Flowcharting for Project Control

One machine can do the work of fifty ordinary men.
No machine can do the work of one extraordinary man.

—ELBERT HUBBARD—

''I'm tracking my project with a method used by the government for a submarine development program,'' one manager told another. ''And now I can really identify with the Navy.''

''Why, because it helps you keep your project on schedule?'' the other one asked.

''No, because I'm having trouble keeping my head above water.''

If you have a lot of time, you can develop and use a complex scheduling system to control your project. However, if you are facing the crunch most project managers face, you're continually battling to stay on schedule or just to catch up. The secret is to find an effective method you can put into play quickly that also gives you the daily information you need to control the schedule effectively. Remember, too, that no

system can replace your personal effort and communication with team members; systems are only tools that you put into use.

The advantage of the Gantt chart is that you can put it together quickly. If properly tracked, your schedule can be controlled through Gantt chart monitoring overall as well as by specific phase.

The disadvantage of the Gantt chart is that it does not help you identify the weak links in your process, points where information passes from one person to another, where outside resources convey information to or receive information from your team, and where an action cannot be taken until someone else completes a preceding action. A Gantt chart only shows you when a project phase begins and ends and how actual times compare to the schedule. Your network—the actual communication and conveyance of information between core team members and other resources—can be tracked only with a more elaborate system.

Guidelines for Project Control

Any control procedure has to balance effectiveness with efficiency; this is not always easy. Your project is intended to move along at a healthy pace, with phases completed on time and within budget. That itself is a sign of effective leadership and control on your part. However, although effective control looks easy from the outside, it requires careful planning and leadership. Some guidelines to remember:

1. ***Define the criteria for the completion of each phase.*** A lot of focus is placed on phases and their completion. This is important, of course, but what are your *criteria* for completion? Define successful completion for each of your phases. For example, if a phase involves designing an improved process, is it really an improvement? Is it faster, easier, better controlled? How do you know the project is moving in a positive direction? Your overall project goal may be clearly defined, but each phase should also be subjected to this standard.

2. ***Execute controls in manageable units.*** Control is a concept that often cannot be achieved because the overall demand is overwhelming. Just as you read a book one chapter at a time, control has

to be broken down into digestible, smaller units. You do not expect to accomplish all of your control steps in a single effort, so define the overall control expectation with a series of phase-specific steps. This makes the job easier and success much more likely.

3. ***Hold regular (but short) meetings to check project status and to update everyone.*** Meetings can kill any project, so they have to be kept brief and effective. Control cannot take place in a project manager's efforts alone; the whole team has to be involved. Whether you hold special meetings just to go over progress in control-related areas or incorporate this idea as an agenda item in your periodic team meetings, it is essential to spend time reviewing and planning the *control* aspects of the process.

4. ***Build in monitoring systems during phases.*** As you design changes to processes, build in the control elements and ways to monitor them. Just as accountants have many rituals designed to ensure accuracy and protect liquid assets, every project manager needs to develop easily applied but effective methods for building red flags into the project. These will take on characteristics depending on the kind of project, work environment, and the project itself, but including a monitoring system is one of the most important forms of project control.

5. ***Build control into the quality aspect of the project.*** Control and quality are really not separate efforts. It is a mistake to attempt to break projects out into three different areas of work: process (input through output), quality (reduction of defects), and control (budgeting and scheduling, labor oversight, reduction of losses from theft or carelessness, for example). It's really one overall chain of events and the process, quality, and control issues are attributes of the whole effort. Your project is going to be more effective and successful when you merge these elements into one, single value chain (see Chapter 9).

6. ***Anticipate problems to avoid them.*** Control cannot be only a responsive matter. If you take steps to correct problems only after they occur, you miss the opportunity to prevent the same problems in the first place. Remember, too, that many problems are expensive in terms of profit and loss, customer relations, branding, and morale, to

name a few areas. The whole concept of risk management recognizes the need not only to fix problems after they occur, but also to mitigate loss or prevent it altogether through farsighted control measures. Control based on avoiding loss may be the most valuable form, even though its dollar benefit is invisible. You never know how much money loss you *prevent* because the loss doesn't occur.

7. ***Communicate expectations, and then verify results.*** Leadership in your project is based largely on how your team is led. If you are able to express your specific expectations, you have every right also to get results; by the same logic, if you do not communicate your expectations, you have no right to the results you want. So if you don't make a specific goal about where you want to go, you have no way of knowing how well your team is performing. Of course, the mere communication of your expectations is only the first part of the two-part task. You also need to track progress and monitor results.

8. ***Use consistency to create a predictable control environment.*** Good project managers are consistent. Find a good working method with your team, and consistently apply the same controls, including communication, verification, monitoring, follow-up, and revision. Your consistency gives team members a sense of predictability while ensuring everyone that you know how to lead. Inconsistent behavior grows from not planning a project at all, but consistency is the lifeline the team wants and needs.

9. ***Be aware of high priorities, and put your energy there.*** In deciding which kinds of controls are needed and how to create them, also be constantly aware of priorities. Some controls are going to be quite urgent, whereas others are minor and can be deferred or delegated. For example, discovering that products are being shipped with defects is a critical priority, and the problem has to be fixed immediately. Worker complaints about low-quality coffee in the lunchroom affect morale but are nowhere as important as the first issue. Setting priorities makes you effective and helps move the improvements in your project to successful completion.

10. ***Be prepared for the unexpected, and move quickly to adjust.*** You can rely on one thing with certainty: You are going to face

unexpected problems during the course of your project. This is why no budget or schedule is ever final. Either has to be revised constantly. The normal chaos in this environment is going to challenge your leadership abilities, but as long as you are prepared to move quickly and adjust to unexpected problems, you will be able to steer the project to a successful, on-time, within-budget completion.

Listing Out the Phases

In Chapter 6, we used an example of an eight-phase project for improving procedures in a processing department. In that example, phases were broken down and listed in order of precedence. This is the first step in developing a definition of your project network; however, a problem may arise when you attempt to distinguish between an ''event'' and an ''activity.''

An activity is the step (or steps) involved at each phase. An event is the result (e.g., completion of a report) or some other necessary step (e.g., receipt of information from another team member).

As a general rule, an activity occurs during a phase and an event is what comes from the combined activities. The event commonly is a requirement before a subsequent phase can proceed.

