# 1987 TRANSACTIONS

AACE 31st Annual Meeting
Atlanta, Georgia

## OF THE AMERICAN ASSOCIATION OF COST ENGINEERS



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# FOREWORD

## 1987 AACE TRANSACTIONS

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These **TRANSACTIONS** constitute a record of the technical papers at the AACE 31st Annual Meeting June 28 through July 1, 1987. The aim of the Association's Annual Meeting is to bring people together who have a common interest in cost engineering and to provide a forum for the discussion of technical matters. The meeting is intended to implement the basic objective of AACE, namely, to advance cost engineering through the application of scientific principles and techniques to problems of cost estimation, cost control, business planning and management science, profitability analysis, project management, planning and scheduling.

The technical program, directed by Technical Program Chairman Michael E. Horwitz, PE CCE, was organized into 6 concurrent sessions composed of technical papers, technical panel discussions, and workshops sponsored by the various technical committees of AACE. The technical papers were divided into 13 symposia:

- **A. Planning and Scheduling**
- **B. Computer Applications**
- **C. Capital Cost Estimating**
- **D. Operating and Manufacturing Costs**
- **E. Energy Costs**
- **G. Management Systems**
- **H. Construction Cost and Schedule Principles**
- **I. Capital Cost Control**
- **J. Utility Cost Management**
- **K. Productivity**
- **L. Education**
- **N. Profitability**
- **O. Mining and Minerals**

In addition, the colored appendix features the "Basic Skills and Knowledge of Cost Engineering" presented by the AACE Education Board. This special 13-session workshop diversifies AACE's educational offerings and provides a solid informational base for today's cost engineers and project managers.

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## SYMPOSIUM S — SKILLS AND KNOWLEDGE OF COST ENGINEERING

*A Special Section Covering the Basic Skills and Knowledge Required by Today's Cost Engineers*

# RECOGNIZING AND AVOIDING PROBLEMS INHERENT IN TODAY'S SCHEDULING ENVIRONMENT

by David L. Freidl, CCE

## INTRODUCTION

The purpose of this paper is to provide an overview of today's scheduling environment and address several problems which repeatedly occur. It is written with the intent that if scheduling engineers are aware of these problems, they can take the necessary steps to avoid difficulties which may occur at a later time. The problems discussed fall within two general categories--those which are within scheduling's authority and those which occur external to planning and scheduling's scope of authority.

The recommended solutions to the problems have proved effective on actual engineering and construction CPM schedules. They are not intended as a panacea for all the ills which planning and scheduling is susceptible. Each project has unique schedule parameters which must be considered in selecting a proper course of action. The solutions offered in the text are intended as a guide, leaving the decision regarding the final course of action up to the scheduling engineer and the dictates of the individual project.

## TODAY'S SCHEDULING ENVIRONMENT

The basic requirements of an effective project schedule program have not significantly changed over the past fifteen years. The function of the schedule remains to model actual conditions on the project and report status on activities shown in progress. The schedule has to be manageable, responsive to changes, capable of storing project history, and have the ability to generate timely and understandable reports. The schedule must also have the ability to maintain continuity when personnel turnovers or external factors disrupt the established plan for the project.

From a technological point of view, Main Frame (MF) CPM programs have been replaced with Personal Computer (PC) schedule applications. The advent of the personal computer and sophisticated software packages to handle project control needs have placed the scheduling function at the work site, localized under the autonomous control of the scheduling engineer. Supplemental software has forged a new frontier in the flexibility of data manipulation and the manner in which information can be presented.

The responsibilities of the scheduling engineer have also changed. Limited budgets for schedule preparation and maintenance require schedule expertise which encompasses multi-discipline engineering and construction scheduling capability under various types of contract conditions. Schedulers must also be capable of manipulating schedule data and generating the project period reports within the PC environment. Today's technology has reduced the drafting and clerical functions necessary to maintain project schedules, replacing them with Computer Aided Drafting and Design (CADD) and supplemental software packages. The application of this new technology has also changed the corporate planning and scheduling structure. Technical support personnel, consisting of schedule systems analysts, work with groups of schedulers to find new and more cost effective ways to use the software and hardware available.

