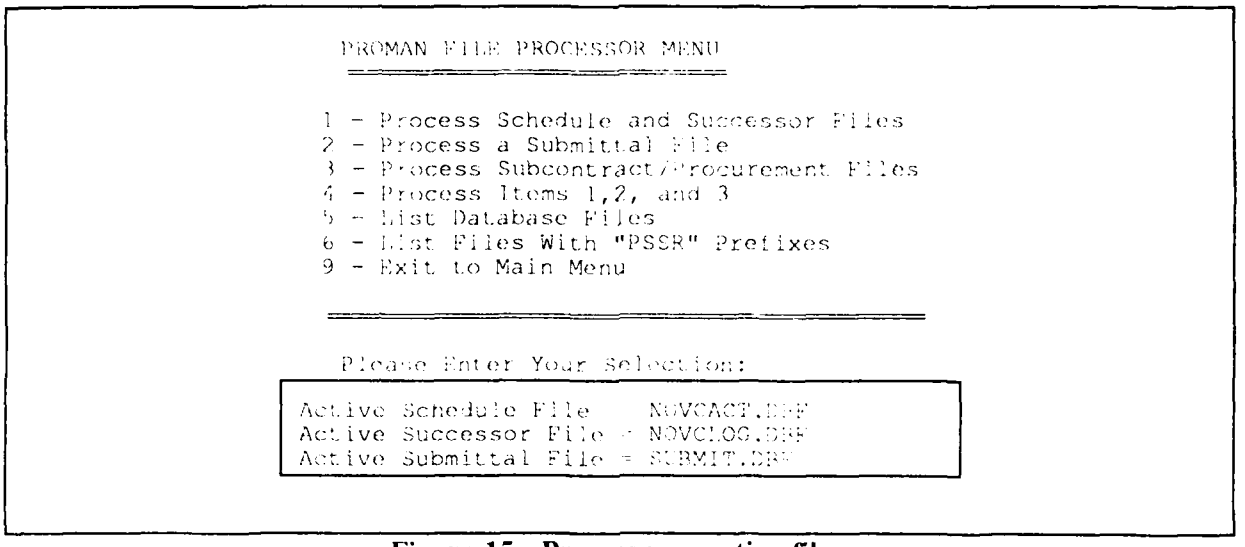

Figure 15. Process new active files.

Two file utilities are available from this screen to assist in determining which files should be processed. One lists all database files (for schedule, successor and submittal files), and one lists all files that begin with "PSSR" (for subcontract and procurement files).

As PROMAN processes new files, a message indicating each stage is displayed on the screen (Figure 16). The computer keyboard should be untouched until the reports are completed. Any keypress will interrupt processing and may destroy important data. Do not interrupt processing.

Input the entire filename, including filename extension if present, of the PSSR "procurement" ASCII file to be compared against Schedule and/or Submittal files. In order to run reports which require the PSSR data, a filename MUST be input here.

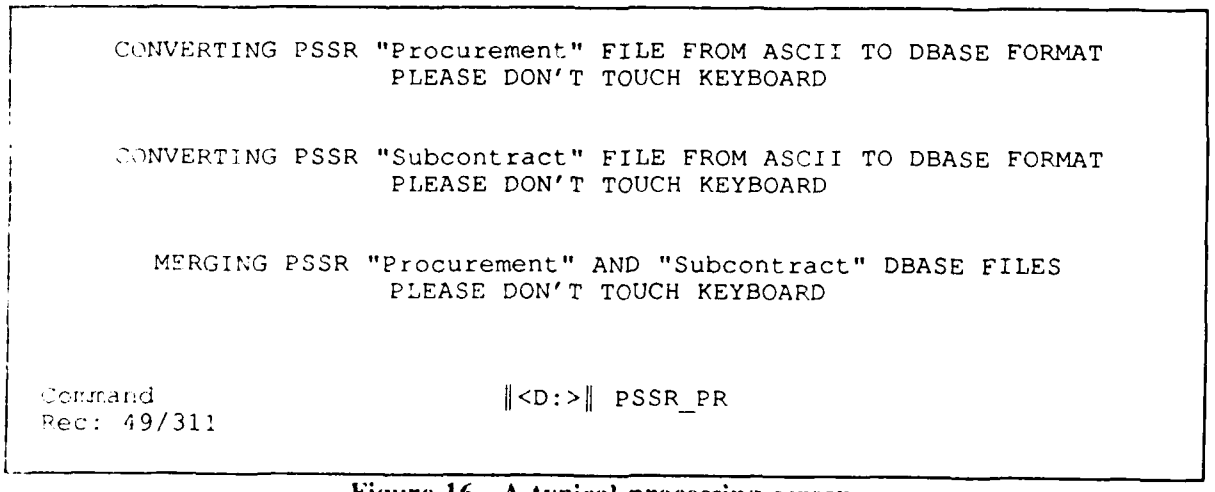

Figure 16. A typical processing screen.