Why are these definitions important? They point out a common flaw in the way that processes move along. If you make use of a flowchart to define a process, you will draw a series of boxes or circles that are joined together with lines. The tendency is to use boxes to describe activities, so the lines become nothing more than connectors between a series of sequential activities. How do you define time requirements in such a flowchart? You and your team can become confused if activities reside within the flowchart's boxes but time estimates are tracked on the lines. It is more accurate and easier to track processes when you use one of three alternate methods:

1. Writing events (i.e., the end results of phases) within boxes and using the lines in between to describe activities and the time required for those activities

Beyond Activities and Events—Interactions

Some additional definitions, while not essential to the listing of phases, also help to explain differences in how projects proceed. These relate to the three types of interactions that your core team experiences:

- ***Mandatory dependencies.*** These are the requirements of a project. For example, a project involving revised departmental procedures includes mandatory dependencies on the work requirements for each employee in the department. These dependencies also are referred to as hard logic.
- ***Discretionary dependencies.*** These are interactions left to team members. Whenever a team member has choices in how to proceed, that individual may rely on a particular approach or sequence to a problem, for example. Discretionary dependencies also are called soft logic.
- ***External dependencies.*** These refer to any relationship between your core team and an outside resource, such as another department or division, a vendor, or a consultant, for example.

2. Isolating activities in the boxes with events written below in a separate box, then using the lines to describe the time requirements for activities
3. Writing activities in boxes with events listed below, and tracking time on a separate line

The first method is appropriate for large-scale and exceptionally complex projects. The second method enables you to track activities and time, the critical requirement for scheduling control, and to isolate and identify activities falling outside of that process flow. The third method can prove to be the most practical for smaller projects in terms of time and steps.

For any scheduling system more involved than the Gantt chart, begin by organizing phases in a logical sequence and by task or subtask

within each phase. Your purpose should be to identify the precise sequence of activities and events and to recognize when the first draft includes out-of-sequence tasking. For especially complex phases, you may need to map out two or more events that come up at the same time.

Work Breakdown Structures

Work Breakdown Structure (*WBS*) is an organizational method for scheduling control. This method encompasses both outlines and graphs as a means for controlling your project schedule; you may need to develop and use both, or build flowcharts from a carefully constructed WBS in outline form.

The purpose in using WBS is to make sure that your schedule includes everything you are going to need to execute your project. It organizes your schedule by finding steps you may otherwise skip or overlook. There are important distinctions between WBS and the schedule itself. WBS is a tool you employ to make sure the schedule is comprehensive, that proposed phases are placed in the logical sequence, and that team assignments are given out logically, evenly, and based on required skills.

A good way to understand how WBS works is to see how it helps to create a powerful schedule. WBS lists tasks, and in the scheduling phase you determine their sequence; the same is true for task assignments. So given these distinctions, it makes the most sense to start out with WBS in outline sequence and then build a flowchart. As long as the WBS outline includes all known tasks and processes, the flowchart will determine (a) the logical sequence of work, (b) the proper team member or members to execute the work, and, most important of all, (c) the interdependencies of team members to one another and to stakeholders outside the team.

The use of a WBS outline to create a network diagram of the project or a finely detailed flowchart makes scheduling comprehensive and inclusive by cutting down on the chances that important phases will be left out. A common reason for scheduling problems is the discovery that work cannot proceed as originally planned because an important

step was overlooked when the schedule was first created. WBS ensures that your original schedule will not be missing any steps.

Consider this example: You test a new procedure for two weeks. During the test, you compare outcomes with the old system four times and make any needed adjustments in the new procedures. In this case, the phase is broken down and identified by four separate events within the phase, one for each time the two systems' results are compared.

Organizing a project in this way is called WBS, and it can be achieved through either of two formats—the outline format or the tabular format.

The Outline Format

In the outline format, each phase is listed as a major heading and details are listed as subheadings. This format offers several advantages:

- ***You can identify responsibilities by team members.*** On the outline itself, each task or series of tasks is first broken down by description. Once you are satisfied with the outline, you can assign team members to a task or series of tasks. If one team member will have primary responsibility and others will assist, this should be indicated as well. Thus, starting out with a rather simple outline, the entire project can be expanded into a nicely detailed summary of phases, steps, and responsibilities.

- ***You can control time in considerable detail.*** The time estimate for each phase can be specified, and subroutines can be broken out in terms of hours or days estimated for completion. With the outline completed, you can then map out time requirements and constraints. The time element is a further elaboration of the sequence outline.

- ***You can look for weak links in the procedure where your involvement is required to keep the process moving along on schedule.*** Controlling and managing weak links—points where work passes from one person or group to another or where one event has to

be completed before another can begin—is the key to schedule control. Your outline can be used to highlight those critical points.

Achieving complete control over the schedule is the benefit to mapping out the schedule in complete detail. However, knowing where the weak links occur is only the first step in controlling them. You need to take two additional steps: bringing weak links to the attention of the team members who are involved in the work, and following up and monitoring the weak link itself to ensure that the process does not break down.

Also remember that team members on either side of the weak link (i.e., those passing along the work and those receiving it) can contribute to the breakdown of your schedule. To keep things moving along, you need the work completed and delivered, and you also need the receiving side to go into action right away.

Using the example project introduced in Chapter 5—the revision of current procedures in the accounts payable department—the outline format looks like this:

Project: Procedure Revisions

1.0 Document current procedures
    1.1 Interview employees
    1.2 Review documentation
    1.3 Update documentation
2.0 Prepare procedure flowcharts
    2.1 Identify workflow
    2.2 Coordinate work between employees
    2.3 Review flowcharts
    2.4 Adjust workflow
3.0 Summarize paper flow
    3.1 Prepare final workflow
    3.2 Identify sources
    3.3 Identify destinations
    3.4 List department reports
4.0 List problem areas and solutions
    4.1 List inefficient areas

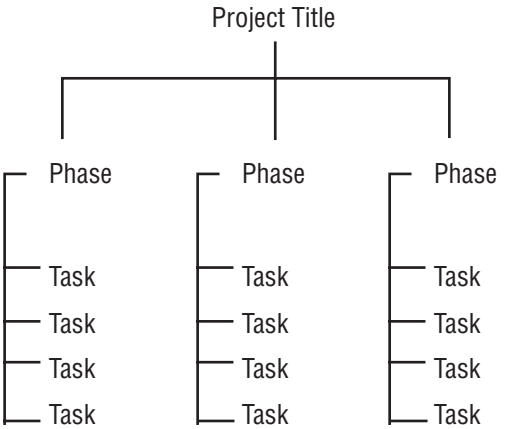
4.2 Identify weak links
4.3 List possible solutions
4.4 Summarize solution ideas
5.0 Develop improved procedures
5.1 Prepare flowcharts
5.2 Develop narratives
6.0 Track sample transactions for one week under existing procedures
6.1 Identify test area
6.2 Track daily totals
6.3 Summarize data
6.4 Prepare summary report
7.0 Track sample transactions for two weeks under proposed procedures
7.1 Isolate daily test area
7.2 Process information
7.3 Summarize data
7.4 Compare to totals under old system
7.5 Prepare comparison report
7.6 Adjust new system as needed
8.0 Prepare and deliver final report
8.1 Explain problem/solution
8.2 Summarize test data

The Tabular Format

The second WBS method is the tabular, or organizational, format. The same information is arranged from top to bottom, with each phase broken down much like an organization chart, as shown in Figure 7-1.