New technology and changes within the construction industry itself are primary factors affecting the new scheduling environment. Interest rates, changes in demand, and environmental considerations have all played a role in altering the way scheduling is performed. Large capital projects having long payback periods and significant cash flow have given way to smaller projects dealing with maintenance and upgrades of existing facilities. Concurrently, there has been a shift away from the cost plus type contract to lump sum or fixed price contract arrangements. This type of contracting mandates fixed budgets for service related functions, limiting the amount of resources assigned to project scheduling. In order to win jobs under these conditions, projects are bid with minimum time frames, making cost effective schedule control a necessary goal in assuring profitability. The recognition and solutions offered for the problems which follow may aid in the achievement of that goal.

## PROBLEMS IN SCHEDULE DEVELOPMENT AND IMPLEMENTATION WITHIN SCHEDULING'S SCOPE OF RESPONSIBILITY

### Avoiding Excess Detail in the CPM Data Base

A recurrent problem in CPM schedules is that a data base has been implemented which is too detailed relative to the scope of work being managed. The error originates in the preliminary stage of schedule development where an attempt is made to impose firm control over the project schedule and cost. The size of a data base becomes inflated by a perceived requirement to insure that every element of the project cost estimate is accounted for in the schedule model. This results in the addition of activities which address resource requirements for indirect cost items, contingencies, etc. The problem becomes manifest in the execution phase of the schedule. At that point, the scheduler finds himself trying to cope with logic that is strangling in its own size and complexity, often adversely impacting the focus of the schedule effort. Valid critical paths are obscured by strings of logic whose float is a function of schedule activities which have no bearing on the completion of a given milestone. A clear picture of what the real schedule problems are becomes difficult to present. Reports become filled with critical logic sequences which are a function of incremental schedule time added by engineers who have allowed a "cushion" on each activity to cover unforeseen schedule impacts.

The CPM data base described above may require a schedule program located on a main frame computer system, located off the project and dependent on outside personnel. This removes the schedule advantage afforded by a PC and results in longer turnaround time for data feedback. Other liabilities include limited report writing capabilities, higher cost of services, and loss of effective focus.

Recommended Solutions. Reduce the amount of detail by limiting the number of non-critical schedule activities, using fixed constraint dates or prudent lead/lag factors to account for proper time sequencing and resource allocation. The lack of detail can then be compensated for by providing definitive activity status information in the period schedule reports. Figure 1, "PC and Software Applications for CPM Scheduling", illustrates how the schedule program can be supplemented through the use of records management and spreadsheet programs. In addition to the period reports generated within the schedule program, supplemental reports addressing discreet critical schedule activities can be listed as records and updated by modifying each record according to the latest schedule information. Table 1, "Critical Activities List", illustrates a typical output report format for critical activities generated through the use of a records management program. Data from the resource module can be listed cumulatively or incrementally in spreadsheet format and easily appended to include updated resource/cost information. Table 2, "Productivity Analysis", shows the added flexibility which can accrue through the use of a spreadsheet program to analyze data from the schedule resource model. The quality and turnaround time for these reports can be enhanced by the use of PC's with large memory capacity, laser printers, data editing software, PC networking, and CADD techniques. Finally, having access to state-of-the-art hardware and software programs affords the scheduler more time for critical path analyses, preparation of work around plans, and "what if" scheduling.

### Problems in Data Extraction and Manipulation

If insufficient preplanning is not done on the schedule and resource module code libraries, problems in extracting discrete portions of the data base occur. The flexibility and report writing capabilities of the schedule program become limited, resulting in client and project reports that convey only general information in a ridged format. Also, activity node numbering schemes designed for data extraction may create difficulties in tracing paths, analysis, and data input.

The genesis of any good project schedule plan lies at the activity level. Sorting and extraction capabilities are built in at this level as well. Activities contain some parameters which are only partially influenced by the scheduling engineer. Durations, description format, resource type, unit rate, work breakdown structure, and the methods adopted to calculate percent complete and earned value are usually dictated by the project or the accepted control system. The design of the node numbering sequence and code structure is, however, usually left up to the scheduling engineer.