5 - Change Active Project Files

Active Project Files are the files whose names are supplied as default filenames until they are changed under this menu option, or until a new file is processed under the "Process New Project Files" menu (Figure 17).

```
                Change the active file names

          Active Schedule File =  DECCACT.DBF
        Active Successor File =  DECCLOG.DBF
        Active Submittal File =  SUBMIT.DBF
```

Figure 17. Change active files.

Specifying Report Output Information

Before running batch reports, PROMAN allows the selection of output method from four available options. When these options are displayed, you must select the output mode for reports, either to send reports to a file, to a printer, or to both. (Figure 18)

```
                CHOOSE OUTPUT METHOD:

P               Print Report
B               Print AND Make Disk File of Report WITH PRINTER CODES
D               Make Disk File of Report WITH PRINTER CODES
A               Make Disk File of Report WITHOUT PRINTER CODES

SELECT ONE OF THESE OPTIONS <P,B,D or A>:  D

                VALID OUTPUT CHOICE.

Even if you chose to direct your Reports only to a disk file,
information about the printer on which this disk file will
eventually be printed is required to properly format the output, IF
you will be sending the file directly to a printer.

                Please identify your printer type:

                W   Epson Wide-Carriage or Compatible
                L   Hewlett-Packard LaserJet or LaserJet2

                Enter Your Choice:  L
```

Figure 18. Output mode selection screen.

To select an option, enter the letter associated with an option and then presses "Enter." If an invalid letter is typed, the program will return an error message and you will be given the opportunity to make a correct entry. If the letter entered is one of the valid choices, the choice is marked with an asterisk.

Option "P" sends output only to the printer. Option "B" allows the preparation of both printed and electronic copies with printer codes when required. Option "D" allows later printing of a report (particularly useful when attended printing and unattended report runs are appropriate). Option "A" sends output to a disk file with no special computer codes. Option A is useful if the output file is to be imported into another application program, such as a word processor, or printed on any wide-carriage printer. For best results when importing a file into a word processor, the document should be set up to allow 80 characters per line. Regardless of what option is chosen, the report will be displayed on the screen as it runs.

If options "P," "B," or "D" are selected, you must designate which printer code set to use, either the "Epson Wide-Carriage or Compatible" or the "Hewlett-Packard LaserJet or LaserJet 2."

The following paragraphs contain a brief description of each of the PROMAN reports.

Report A: PSSR/Schedule Matching

Algorithm

Report A prints data for each Schedule Activity which matches the first nine characters of one or more PSSR (Procurement File) Activity ID numbers. (Duplicate Activity ID numbers in the PSSR files are repeated if they match more than one Schedule Activity ID number.)

User-Modifiable Items

Initial PSSR and Schedule filenames.

Output

Output from Reports A, C, D, E and F follow the same format. The following items are listed from each matching Schedule Activity, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity.

For all PSSR Activities matching each Schedule Activity, the following items are listed, in this order: PSSR Activity ID number, Description (text), Vendor Name (text), Arrive on Site date, Required date, the difference (in days) between the Schedule Early Start date and the PSSR Arrive on Site date, and an arrow indicating which groups of matching PSSR Activities show the largest difference between the Schedule Early Start date and the PSSR Arrive on Site date.

At the end of Report A, PROMAN lists the number of Schedule Activities and PSSR Activities which met the search criteria.

Report B: PSSR/Schedule "PR" Code Matching

Algorithm

Report B prints data for each Schedule Activity which is a "Procurement" Activity (and thus has a "PR" or a "PR-" embedded in its Activity Number), and which lacks any matching Activities in the PSSR (Procurement) File. Therefore, Report B lists Activity data only from Schedule files.