Either the outline or tabular method can be employed. The outline format provides more flexibility for adding time and responsibility details, so the decision to use one method or the other should depend on the project's complexity and the size of your core team. Once you have completed the definitions in the WBS system, you can next prepare a diagram and time requirements in a visual format.

Figure 7-1. Tabular format.



CPM and PERT Methods

Between 1956 and 1958, two scheduling control systems came into popular use. These are called Critical Path Method (CPM) and Program Evaluation and Review Technique (PERT). Both of these systems originally were designed to track time in projects involving concurrent activity and to monitor and control expenditures of time. Since their introduction, CPM and PERT have been expanded for use in many project applications, including budgeting, resource management, process definition, and quality control. When the two systems are combined and used together, the process is referred to as a PERT/CPM network.

In the most technical of uses, both CPM and PERT are used to analyze time use on a mathematical model. CPM provides modeling for phase start and end dates with the intention of identifying the float, or that amount of time that can be absorbed in later phases to offset time overruns in earlier ones. PERT is employed to show weighted averaging of phase time estimates and is not used as commonly as CPM.

While mathematical modeling provides some value to the highly technical project and a certain level of control to the project manager (particularly in engineering and similar environments), CPM and PERT can be used effectively purely for visual aid modeling. Leaving the mathematical analysis and weighted averaging of time studies behind,

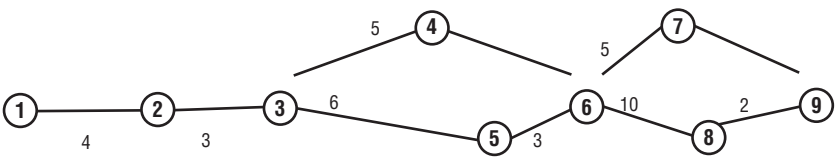
virtually any project manager can employ the techniques of these tools for visual control of any project. In fact, too much emphasis on purely mathematical modeling can take away time for hands-on management and supervision, and tends to move the project manager out of touch with the team.

A practical application for CPM involves using the visual representation of a project and its phases to calculate the maximum time in which projects can be completed, given overall deadlines. CPM can help you to identify points at which time segments can be moved around and time overruns can be absorbed without missing a final deadline. In CPM, concurrent activities are also called ''parallel'' tasks, and those activities that cannot begin until a previous activity has been completed are called ''dependent'' activities.

By mapping out the parallel and dependent activities in a model of the project, you can identify a pattern for how the job could progress. You can discover avenues for parallel activities that could save significant time throughout the project by identifying workflow with the use of CPM. The process of developing CPM often begins by organizing phases and developing a schedule using the Gantt chart. That information can then be converted to a CPM chart such as the one shown in Figure 7-2.

Figure 7-2 is a network diagram employing CPM principles. It shows the critical junctures and activities by numbers, each of which is circled. The time requirements to move from one activity to another are represented by the number of days estimated between activities (or phases). These are the numbers above or below lines joining the circled phases. Note that the concurrent, or parallel, activities are represented by a split in the critical path, as seen between the activities numbered 3 and 6 and again between 6 and 9 in the diagram.

Figure 7-2. CPM diagram.



When CPM is used to schedule and track time alone, it still involves several separate factors: minimum and maximum time required, phase and project-to-date time expended, and earliest possible start and finish times. Procedures can be employed to track and calculate these times, and to isolate the floats available to you as project manager. Thus, CPM graphs can be used to present a combined best case and worst case, as well as identify potential floats that can be used to absorb unfavorable time variances.

As useful as the visual model of CPM is for large and complex projects, it may be too time-consuming to monitor manually and perhaps overly complex for smaller, shorter-term projects.

Automated Project Management Systems

Project management, like so many other business applications, lends itself well to automation. As long as you can put software to work quickly and don't have to spend excessive time working through software limitations, duties such as schedule control—especially where graphics are employed—can be made quick and efficient.

Automation is suitable whenever you are spending too much time maintaining a monitoring system. In other words, if your oversight duties remove you from the equally important routines that help you stay in touch with team members, then they are counterproductive and not efficient. If you need to manage a large body of project-related scheduling information, software makes more sense than trying to operate a system by hand. The best kind of software program is one that lets you, as project manager, input and review information without having to wait for someone else to process it for you. You'll also want to review how well graphics can be created and displayed in available software packages (see the sidebar ''Charting Features of Scheduling Software''). A list of websites of vendors of scheduling software is offered in Chapter 6.

The decision to employ software as part of your project management duties depends on how many projects you are assigned. If you deal with isolated projects occasionally, it will be difficult to justify the cost of a suitable, versatile program. However, if project management

Charting Features of Scheduling Software

Many specialized scheduling programs allow you to construct graphic representations such as CPM, PERT, and Gantt charts. These include:

Project Kickstart	www.projectkickstart.com
SmartDraw	www.smartdraw.com
Task Manager	www.taskmanagementsoft.com
Primavera P6	www.primavera.com
Business Process Manager	www.planview.com

is a regular part of your duties, you may convince management that an investment in effective software will save time and money and assist you in delivering project outcomes on time.

Be sure that the software you consider purchasing is truly designed for project management—specifically that it provides you with scheduling and budget control features that you need. Some ''project management'' software packages are, in effect, nothing more than time management programs. Address files, e-mail notification and control, appointment reminders, and basic graphing capabilities are not worth the extra investment—not only because you probably have these features available to you as part of your operating system, but also because they provide no real value to justify the extra cost.

Other Resources

Check shareware and freeware sources to find flowcharting software online. One website worth reviewing is www.smartdraw2.com.