Recommended Solutions. A well designed code structure can compensate for the lack of detail in the node numbering scheme. A definitive code structure, established and implemented as part of initial logic input, assures that needed extraction capability will be available during the project execution phase. Implementation of the code structure at this time also allows for cost effective batch processing and electronic data manipulation. Modi-

FIGURE 1

PC SOFTWARE APPLICATIONS FOR CPM SCHEDULING

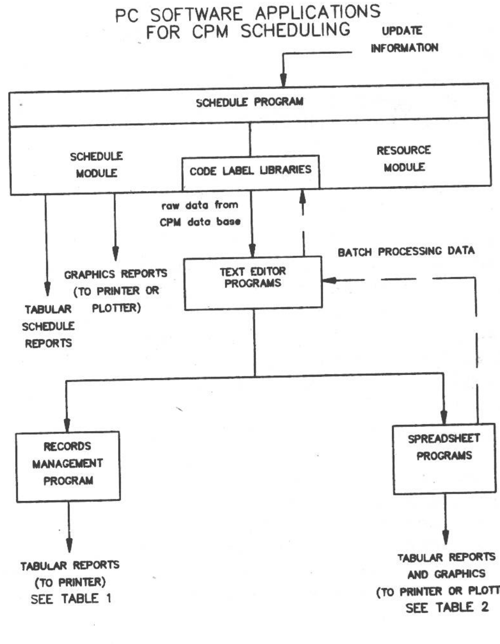


TABLE 1

CRITICAL ACTIVITIES LIST
DATA DATE NOV 5, 1986.

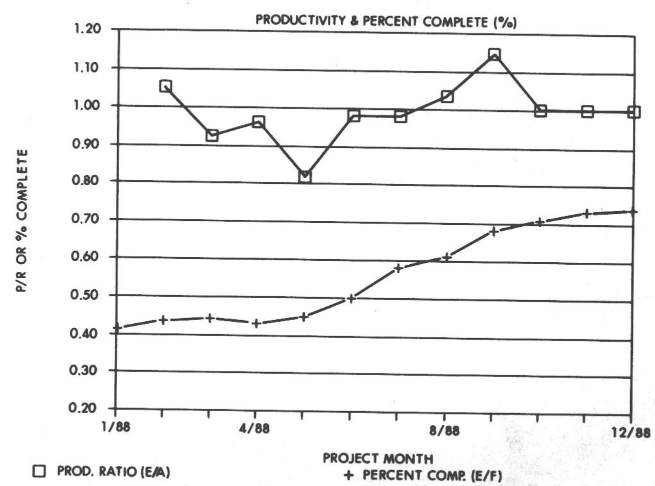
| ACT. NO. | TOT. FLT. | ACTIVITY DESCRIPTION | CAUSE | CORRECTIVE ACTION | RES ORG |
|---|---|---|---|---|---|
| ** SYSTEM IS: AES | | | | | |
| 3070 | -7 | PREPARE PROPOSAL FOR STUDY IMPLEMENTATION- DCN 105C | RESOURCE REQUIREMENTS FOR THIS DCN HAVE NOT BEEN RESOLVED. TIES TO IMPLEMENT STUDY RESULTS (3085) AND ON TO VERTICAL PANEL LAYOUT DRAWINGS. | XYZ AND HA TO RESOLVE RESOURCES ON. | XYZ |
| 3085 | -7 | IMPLEMENT STUDY RESULTS | REQUIRES RESOLUTION OF DCN 105C ACT. 3070 ABOVE. OUT OF SEQUENCE PROGRESS HAS BEEN TAKEN. LOGIC TIES TO THE I&C WORK REQUIRED FOR THE VERTICAL PANEL LAYOUTS. | SEE ABOVE. | XYZ |
| ** SYSTEM IS: APH2 | | | | | |
| 1125 | -30 | FINAL ENGINEERING AND DESIGN -FOUNDATIONS | COMPLETION OF STRUCTURAL DESIGN WORK TIES TO THE FINAL YARD PIPING IN THE AREA (ON HOLD). NO PROGRESS TAKEN. | FOUNDATION DRAWINGS WILL ISSUE FOR DETAILING BASED ON THE EXISTING DESIGN. RESOLUTION OF THE YARD ARRANGEMENT QUESTION IS EXPECTED IN LATE NOVEMBER. | HA |
| 2275 | -30 | FINAL ENGINEERING AND DESIGN -MECHANICAL | LOGIC TIES FROM FINAL ENIGINEERING AND DESIGN IN THE ELECTRICAL DISCIPLINE. (SEE BELOW) | CONTINUE WITH THE DRAWINGS USING AVAILABLE INFORMATION. | HA |
| 3050 | -30 | FINAL ENGINEERING AND DESIGN -ELECTRICAL | RECPT OF VNDR DRWGS WAS 2 WKS LATER THAN SCHEDULED REF. ACT.(8200). ACTIVITY TIES TO DRAWING ISSUES WHICH WERE ASSUMED TO BE IN ELECTRICAL BID PACKAGE. | HA SHOULD EXPEDITE THE RECIEPT OF REMAINING ELECTRICAL DESIGN INFORMATION OR RESCHEDULE THE DWG ISSUES. THE BID PACKAGE WILL BE ISSUED BASED ON THE AVAILABLE DESIGN INFO. | HA |