User-Modifiable Items

Initial PSSR and Schedule filenames.

Output

Output from Report B includes the following items, listed from each Schedule Activity meeting the above criteria, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity.

At the end of Report B, PROMAN lists the number of Schedule Activities which met the search criteria.

Report C: Date Comparison 1

Algorithm

Report C prints data for each Schedule Activity which matches one or more PSSR (Procurement File) Activity ID numbers, and for which the latest PSSR "Arrive at Site" date is later than the matching "Schedule Early Start date," for which the matching Schedule Activity has a Float of fewer than 10 working days. (Note that duplicate Activity ID numbers in the PSSR files are repeated if they match more than one Schedule Activity ID number, using a match of the first nine characters.)

User-Modifiable Items

Initial PSSR and Schedule filenames.

Output

Output from Report C follows the same format as Report A.

Report D: Date Comparison 2

Algorithm

Report D prints data for each Schedule Activity which matches one or more PSSR (Procurement File) Activity ID numbers, for which the latest PSSR "Arrive at Site" date is later than the matching "Schedule Early Start" date by a number of days greater than 20 percent Float for that Activity, and for which the matching Schedule Activity had a Float of more than 10 working days. (Note that duplicate

Activity ID numbers in the PSSR files are repeated if they match the first nine characters of more than one Schedule Activity ID number).

User-Modifiable Items

Initial PSSR and Schedule filenames.

Output

Output from Report D follows the same format as Report A.

Report E: Submittal Comparison 1

Algorithm

Report E compares date consistency among Activities having matching information in the Schedule, PSSR, and Submittal Register files. Data is printed for each Schedule Activity which matches one or more PSSR (Procurement) File Activities, which also contains matching information in the Submittal file, and for which the PSSR "Submittal to CE" and "CE Submittal Approval" dates do not match, for which the Schedule Activity has (by default) fewer than 10 days of Float. (Duplicate Activity ID numbers in the PSSR files are repeated if they match the first nine characters of more than one Schedule Activity ID number.)

User-Modifiable Items

Initial PSSR, Schedule and Submittal filenames. Also, you can change the value of the float (Default Value: Float = 10 days).

Output

Output from Report E follows the same format as Report A.

Report F: Schedule/Submittal Comparison 2

Algorithm

Report F compares date consistency among Activities having matching information in the Schedule, PSSR, and Submittal Register files. Data is printed for each Schedule Activity which matches one or more PSSR (Procurement) File Activities, which also contains matching information in the Submittal file, and for which the PSSR "Submittal to CE" and "CE Submittal Approval" dates do not match, and for which the difference between the PSSR dates and the Schedule dates is (by default) greater than 20 percent of the Float. (Duplicate Activity ID numbers in the PSSR files are repeated if they match the first nine characters of more than one Schedule Activity ID number.)

User-Modifiable Items

Initial PSSR, Schedule and Submittal filenames. you can also change the percentage difference between the PSSR and Schedule dates. (Default Value: Percentage = 20 percent).

Output

Output from Report F follows the same format as Report A.

Report G: Manpower Variance

Algorithm

Report G prints those Activities requiring (by default) more than 20 Men Per Day, calculates and prints the Mean and Standard Deviation for Men Per Day for groups of Activities having (by default) the same CSI Standard Code, and for those Activities which are (by default) more than 1.00 Standard Deviation above or below the group mean, and lists the relative difference in Standard Deviation from the group mean.

User Modifiable Items

Initial Schedule filename. You can also change the minimum number of Men Per Day per Activity to search the threshold number of Standard Deviations above or below the group mean used to flag particular Activities, and the Activity Code or Activity ID Code used to group Activities. All of these user-defined items are listed on this title page; in addition, the Activity Code or Activity ID Code and the threshold number of Standard Deviations are included in the header of each page. (Default Values: Men per Day = 20; Standard Deviation Multiples = 1.00; Code = STND.)

Output

Output from Report G includes the following items listed from each Schedule Activity meeting the above criteria, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity. Also output are the number of Men Per Day required by that Activity, and a column indicating the relative difference from the group Mean, in Standard Deviations, for that Activity.

At the end of Report G, PROMAN lists the number of Schedule Activities found.