You may also be able to modify your existing graphics routines to create your own Gantt chart and schedule, budget, and other project-related controls. However, before automating by purchasing software, or modifying existing software in your operating system, be sure you take the following preliminary steps:

1. ***Solve the problem of management over projects first.*** Many of the difficulties you encounter in your role as project manager have to do with issues you cannot resolve through automation. These include human relations, time and budget estimation, and outside obstacles—in other words, exceptions to the way that processes should operate. You need to first master these management-related problems through experience, intuition, and knowledge. Automation is no replacement for good old-fashioned management.

2. ***Identify recurring processes that are best handled through automation.*** Within the project management realm, certain recurring tasks can be automated—just as certain of your departmental routines may be appropriate for automation. Because by their nature projects deal more with exceptions than with routines, you need to find software flexible enough to serve you in the ways you need. Beyond that, you will need to deal with nonroutine problems in nonroutine ways.

3. ***Automate for efficiency of processing, and not to replace your direct involvement with your core team.*** It is a mistake to believe that even the best software program can replace the need for direct management. The two have nothing in common. Never forget the need for direct and regular contact with team members.

4. ***Don't confuse project objectives with automation objectives.*** Another common problem is to let the underlying objectives of the project slide and become replaced with automation itself. The purpose of software is to give you the tools to manage information, arrange and report it in useful formats, and overcome paperwork and the time it wastes. Always keep the program and your objectives in mind.

5. ***Don't change your procedures to fit a program's limitations.*** A problem with software is that it might be designed for a particular type of project, and that won't always be a good fit for your work. When you end up with software that is not a good fit for your procedures, remember that the project should come first. Don't change the way you want to process work to fit with the design of the program.

6. ***Develop a practical and efficient system for managing your projects manually.*** First, overcome the problems associated with project management—as a facet of your management and leadership abilities rather than as routine-based processing methods. Next, look for ways to increase efficiency, save time, and improve communication. First comes your system for leading the team; only when that's under control should you concentrate on procedural ideas.

The most effective method for controlling a project with time constraints in mind involves the use of informative graphics, a well-thought-out schedule, and cooperation from your core team. Lacking those advantages, even the most expensive and sophisticated software will not help. Remember, the WBS, Gantt, and CPM techniques are graphic modeling provisions in software, or they are manual tools you can devise by hand. The software you select should make the use of those tools more efficient, rather than replace them with something better. You cannot expect software to take your place; its purpose is to improve your use of time and help with the communication of ideas between yourself and core team members.

Setting Your Flowcharting Rules

The essential tool for project management is the flowchart. However, to make your flowchart truly useful, you need to list much more than just activities and sequence. You also need to identify the important elements of responsibility by team member, time controls, events (e.g., reports, forms, information supplied from the outside), and coordination of every process within phases of the project.

In other words, the Gantt and CPM forms are useful, but they do not always go far enough. To make your project flowchart most useful, you have to expand beyond Gantt and CPM and also move away from traditional vertical flowcharting. You need to develop a series of rules to help in the construction of flowcharts. These rules are:

- ***Always use the precedence method.*** To establish the correct sequence of activities and events, the entire project should be listed

and flowcharted in the most logical format. This is most easily achieved beginning with a nicely detailed outline, such as the WBS format. Does each activity and event even fit according to what precedes it and what comes after it?

■ ***Make sure the path of activities and events makes sense.*** Your task in building the flowchart is simplified by recognizing that the lines connecting the boxes or circles are much more than connecting lines. The path of activities and events works only when it is arranged logically. Every action is generated by a preceding action or event and leads to a subsequent action or event. No one action should begin without a preceding one, and no action should ever lead to a dead end.

■ ***Remember that an activity cannot occur until a preceding activity or event has been completed.*** This rule assumes a direct connection between the current activity and the proceeding activity or event. Concurrent activities can also be under way and operated by different team members or groups. However, when scheduling your project, operate under the precedence constraint on each activity path.

■ ***Plot, explain, and control concurrent events carefully.*** Team members who are not used to working from network diagram flowcharts will be confused when the path splits off into two or more concurrent routes. As the flowchart begins to look like an electrical diagram, team members will find it difficult to follow the logic. Thus, plan each path carefully and ensure that the steps make perfect sense. You will need to lead team members through the maze to ensure that the steps in the flowchart are followed completely.

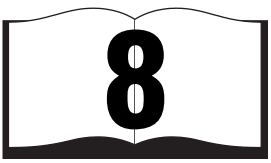
■ ***Exercise control over weak links, as this is the key to successful project management.*** More than anything else, the flowchart helps you to identify the weak links in the process. If errors and delays are going to occur, they probably will occur at these linking points—where work passes from one person or group to another. By knowing when and where these points occur, you can anticipate and prevent schedule delays that most often characterize projects. As the result of taking greater care over weak links, you provide the most effective form of scheduling control.

■ ***Make flowchart decision steps with great care, to avoid confusion.*** A simple flowchart is not confusing; one step follows another. However, you will encounter decision points where the flowchart breaks into two or more segments, based on the complexity of the decision. A yes or no decision has two possible paths and subsequent steps; more complex decisions will involve more than two possible paths. Accompany decision points with narrative sections that offer additional explanation of actions for the team member who is affected by the outcome. Work closely with team members who will exercise the decision to proceed beyond that point, to ensure that the right path is taken.

The next chapter shows how to combine all of the elements of project management and put the precedence method into action in order to provide yourself and your core team with the best tool possible: a working flowchart.

WORK PROJECT

1. Describe three benefits of organizing your schedule using Work Breakdown Structure (WBS) in outline form.
2. List and explain the guidelines for automating project management.
3. List and explain at least three rules for flowcharting.



Designing the Project Flowchart

I have made good judgments in the past. I have made good judgments in the future.

—DAN QUAYLE—

''I gave up on flowcharting after trying it for a while,'' the manager stated. ''It was just too complicated.''

''What do you mean?'' the employee asked. ''I thought flowcharting was supposed to help keep to a schedule.''

''We finished on time. But instead of coming out with the result I expected, we built a radio.''

A visual summary of your project is essential for schedule control and work assignments. Your project management function works best when you think of it in terms of visual control features. Thus, your goal is to come up with an effective flowcharting method, one that is more than just a procedure. It has to be easy to work with and modify when necessary. Too often, flowcharting itself becomes a useless procedure

that, once done, adds little or nothing to the actual process of running the project.