TABLE 2

PRODUCTIVITY ANALYSIS

| MONTH | 4/86 | 5/86 | 6/86 | 7/86 | 8/86 | DATA DATE 9/86 | 10/86 | 11/86 | 12/86 |
|---|---|---|---|---|---|---|---|---|---|
| EARNED | | | | | | | | | |
| PRE(1986) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 |
| PERCENT EARNED | 0.200 | 0.218 | 0.267 | 0.350 | 0.380 | 0.450 | 0.475 | 0.500 | 0.505 |
| CONTRC HRS. | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 |
| % earned * [F] | 1.7 | 1.9 | 2.3 | 3.0 | 3.3 | 3.9 | 4.1 | 4.3 | 4.3 |
| SUBMITTED DCNS IN PROGRESS | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | 0.3 | 0.4 | 0.4 |
| EARNED HOURS | 3.9 | 4.1 | 4.5 | 5.3 | 5.6 | 6.2 | 6.4 | 6.7 | 6.7 |
| EARNED (INCRE.) | -0.4 | 0.2 | 0.4 | 0.8 | 0.3 | 0.6 | | | |
| ACTUAL | | | | | | | | | |
| PRE(1986) | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | 2.0 | | | |
| PERCENT ACTUAL | 0.203 | 0.225 | 0.275 | 0.360 | 0.389 | 0.450 | | | |
| CONTRC HRS. | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | | | |
| % actual * [F] | 1.7 | 1.9 | 2.4 | 3.1 | 3.3 | 3.9 | | | |
| SUBMITTED DCNS IN PROGRESS | 0.2 | 0.2 | 0.2 | 0.3 | 0.3 | 0.3 | | | |
| ACTUAL HOURS | 3.9 | 4.1 | 4.6 | 5.4 | 5.6 | 6.2 | | | |
| ACTUAL (INCRE.) | -0.4 | 0.2 | 0.4 | 0.8 | 0.2 | 0.5 | | | |
| PROD. RATIO [E/A] | | 0.818 | 0.980 | 0.979 | 1.034 | 1.148 | 1.000 | 1.000 | 1.000 |
| TOTAL EARNED | 3.9 | 4.1 | 4.5 | 5.3 | 5.6 | 6.2 | 6.4 | 6.7 | 6.7 |
| TOTAL FORECAST | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 |
| PERCENT COMPLETE | 0.46 | 0.47 | 0.52 | 0.62 | 0.65 | 0.72 | 0.74 | 0.78 | 0.78 |

XYZ COMPANY



fications to a code structure when the schedule is in its execution phase requires significant time, expense, and manpower allocation. Figure 2, "Suggested Code Structures", illustrates flexible activity and resource code library configurations. The actual code field selection is left up to the scheduling engineer, as dictated by the unique requirements of the project.

FIGURE 2

SUGGESTED CODE STRUCTURES

ACTIVITY CODE STRUCTURE

| CODE FIELD | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| NUMBER OF COLUMNS | 2 | 1 | 1 | 4 | 4 | 2 | 9 |
| CODE FIELD DESCRIPTION | UNIT | PRIMARY RESP. | DISC | AREA | DISC | ELEV | W.B.S. |

| CODE FIELD | 8 | 9 | 10 |
|---|---|---|---|
| NUMBER OF COLUMNS | 2 | 1 | 1 |
| CODE FIELD DESCRIPTION | SPEC. | CONSTR. PACKAGE | MILE STONE |

RESOURCE CODE STRUCTURE

| CODE FIELD | 1 | | 2 |
|---|---|---|---|
| NUMBER OF COLUMNS | 4 | 2 | 1 |
| CODE FIELD DESCRIPTION | CRAFT/DISCPLN./ MATERIAL TYPE | | RES. TYPE |

From a scheduling point of view, node numbering schemes which require more than six digits or are alphanumeric in nature should be avoided. Tracing critical paths through various disciplines is difficult enough, especially when lag factors and fixed constraints are present, without having to consider non-uniform activity numbers. Micro and multiple calendar scheduling environments add to these analysis problems. Large alphanumeric node numbers also make it more difficult to locate where critical intradiscipline logic ties occur. When activity identification is required by visual means, a uniform code within the description should be used.