Report H: Cost Variance

Algorithm

Report H prints those Activities requiring (by default) more than 2000 Dollars Per Day, calculates and prints the Mean and Standard Deviation for Dollars Per Day for groups of Activities having (by default) the same CSI Standard Code, and for those Activities which are (by default) more than 1.00 Standard Deviation above or below the group mean, and lists the relative difference in Standard Deviations from the group mean.

User-Modifiable Items

Initial Schedule filename. You can also change the minimum number of Dollars Per Day per Activity to search the threshold number of Standard Deviations above or below the group mean used to flag particular Activities, and the Activity Code or Activity ID Code used to group Activities. All of these user-defined items are listed on this title page; in addition, the Activity Code or Activity ID Code and the threshold number of Standard Deviations are included in the header of each page. (Default Values: Dollars Per Day = 2000; Standard Deviation Multiples = 1.00; Code = STND.)

Output

Output from Report H includes the following items listed from each Schedule Activity meeting the above criteria, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity. Also output are the number of Dollars Per Day required by that Activity, and a column indicating the relative difference from the group Mean, in Standard Deviations, for that Activity.

At the end of Report H, PROMAN lists the number of Schedule Activities found.

Report I: Time Variance

Algorithm

Report I prints those Activities requiring (by default) more than 40 Working Days, calculates and prints the Mean and Standard Deviation for Working Days for groups of Activities having (by default) the same CSI Standard Code, and for those Activities which are more than 1.00 Standard Deviation from the group mean, lists the relative difference in Standard Deviations from the group mean.

User-Modifiable Items

Initial Schedule filename. You can also change the minimum number of Working Days per Activity to search the threshold number of Standard Deviations above or below the group mean used to flag particular Activities, and the Activity Code or Activity ID Code used to group Activities. All of these user-defined items are listed on this title page; in addition, the Activity Code or Activity ID Code and the threshold number of Standard Deviations are included in the header of each page. (Default Values: Working Days = 40; Standard Deviation Multiples = 1.00; Code = STND.)

Output

Output from Report I includes the following items listed from each Schedule Activity meeting the above criteria, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity. Also output are the number of working days required by each Activity, and a column indicating the relative difference from the group Mean, in Standard Deviations, for each Activity. At the end of Report I, PROMAN lists the number of Schedule Activities found.

Report J: Logical Analysis

Algorithm

Report J prints the construction Activities on each floor which do not follow a normal construction progression pattern. This pattern is defined by examining (by default) the "Sort Details Code" for each Activity in the Schedule file. The normal progression (assuming the default "Sort Details" code) is defined as: Earthwork, Structural Steel, Concrete, Rough-in, Drywall, and Finish. Activities deviating from this progression are identified and printed. In addition, drywall Activities which are to be finished before the start of roof Activities are identified and printed.

User-Modifiable Items

Initial Schedule filename, Activity Code or Activity ID Code. PROMAN enables these schedule codes to be user selected. This does not imply that these codes were correctly chosen when input, or that the values for these codes are subsets of those defined within the Primavera Code Dictionary.

Output

Output from Report J includes the following items listed from each matching Schedule Activity, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity.

Report K: Activities To Crash

Algorithm

Report K prints the four most critical paths in the schedule database. It does this by sorting schedule information by total float and finish date, and then by searching for the four most critical paths. Report K also analyzes Manpower Loading for critical path activities. The report lists those activities whose Manpower Loading is greater than a user-specified amount. Activities with durations greater than a user-specified amount are also listed. The final section of Report K identifies activities with Relation Durations in excess of a user-specified percentage.

User-Modifiable Items

Manpower Loading Value, Duration Value, and Duration Relation Percentage (Default Values: Duration Value = 20; Duration Relation Percentage = 20 percent).

Output

Output from Report K includes the following for each critical path: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Actual Start date, Actual Finish date, Float, Remaining Duration, Percent Complete, Original Duration, Lag, and Relation. Output for Manpower Loading, Remaining Duration, and Relation Durations follow each critical path.

Report L: Delays in Design

Algorithm

Report L requires data from two schedule update files. It prints data for each activity which (by default) has a "DR" STND code and a Float greater than 10 days, and which (by default) has lost 10 percent of that Float between two Schedule updates.

User-Modifiable Items

Initial Schedule update filenames. You can also change the value of the float and the percentage difference (Default Values: Float = 10 days, Percentage = 10).

Output

The following items are listed from each matching Schedule Activity, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity.