The Gantt chart helps you to identify the sequence of activities and events. That is a good starting point and helps in the identification of the initial schedule. Considering that there is much more to controlling your project, you need to move beyond the initial charting and develop a flowchart that allows you to track several activities at the same time: scheduling, work assignment, weak link identification, beginning and ending dates for phases, and event outcomes.

A project is likely to involve complex interactions among members of your core team and between the core team and outside resources. In most projects, the level of interactions will accelerate as the project moves into the midrange and end phases, so control at those points becomes critical. At those times, more elaborate and detailed flowcharting is called for. To be practical, you need to stick with the precedence method while designing a visual procedure that is effective for coordinating the efforts of many team members and outside resources, often operating on two or more paths within the project. You have to act in the role of coordinator and supervisor. If any one path of activity is delayed, it will affect the other paths and all future phases, as well as the final deadline.

Imagine how difficult a task you face with ten, fifteen, or more core team members when five or six phases are under way at the same time. A well-designed flowchart helps you to keep track of all the work going forth at the same time without having to directly supervise each and every step. The flowchart helps you to keep an eye on the future while helping several subteams continue along their paths. In this respect, the project manager operates like a conductor leading a large orchestra. He cannot be in all sections of the orchestra at the same time and cannot take over and play instruments himself; he has to stand in the leadership position and follow the score. Just as the score reminds the conductor what each and every instrument and section needs to do, the flowchart shows the project manager how to keep all sections together, work harmoniously, and conclude the project in a timely manner.

The goal of bringing a complex project to a timely conclusion re-

quires that you keep a close eye on responsibility for each activity within each phase. One problem with the Gantt chart is that it is not set up to define responsibilities among team members, nor does it show how to coordinate those responsibilities when multiple tasks are proceeding together. The emphasis is on sequence and time alone. An alternative, the network diagram, provides you with all of the information you require and combines scheduling with assignments on one continuous form; it also identifies the precedence of activities and events, even when several are proceeding concurrently.

Activity and Event Sequences

Think of the flowchart as a visual procedural summary for your project. Rather than working from a narrative listing of duties and responsibilities, the flowchart identifies activities and events in a simple visual manner. You can achieve a lot of detail with simple square or rectangular boxes (representing activities and events) and lines (representing precedence and workflow).

Most people are familiar with the vertical flowchart. This design is natural since we write narratives from top to bottom, and the origin of flowcharting is an attempt to create a visual representation of workflow in the same manner. The starting point is at the top and the end is at the bottom. Any decision points loop back to a previous step; any concurrent activities call for dividing the flow into sequences shown left to right. The vertical flowchart works quite well when one individual executes all steps and makes all decisions, and when one activity follows another with a limited number of decisions or concurrent paths. However, most projects involve several people, many concurrent paths, and complex decision-making points.

A useful and practical working document should be based on precedence. However, individual team members will be less concerned with the big picture (in other words, what other individuals or team groups are doing) and more concerned with their routines. Thus, their interests are with the immediate phase and its tasks.

A good starting point is to identify the attributes of events that have to occur in your project. The final outcome is only the last event.

Chances are, many other events will be required as well. It is necessary to carefully define the kinds of interactions you will encounter during the course of a project. This effort helps you to recognize weak links, improve interteam communications, and develop a flowchart that can serve as a working document to guide you and your team through what may be a complex project maze. In defining activities and events, several assumptions can be made:

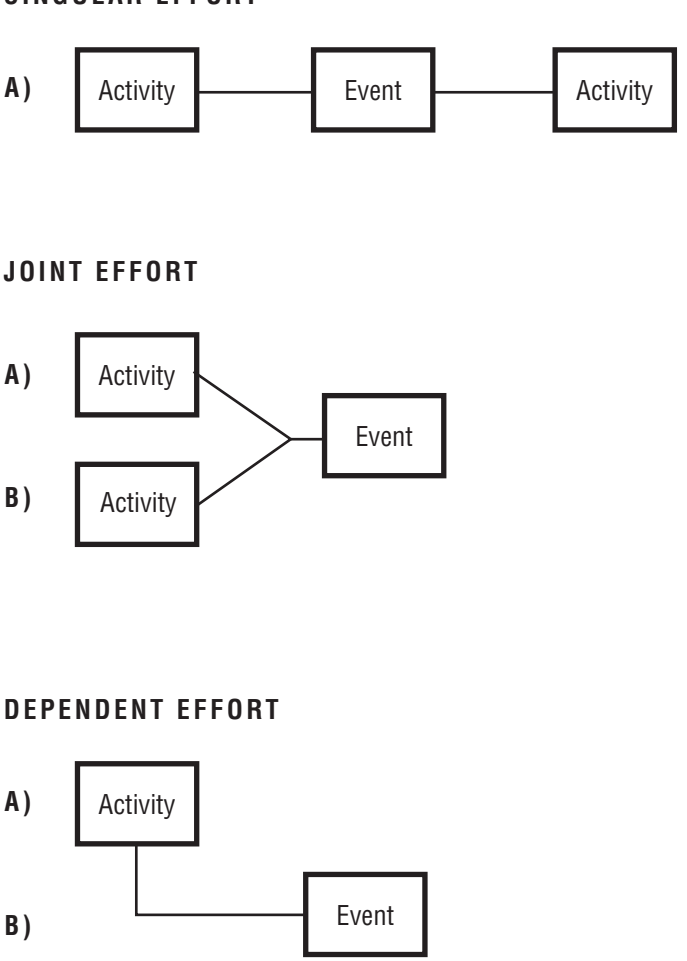
- ***Some events have predetermined sequences.*** An event has to be completed before subsequent activities can begin. (This is the basic rule under the precedence method.) A future activity, then, requires completion of a prior action. This situation is called a *singular* effort, and it is the simplest version of work progress. If you are solely responsible for a phase, you can break it down into a series of singular activities and events.

- ***Some events depend on multiple activities.*** Some events do not occur after the completion of a singular activity. For example, your next step may require completion of the current step plus completion of another activity by a second team member. This is one of the weak links where delays can occur—when one person's work progress depends on the timely completion of work by someone else. When two or more people work to finish activities, both of which are required for the event, it is called a *joint* effort.

- ***Activities and events can take place apart from each other.*** Some events can occur only after someone else has completed a separate activity. This is another weak link that invites delay in your schedule. A team member responsible for the event can proceed only after someone else has completed a prior activity. This situation is called a *dependent* effort.