Alphanumeric node numbering sequences increase input errors when large numbers of activities are being inputted as a package. Their only justification is when program restrictions limit the amount of code fields and all other extraction possibilities have been exhausted. Finally, the use of an "intelligent" node numbering option is fine if the size or complexity of the node number does not increase.

## PROBLEMS IN SCHEDULE DEVELOPMENT AND IMPLEMENTATION OUTSIDE OF SCHEDULING'S SCOPE OF RESPONSIBILITY

### Avoiding CPM Logic Which Does Not Reflect Actual Work Status

Problems of this nature are partially outside the scope of planning and scheduling's responsibility and usually become manifest during the execution phase of the schedule. Schedulers find themselves with CPM logic which produces:

1. Schedule "look ahead" reports which indicate strings of logic which are not consistent with the actual work being performed.
2. False critical paths showing remaining durations on activities that are not consistent with actual time frames to do the work.
3. Actual and budget forecast to complete quantities which are inconsistent with other quantity tracking systems.

The primary reason this occurs appears to be that the supervisor responsible for reporting progress was not involved in the development of the logic. A second, more probable reason is that the responsibility for updating and maintaining the schedule has become centralized within the scheduling discipline.

Recommended Solutions. The responsible design or field supervisor should be given the opportunity to concerning how the work should be performed. It also gives that individual a chance to review the overall relationship between his work and that of the other disciplines. If available, a definitive scope document and project historical data should also be provided. Figure 3, "Project Schedule Development Flow Diagram", illustrates a successful sequence for effective project preplanning and schedule maintenance. Note that it shows discipline input to the schedule well before detailed logic diagrams are developed.

The second solution has its roots within the organization structure. It is outside of scheduling's scope of authority and requires the decentralization of the schedule update and maintenance responsibility. The majority of today's engineering and construction efforts are performed under a strong matrix type organization, making individual disciplines responsible to a task force organization (the project) and a functional organization (corporate technical support). From a discipline standpoint, engineering and design operates well under this organization structure because all discipline related functions are addressed within the scope of the overlapping organization structures. Problems requiring technical assistance are resolved through the chief engineers within the functional organization. Direction and design implementation are dictated by the project organization. The strong matrix organization structure enforces a centralization of each discipline's responsibility within the structure defined for it.

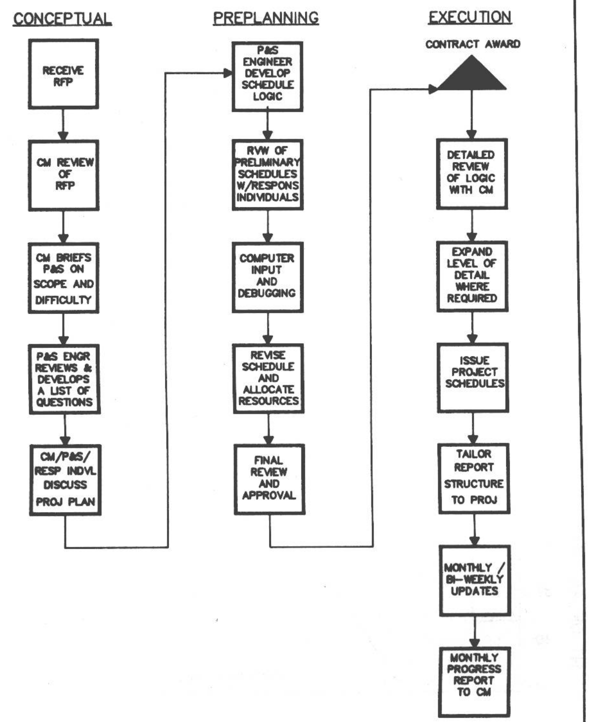



FIGURE 3
PROJECT SCHEDULE DEVELOPMENT
FLOW DIAGRAM

What has occurred is that the responsibility for the schedule has become polarized within the scheduling department. As such, other disciplines deemphasize their responsibility for scheduling, choosing to believe that it falls outside their scope as defined by the organization structure. What has resulted today is a self perpetuating philosophy which is counterproductive to the project and its goals of completing projects on time and within fixed budgets.