At the end of Report L, PROMAN lists the number of activities which met the criteria.

Report M: Contractor Grading

Algorithm

Report M requires data from one Schedule update file, and a matching PSSR and Submittal file. First, it calculates a "rating" of the percentage of PSSR and Submittal which correspond to Schedule Activities, the percentage of PSSR and Submittal which correspond to Schedule procurement Activities, the number of nonprocurement Activities with durations exceeding 20 days, and the number of correctly coded Schedule Activities (assuming that the NTF Dictionary Codes within Primavera are correct). Report M also sums the number of Schedule Activities having negative float, determines the percentage of Activities on the four most critical paths which met their Early Start Date, and analyzes the Activities on the four most critical paths in terms of the time remaining and the time expended. Report M analyzes the percentage of Activities which have adequate "Actual Start Dates," analyzes the percentage of Activities having "Percent Complete" greater than zero or a Remaining Duration with no "Actual Start Date," and analyzes the percentage of Activities having "Percent Complete" greater than zero or a "Remaining Duration" with "No Actual Start Date." It also analyzes the percentage of Activities with "Remaining Duration" greater than their "Original Duration."

Before running Report M, "Report K: Activities to Crash" should be run to determine the four most critical paths in the schedule file. If Report K has not been run previously, only the "Actual Start Date" Analysis is affected.

User-Modifiable Items

Initial Schedule update filenames. You can also change all of the grading "threshold" values, which are used to determine the "grade" or rating given to the contractor. You must input the correct Primavera Data Date in order for one of the subitems to work, since the "Data Date" cannot be included in Primavera Phase export files. You can choose to generate a Summary Report, a Detailed Report, or both together.

Output

Report M yields two kinds of reports: (1) a Summary Report which gives the grade for each subitem in the two overall grading items in English-like text, and/or (2) a Detailed Report which lists all of the Activities matched in the Report M algorithms and summarized in the Summary Report.

Report N: ASCII Interface/File Format

This routine converts project schedule data from an ASCII file format to the format used in PROMAN. The ASCII file must have been previously created and must follow a standardized logical file format. Use the format specified in Appendix E (Scheduling System Data Exchange Format) to create schedule or successor files. For submittal files use the format specified in Appendix D (Submittal Text

File Format). Any project management software which has the ability to export data in ASCII format can save data for each project into a single file. Likewise, if a file is created following those standards, it can be used by any project software which can import ASCII files.

After selecting Report N from the Main Menu, you are prompted for file information related to the Schedule text file. There are three choices, to:

1. Type in the name of the ASCII text file which corresponds to the schedule and successor database files

2. Enter a **SPACE** and press **ENTER** if schedule/successor databases will not be used

3. Exit to PROMAN and create the text file.

You are prompted for identical information about the submittal text files. The same steps can be repeated for the submittal files.

Report O: Activity Slippage

Algorithm

Report O accepts up to five schedule files and compares an Activity's Early Start date, Duration, Float, and Productivity (defined as Actual Duration/Original Duration). If there is a change from the previous schedule file, the activity is printed. If the productivity index exceeds one Standard Deviation, then the report prints that number of Standard Deviations.

User-Modifiable Items

Enter up to five schedule files which are checked for validity. You may also enter which Activity Code to sort on (Default Value: Code = STND).

Output

The following items are listed from each matching Schedule Activity, in this order: Schedule Activity ID number, Title (in text), Early Start date, Early Finish date, Late Start date, Late Finish date, Float (in days), Original Duration of Activity (in days), Remaining Duration of Activity (in days, and at the time the Schedule was last calculated in Primavera), and Percent Completed of Activity, the Productivity Rate, and if applicable, the number of Standard Deviations over the mean.

Report P: Activity Coding Module

Report P (the Activity Coding Dictionary) will be run after all information for the other reports has been entered. This module prompts for the name of the Activity Code to search. The choices are:

RESP - Responsibility	AREA - Task Area
LVLS - Level of Detail	SORT - Sort Details
SUBS - Subcontracts	SUAR - Task Sub-Area
TYPE - Type of Work	STND - CSI Standards

The module will then ask for the name of a project-specific Activity Coding Dictionary. If no such Activity Coding Dictionary exists at the time of the request, one will be created using the name entered at this point. The project-specific Dictionary provides an area to add special terms relevant to a given project so that task descriptions can be more useful to project personnel.