The three types of sequences are illustrated in Figure 8-1. Note that the singular effort occurs on one horizontal line, indicating that one team member is responsible for the activities and the event. Joint and dependent efforts are split into more than one line because more than one person is involved in the workflow.

Figure 8-1. Sequences of activities and events.



These are important distinctions, and being aware of the differences helps keep your project on schedule. The distinctions also help your core team members to understand their role and the big picture, avoiding the all too common confusion that accompanies projects. In other words, good definition helps avoid chaos.

Weak links can include problems on several different levels of your project. Weak links can occur when passing information from one core

team member to another; when processing toward a common event involves multiple paths; and when the team cannot proceed until an outside resource acts in some way.

The Vertical Flowchart and Its Limitations

When asked to prepare a flowchart, most people go immediately to the vertical format. This is natural and to be expected, and it's even appropriate for relatively simple processes. Using the example from Chapter 6, where the project involves revising accounts payable procedures and testing them, the vertical flowchart can be prepared quickly from an outline such as this one:

Phase	Description
1	Document procedures.
2	Prepare flowcharts.
3	Summarize paper flow.
4	Describe problems and solutions.
5	Design improved procedures.
6	Track the old system for one week.
7	Track the new system for two weeks.
8	Prepare the final report.

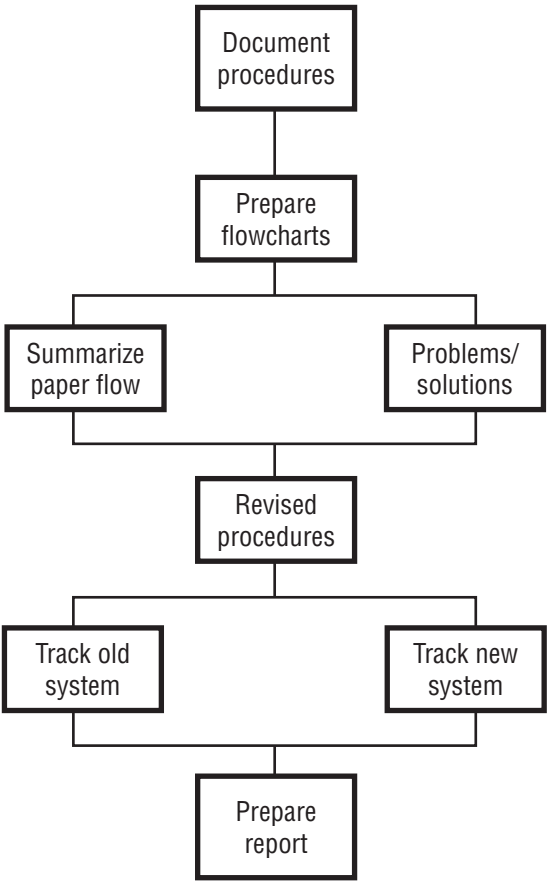
Recalling that phases 3 and 4 and phases 6 and 7 are executed concurrently, a vertical flowchart can be prepared, as shown in Figure 8-2.

While this format presents the steps directly and in the proper sequence, the vertical flowchart has several flaws. They are relatively minor for a simple project such as the one in the example, but when they are carried over to a more complex project, the flaws present significant management problems. These flaws are:

- ***The flowchart does not show time requirements for each phase.*** All it shows is the sequence of activities. Thus, to watch time as well as sequence, you would need both a vertical flowchart and a Gantt chart.

- ***The flowchart does not let you see the division of responsibilities.*** Like the Gantt chart, this flowchart does not give you a break-

Figure 8-2. Vertical flowchart.



down by team member or subgroup. Even with a vertical flowchart and a Gantt chart, this essential element is lacking.

■ ***The vertical flowchart does not show concurrent activities in adequate detail.*** Breaking out the top-to-bottom sequencing is a first step, but it does not provide you with a combined activity and time picture of what needs to occur.

For effective scheduling control, the vertical flowchart has no real value. It is just a visual form of the outline, expressed in boxes and

lines rather than as a list. However, it is useful as a preliminary step toward developing a more practical flowchart: the horizontal network diagram, also called the Precedence Diagramming Method (PDM).

The Horizontal Network Diagram and Its Advantages

Some project managers view horizontal flowcharting as nothing more than an elaboration of the Critical Path Method (discussed in Chapter 6) for managing time and resources. However, it is much more. The practical applications of the horizontal network diagram enable you to express even the most complex project in a concise, visual format. The diagram serves not only as an effective and practical control mechanism, but also as a training tool. The properly developed horizontal network diagram is the key to managing even the most complex project, training and orienting your core team, and expressing schedule and work-sharing ideas.

To develop the horizontal flowchart, you should start out with a vertical flowchart as a way to communicate a Work Breakdown Structure (WBS) outline, if only to make sure that your steps take place in a logical sequence. For complex projects with many phases, a large core team, and many concurrent paths, the real order of execution will not be obvious from a vertical flowchart alone. Any sequencing problems will be discovered only when you begin work, and at that time the need to redefine the sequence is likely to throw your schedule into disarray. It will also be confusing to team members. The advantage to the horizontal network diagram is that it can be developed in advance while providing you with all of the elements you require.

Using the activity steps shown in the vertical flowchart, you can add more information when you map out the project horizontally. However, activity sequence is only the skeleton for the body of your schedule control system. To round it out, you also need to identify and track:

- Deadlines for each phase
- Time requirements and constraints for each step
- Individual team members or subgroups who will execute each phase

- Weak links (i.e., where effort involves two or more people or groups)
- Flow of work from activity to activity, leading to events
- Definition of events that will be produced throughout the project

All of these features can be incorporated into the horizontal flowchart without making it overly complex and without losing the simplicity that makes flowcharting effective. Individual team members and subgroups can follow their own requirements and see how they interact with other team members. The advantages of the horizontal flowchart include:

- ***It shows interaction between team members.*** Project activities and events do not occur in isolation. If they did, each team member would be able to execute a phase without the involvement of anyone else. The points where interaction occurs are the points you need to watch most closely, because you need to coordinate the efforts of the team and not just the work of each individual.

- ***It establishes an exact sequence.*** Attempts to flowchart without application of the precedence method invariably run into problems. Some projects wander from a set schedule because of confusion over the proper sequencing that is required; thus, a phase is held up because a necessary step was scheduled in the wrong place. The horizontal flowchart tracks sequence logically and easily, even when several paths are going on at the same time.