Planning and scheduling needs update information from other project elements to function effectively. Successful schedule implementation relies heavily on input from the other disciplines outside scheduling's scope of authority. Individual disciplines must assume the responsibility for developing the raw data necessary to update and maintain the schedule program. In order for this to occur, management must adopt guidelines that clearly define the scope of what other discipline's scheduling obligations include. This project philosophy must be actively pursued and enforced by project management at the project level.

Benefits of decentralizing the schedule update responsibility include:

1. A project plan which is better able to integrate unanticipated modifications to the current schedule.
2. A more logical approach for integrating Design Change Notices (DCN's) or Field Change Notices (FCN's) into the schedule.
3. Period schedule reports that accurately model the true status of the job, requiring less "reading into the gray area" on the part of the scheduling department regarding remaining durations and quantities.

The "Tool Versus Club" Schedule Philosophy

Line personnel are hesitant to assign schedule and cost quantities to activities early in the project because they lack definitive information. The problem arises when disciplines remember how, on previous projects, their projections were used as a "club" when their inaccurate estimates were mistakenly perceived as poor performance. They realize that estimates have a way of gathering validity over time and that management has a tendency to look at information as being the product of concise data which was not available at the time.

The problem is compounded by the concept of a stored target schedule. Target schedules establish estimated quantities as a criteria for judging performance against the current schedule. A dichotomy develops between the two--the target schedule reflecting the proposed plan based on the information available at that time, and the current schedule which reflects actual history and changes to the logic which have occurred. If the current schedule is being properly maintained, it is improbable that a comparison between the two will be the same. Target schedule comparisons are more effectively utilized as a tool to highlight the difference between two schedules, than as a measurement of performance.

Recommended Solutions. An effective step to minimize this problem is to make sure that the most definitive available scope documents are used as the point of departure for preplanning or major schedule revision efforts. Relevant schedule history from past projects of a similar nature should also be provided. The scheduler's experience regarding the problems which were encountered when different courses of action were taken on previous projects should also be considered. Additional efforts on the part of scheduling include:

1. Emphasizing the deficiencies in current versus target schedule comparison.
2. Putting forth extra effort to identify and document why the current versus target schedule quantities differ.

Developing a Cohesive Scheduling Staff

Schedule efforts with large data bases require a staff of scheduling engineers to develop, maintain, and update a successful project plan. Melding the different specialties and levels of experience of each member of the team into a cohesive group requires a great deal of leadership on the part of the schedule supervisor. Each member of the staff usually has previously acquired expertise in a given discipline. These schedulers tend to carry previous project philosophies with them as the preconceived goals for their new project. Difficulties arise when they try to implement these philosophies into the new project plan.

Recommended Solutions. The solution process starts by familiarizing the group with the goals of the project schedule plan. As general logic sequences are being developed, discussions among the group must be held to assure that these goals are being adhered to. Prior to data takeoff, prototype logic diagrams should be developed and used as a guide. These logic diagrams then constitute the philosophy of how the schedule will meet its goals. Another reason for using prototype logic diagrams is that they allow for the preliminary analysis of the flow of the work. Logic sequences that are too detailed or overuse lag factors can be adjusted before the package is implemented. This also facilitates the data input process, allowing more than one individual to do data takeoff. These diagrams should also be maintained and updated during the course of the project and used as an aid for training new personnel.

The group should also be made aware of what the report requirements are, how they will be generated, and the method by which earned value is calculated. The capabilities of the code label libraries should be pointed out and how the extraction criteria defined generates a particular report.

Inexperienced scheduling engineers should be shown the various types of drawings and educated as to the function each serves. They should also be made aware of what alternate information sources are available, such as published indices and directories, professional societies, and knowledgeable people within the organization. Information offered by professional societies, such as the AACE and ASCE, also provide a source of training material. The file of historical information kept by the supervising scheduling engineer should be accessible to the members of the department.

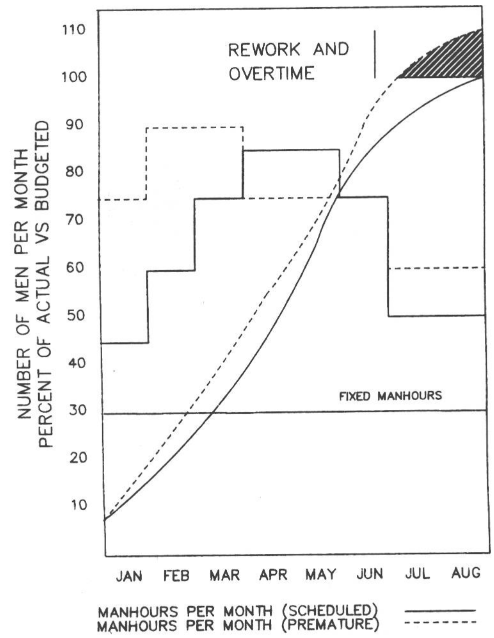
Finally, under no circumstances should a premature schedule, or portion of a schedule, be released to the project without some form of coordinated internal review. Premature schedules which suddenly appear and contain obvious errors seriously erode the credibility of the schedule effort.