Report P then searches every record in the schedule database to compare the code value in the defined code field with the text in the activity's title with the values in the generic and the project-specific dictionaries. This project may require operator intervention to perform the following steps.

1. If there is no text/code combination in either the project-specific dictionary or the generic dictionary, and both the code and the text are entered, You are given the option to add the code and text to the project-specific dictionary file (if one is open).

2. If the text is entered and there is no code, you may opt to modify fields prior to continuing.

3. If multiple cases satisfy the code lookup (i.e., a code is used ambiguously), You see all codes and text entries for the field from the project-specific and/or generic dictionary files and can select from those. The chosen code will be written back to the schedule database.

4. You may always skip any modification.

After each activity is processed, Report P will process the next activity in the schedule database. It is recommended that this module be run separately from the previous reports.

Typical Report Operations

After a set of reports is selected and you indicate no more are to be added, the program collects the information necessary to run all of the reports. Typically, this includes the file names for all associated data bases and, in some cases, parameters such as the codes to be included. File names must be entered using the ".dbf" extension of dBase files.

To illustrate the procedure, Figure 9 displays a screen replica of a request for two file names. In each case, the text describing the required file is displayed on the screen and the default file for that request is displayed in the input area. If the displayed file is correct, You press **ENTER**. The program will search for the displayed file. If the file is not present, an error message will appear and the program again prompts for a filename. When the file is found, a message indicates that the filename is valid and the program moves to the next request.

Running the Program

After all parameters are entered, the actual reports are run. Depending on the size of the input databases and the number of reports selected, the run time can vary from 5 min (for Report K alone), to 15 min (for Reports S through X), to overnight (for all reports). When all reports have been completed, You will be returned to the PROMAN main menu.

Leaving the PROMAN Program

You should exit the PROMAN program only by choosing "9" at either the "Main Menu" or the "Run Batch Reports" menu. Although pressing "ESC" or "Ctrl-C" will interrupt processing of files or reports and terminate the program, it does so at some risk to the data files. Exiting in the middle of report generation may destroy data files. Input files should remain intact, but newly created files may have to be manually erased.

4 SUMMARY

This report has discussed the implementation of the PROMAN schedule analysis software to large, cost-plus construction projects, and has made recommendations regarding the scheduling and planning of those projects.

Large construction projects require that approved and appropriate schedule changes be included in each updated schedule. To complement commercial software that can match activities to compare changes in start dates and to identify floats, USACERL developed PROMAN, a comparison program which identifies all additions, deletions, and logic and lag changes. For this study, USACERL, under a contract with the Construction Automation Support Center, modified PROMAN with an expanded set of schedule analysis tools, developed for the NTF Office to provide coordination between procurement and submittal systems, rapid identification and analysis of the critical paths through the schedule, analysis of the variance between groups of schedule activities by cost, time, and manhours, and several other features.

Although this version of PROMAN was enhanced for use with the computer configuration at the NTF office, techniques are outlined to assist Area/Resident Office personnel to install and implement the program. The PROMAN program may require modification for use with configurations other than those used on the NTF project. (PROMAN is sufficiently developed to allow experienced construction office personnel to modify the software source code (Volume II). A properly prepared cost-plus construction project can use PROMAN to measure cost and productivity, to track delivery of materials, and to compare intermediate and general schedules.

Before beginning a large cost-plus project, District and Construction Field Offices should consider several factors related to scheduling and planning:

1. The Architect/Engineer should furnish a design project schedule that logically links related activities in the project in a Network Analysis System.

2. The Area/Resident Office should provide a full-time scheduler specially trained in microcomputer scheduling systems and project scheduling with construction inspection experience.

3. In determining the contractor's incentive fee, an automated system can help to analyze the level of detail needed to define the criteria for grading the contractor.

4. The Area/Resident Office must devise a consistent, independent coding scheme that targets specific groups of activities for precise schedule analysis.

5. Data from the various computer-based systems such as cost and productivity control, and procurement control should be coordinated with schedule data to enhance project control.

6. Large construction projects must be equipped with computer systems for efficient operation. the system should have a fast (20 MHz minimum) 80386 microcomputer with a large capacity (40 MB minimum) hard drive and a math coprocessor, and a fast printer with 132-character-wide carriage and options for condensed and double-strike characters.

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