- ***It draws attention to weak links.*** Since precedence of activity may involve two or more core team members (not to mention outside resources), you need to guide the schedule through its weak links. The horizontal flowchart makes these links easy to spot, showing you where you need to concentrate your attention.

- ***It breaks down areas of responsibility.*** The horizontal flowchart shows all activities for each team member or subgroup. These

activity areas are best described as areas of responsibility rather than simply tasks to be performed by individuals, departments, or teams. One person will not always be solely responsible for a range of tasks. Some areas of responsibility will be a single individual; others will be a subgroup or team within the project team; still others will be an entire department or an outside resource. The horizontal flowchart distinguishes specific areas of responsibility so that everyone can see with ease who does what, when it is done, and how work paths pass from one area to another.

■ ***It shows concurrent activity flow.*** Project managers are easily overwhelmed by the complexity of the process itself, notably when the process breaks down into several concurrent paths. For a complicated project, you may need to oversee a large number of different tasking paths at the same time. If you are not able to track each and every one, you lose touch with the overall progress of the project, and delays and confusion are usually the result. The horizontal flowchart is designed to manage any number of concurrent paths, including interaction between areas of responsibility.

■ ***It ties actions to time controls.*** The horizontal flowchart includes a timeline. This combines the best features of the Gantt chart and vertical flowchart together. When each activity and event is fit onto the timeline, you have a much better tool for managing the entire schedule.

■ ***It lists reports, forms, and other documents—the "events" of each phase.*** Your project probably includes the requirement of event outcomes. These can include interim and final reports; worksheets, forms, and other new documents; as well as information you receive from outside resources. The horizontal flowcharts include a complete listing of all documents generated by project team efforts.

■ ***It aids in communication with your core team.*** Schedule control doesn't take place in the project manager's office; it depends on team effort. The horizontal flowchart allows you to demonstrate to your team where problems are expected, how you plan to solve them, and how different activities occur at the same time. Most of all, the

horizontal flowchart provides an excellent visual representation of the entire project, which benefits all team members.

- ***It allows you to detect and correct schedule variances.*** As your project moves ahead, you will experience scheduling variances for any number of reasons. That isn't a problem. The real problem comes up when you don't have the information you need to correct the variances when they occur, or to take action to get the project back on schedule. The horizontal flowchart shows you where variances are likely to occur so that preventive measures can be taken. It also shows you where likely process times are so that you can absorb time delays. That means you have a chance to take corrective action, such as shifting duties, doubling up effort, or looking for ways to cut down on time requirements in future phases. The horizontal flowchart helps you study these questions and make informed decisions.

- ***It identifies alternatives.*** The initial outline and schedule developed in the form of a Gantt chart or vertical flowchart are reasonable starting points. But when problems arise in the schedule or in core team workload, you must be able to move quickly and modify the original schedule. The horizontal flowchart helps to manage the flow of process information so that even the most complex paths can be modified to suit ever-changing situations.

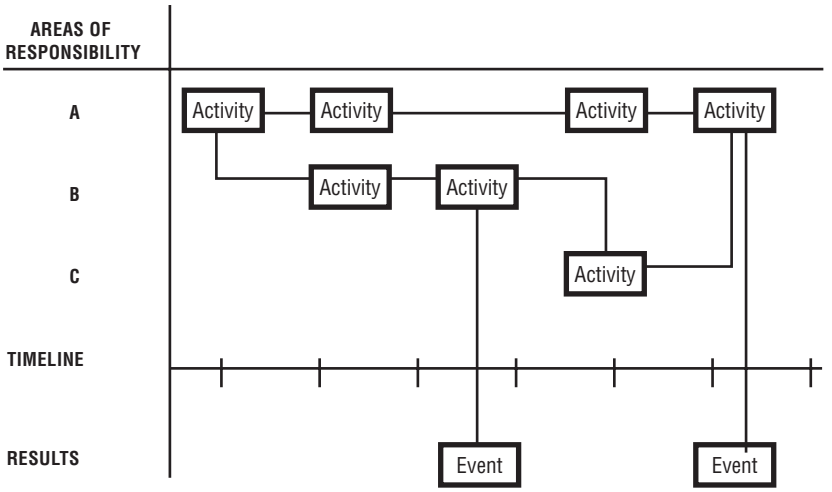
Building the Network Diagram

The horizontal flowchart, or network diagram, is a left-to-right breakdown of each activity. An example of this format is shown in Figure 8-3.

Lines connect activity boxes, but only as a means of demonstrating the sequence of the process and divisions between areas of responsibility. Each box is a separate activity within the sequence and is limited to actions, with events (or results) listed beneath the process flow sections.

This format provides you with all of the scheduling and control features you need. If you look more carefully at the major features of the horizontal flowchart depicted in Figure 8-3, you'll see it also serves as a training tool for your core team. For example:

Figure 8-3. Network diagram format.



Areas of responsibility are described in the first column. Each one (A, B, and C in Figure 8-3) has its own left-to-right process flow so that members of that particular area can see without any trouble exactly what activities they will execute, when those activities occur, and how a work process comes to them, as well as where it goes.

Activities are shown in the order of execution. When a concurrent path is under way, two or more activity boxes appear, separated into areas of responsibility.

Events go on the ''results'' line. Events are separated from activities since the event is the result of completing the activity. This allows you to review all outcomes (e.g., reports, forms, worksheets) of the project, where they come from, and how they are developed.

Timeline identifies the time requirements for each activity. It can be the number of hours or days, depending on how you have organized your schedule and are tracking actual results. You may increase the use of the horizontal flowchart by including two time numbers: estimated time for completion above the line and the cumulative estimate on the bottom half of the line.

The network diagram containing all of these elements provides you with a management tool that removes any guesswork and relieves your having to refer to several sources (e.g., labor hours estimates, time estimate, and a Gantt chart). All of the important information for overseeing your project is contained in the one diagram.

When mapped out in this format, a project can require several pages. For example, if you employ twelve areas of responsibility and twenty-five separate phases, broken down into a hundred or more distinct activities, the network diagram will be long and complex. However, the information it provides will be far more useful than if it were compiled in any other format. In addition to serving as a useful management tool, the horizontal flowchart also provides a useful map for each core team member.

The complexity of the project does not present a problem; the network diagram format is suitable for even the most complex of projects. Because multiple concurrent activity paths can lead to confusion, both among team members and for the project manager, a system is needed to track everything at the same time. Using the network diagram provides that capability.