### Addressing Deviations From the Project Plan

This problem deals with a philosophy which states that "building and engineering a project for the least possible cost dictates getting the work done in the shortest possible time". This philosophy has its origins buried in a fixed price type contract environment. It occurs when the project overrides the established plan, starting work on activities earlier than scheduled, in the hope that the total cost of the job can be reduced by shortening the overall duration. The flaw in this approach is that the hours estimated in the budget are based on tasks with firm engineering preceding them. What results is a much higher amount of labor necessarv to take the existing products and retrofit them to the latest design parameters. Overtime may be necessary to correct this condition if a fixed completion date is required for that portion of the work. The overtime will result in a higher variable cost at the end of the project and no reduction in the fixed costs as thought. Figure 4, "Consequences of a Premature Design/Construction Approach", illustrates how actual workhours exceed budget workhours when rework and overtime are required to modify premature work.

FIGURE ·4

CONSEQUENCES OF A PREMATURE DESIGN/CONSTRUCTION APPROACH



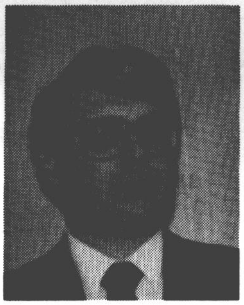

Recommended Solutions. Given the above condition, it is scheduling's responsibility to inform project management of the possible consequences. Resource reports, edit listings showing out-of-sequence progress, and graphics presentations similar to Figure 4 may be necessary. Correcting this problem, however, is management's responsibility.

## SUMMARY

Today's scheduling environment is fraught with potential problems which require an experienced scheduling organization. The planning and scheduling engineers of the 1980's must be well versed in the operation of the personal computer and have a working knowledge of all facets of scheduling. Economics have reduced the number of people which can be assigned to a given scheduling function, creating changes in both the corporate and project approach to the scheduling function. On the project level, the need for an overall project control consciousness which decentralizes update and maintenance responsibilities is mandatory if schedule control programs are to succeed under fixed price type contracts. Along with this, planning and scheduling must assume the obligation to remain current with the latest state-of-the-art equipment and implement the new technologies which are beneficial to the control of the project. Finally, it should also be willing to recognize the professional responsibilities for the training and teaching of those under its charge.

## CONCLUSION

The concept "Forewarned is forearmed" requires that we re-evaluate scheduling in today's environment. Errors which occur during the preplanning and execution phase of the schedule often become obscured in the day-to-day process of scheduling and have disastrous results. By bringing these problems to the forefront and discussing their possible solutions, schedule errors can be avoided and a more cost effective implementation of planning and scheduling principles results. Recognition of these problems becomes even more important given today's small-to-moderate capital projects requiring fixed budgets for successful project schedule development and implementation.



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## Notes

# Notes

# DRAWING SCHEDULES ON A PC WITH CAD

by Philip T. Perzanowski

## INTRODUCTION

As CAD has shifted from mainframe and mini- computer based systems to the personal computer based systems, the cost of a typical workstation has plummeted. Once costing hundreds of thousands of dollars to computerize drawings, a P.C. based workstation can now be purchased for under $10,000 and for the most part are competitive with the larger systems. What part of this advanced technology can we as schedulers use? How can we integrate this tool into our day to day business? What are those of us currently using CAD to expect from the future?

Since the part of our job as schedulers is conveying the relationship of work tasks and the status of those tasks, the use of graphic representation is very important. Any enhancement to these graphic representations will have positive impact on our total product and this what CAD provides. There are three basic uses of CAD in a scheduling environment, automating hand drawn schedules, CAD as a front end input to a scheduling system and modifying scheduling system output. I will explain each of these and give instance of how they are currently being used. I will also address what the next step is in this automation process.

## AUTOMATING THE HAND DRAWN SCHEDULE

Very simply, CAD allows you to draw and edit on a computer and store this information and/or plot it out. So that you can see better what CAD can do in a scheduling environment, let me briefly describe some of the functions/commands that are available with a typical CAD system. I will address the features in four separate groups: drawing, displaying, editing, and utilities.

### DRAWING

Drawing refers to placing entities or on graphic primitives on the screen. Some of the commands that make this up are:

<u>Line</u> — Points are selected and a line is drawn between them. Variations of this allow for a thick line as would be used in a boarder of drawing or a variable width line.

<u>Circle-Arc</u> — These commands require minimal input to generate a full circle or an arc. This input can include center, radius or diameter or in the case of an arc 3 points. One feature which is helpful with this and other commands is the drag mode which allows you to drag the last point with the cursor.

<u>Block, shape or symbol</u> — This is probably one of the most powerful commands because you can save an entity or group of entities and then reinsert them at will. While inserting, you can change the object's rotation, size and even modify it after it has been inserted.

<u>Text</u> — As you would imagine, this function places text on the drawing. In most systems you have the option to select a style, height, justification (left, right, center) and rotation. This has both a positive and negative aspects. The lettering is consistent, sharp and neat, but it changes a manual skill of hand letter into a keyboard typing skill.

### DISPLAYING

Display involves how you visualize what is on a particular drawing. If CAD has one drawback (no pun intended), it is the fact that, depending on the

**resolution (dots per inch on the screen) and the size of your screen, you may not be able to see the detail when looking at a large part of the drawing or the entire drawing. Thus, the need for the following commands:**

| Feature/Command | Description |
|---|---|
| Zoom | This feature controls the amount detail seen. To zoom in, a window is placed around the object to be magnified and just that section is blown up. Zooming out displays the entire drawing or previous screens. |
| Pan | The ability to look at different sections of drawing while staying at the same magnification is provided by PAN. View saves and restores zoomed or panned windows. |

EDITING

Although time can be saved drawing the original with CAD, the greatest gain in productivity can be seen in drawing changes. The following commands are both used to draw originals and in revision:

| | |
|---|---|
| Array | This places multiple copies of an object or objects either in a rectangular or circular pattern. |
| Erase | Selecting an entity or entities and removing them from the drawing is accomplished with erase. |
| Break | Break cuts existing entities and/or erases portions of entities. |
| Copy | Duplication of an object or objects is done by copy. |
| Move | Move picks up existing objects and puts them down in another part of the drawing (cut and paste). |
| Mirror | Object or objects are flipped based on a given reference line with the mirror command. |

UTILITIES

This group of commands help organize drawings and make it easier to draw:

| Feature/Command | Description |
|---|---|
| Limits | An electronic fence is defined and then warns you if you draw outside that boundary. It also gives you a frame of reference for zooming and plotting. |
| Grid | This is a network of uniformly spaced points and functions as a sheet of graph paper. These are used to position objects precisely on the drawing. |
| Snap | This CAD drawing function controls the cursor movement. The increments the cursor moves across the screen are preset. |
| Osnap | Osnap is object snap. It allows you to grab a specific point on the drawing, such as an end of a line or center of a circle. This permits you to connect entities to previously drawn entities. |

Utilizing CAD to draw schedules is the simplest mode to incorporate it into the planning function. This can be accomplished with "off the shelf" software and some minor modifications to improve productivity.

Other than purchasing a system and learning how to use it efficiently, the two biggest problems in using CAD to draft schedules are keying (typing) all the text rather than hand lettering and dealing with the limitation of the screen size.

Let me address both of those briefly. Typing is very often assumed to be a clerical function and not a skill a draft person or scheduler may possess. This can either be overcome by training or by utilizing a CAD program which allows text to be imported from a word processor and delegating the typing to a typist.

The problem of screen limitation can be mitigated by using a screen with higher resolution. A monitor, like a television screen, is composed of a matrix of small dots and called pixels. The number of these pixels that make up the screen determines the resolution; the more the pixels, the higher the resolution, and the more detail that is visible on the screen. Unfortunately this is a high dollar item, and it could add thousands of dollars to your system.

The advantages and disadvantages to using CAD in this mode parallel its use in a mechanical drafting environment. The scheduling groups that will see the most productivity gains are those who utilize standard networks or barcharts and those who are involved in a multitude of revisions to these schedules.

Figure 1 demonstrates the use of CAD to sketch-out a preliminary schedule. This took three