The network diagram is an efficient management tool when multiple concurrent phases are under way, notably when they also are interdependent. For example, one phase may have fifteen activities and another ten. But the second phase has two or three stopping points, awaiting information that develops out of the first phase. In this complex situation, the network diagram illustrates the requirements and helps coordinate the efforts between the groups working on each phase—while also allowing you to keep an eye on the timeline. The key here is in your ability to visualize not only the timing and interaction between two or more subgroups, but also to manage the weak links inherent in the interaction.

The network diagram is also a useful tool for phase review. At the end of each phase, you should ask yourself and your team members a series of questions:

- Have we completed the activities that need to be completed in order to create the events or to move forward to the next phase?

- What weak links are we facing today or likely to encounter in the immediate future?
- What actions should we take now to ensure that we stay on schedule?
- What results do we need from outside resources? Can we make our requests early to prevent the possibility of delay?
- Are we on schedule? If not, where can we make up the variance?

Your efforts will be concentrated on a small portion of the network diagram, specifically weak links and completion points. Upon ending one phase, the next phase should be taken up without pause. When you look over steps coming up in the next few days, weak links will be apparent. You may also need to anticipate periods of exceptionally heavy workflow activity and take preemptive action to ensure that core team members will be available to put in the hours needed. The ever-present timeline allows you to keep a complex project moving all the way through to final completion.

The diagram is constructed in a series of logical steps—beginning with the initial WBS, then creating a vertical outline (if you find that step to be necessary), and then, as a last step, placing the elements onto the horizontal flowchart, with activities moving left to right instead of top to bottom. It is important to go through this process efficiently because a lot of valuable time is consumed if your schedule design is too lengthy. It may be necessary to create a working flowchart with enough information to get the team moving, even though you may need to make changes as work progresses. You can work in one of three ways:

1. ***Build the network diagram on your own.*** You may find that the best use of time is to independently work through the steps required to develop a preliminary network diagram. Then call together the members of your core team, go through the whole process, and invite ideas for improvements or to correct obvious schedule errors.

2. ***Employ the entire team to build the network diagram.*** This is the most difficult approach. Committees do not act and they are not

efficient. However, if phases will involve highly specialized areas of responsibility, you may not know all the steps required for a particular segment of the workflow. Team participation may be a necessity. If so, try to make the process move quickly to avoid using up too much time that could be better spent executing phases.

3. ***Use a small group.*** As a compromise, consider asking only two or three team members to help build the network diagram. While committees are less efficient than individuals, a small committee is preferable to a large one. Upon completion of the draft, it can be presented to the full team for review and modification.

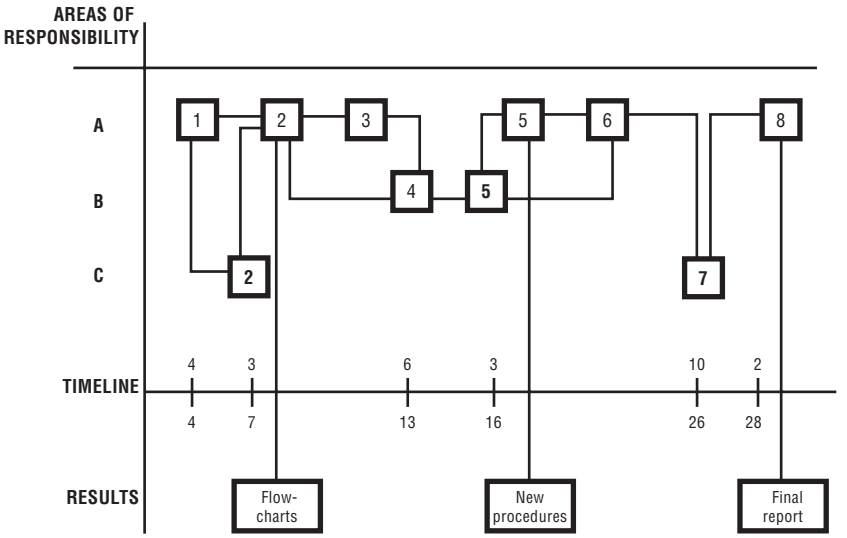
Applying the Network Diagram

Using the eight-step project example presented previously, how should the network diagram be presented? In practice, each and every activity will be isolated in its own activity box, assigned to the proper area of responsibility, and placed on the timeline. Thus, every team member will be aware of who does what, when it is to be completed, and what sequences are involved. However, for the purpose of illustrating this process, the eight steps in our sample project are listed by number. And rather than listing the titles of people in each area of responsibility, they are referred to (for illustrative purposes) as A, B, and C. The network diagram for this simplified project example is shown in Figure 8-4. The diagram has several noteworthy features that are worth commenting on:

- ***Weak links are highly visible.*** These occur in four places: between steps 2 and 4; steps 5 and 6; 6 and 7; and 7 and 8. On a Gantt chart or vertical flowchart, these weak links would not be identified. Only the network diagram reveals these potential problem points.

- ***The solid lines represent primary activity steps; the broken lines represent secondary or supportive activity.*** The broken lines help further define primary workflow while still separating out areas of responsibility.

Figure 8-4. Network diagram application.



A = Accounts Payable Supervisor
B = Accounting Manager
C = Systems Analyst

■ ***Activities and events are clearly distinguished.*** Activities are shown in boxes placed in the process flow section, and events are broken out and separated below in the ''results'' section. This helps clarify the process for you and for core team members.

■ ***The results section is nicely detailed.*** The various items showing up as results show the interim and final outcomes of the project. For complex projects with numerous interim events, this is a very important and valuable feature.

■ ***The timeline puts the process in a good scheduling perspective.*** The timeline in Figure 8-4 shows each activity's schedule in terms of days (above the line) and the cumulative time schedule (below the line). In the example, the project should be completed within twenty-eight days.

Expanded Applications

This sample project involves a small team and a simplified number of phases. While these parameters aid in illustrating the horizontal flow-

chart, they probably won't apply to many of the projects you will manage. It is likely that you will work with more complex teams, many more activities and phases, and multiple instances of concurrent paths.

Three examples of projects where the network diagram is especially useful are those involving the development of new procedures, converting old systems or processes into new ones, and coordinating the efforts of many people or departments.

Example 1

You are working on a project to document all procedures within your department. Workflow includes interaction between department members as well as with other departments, both for receipt of information and delivery of reports. A narrative description would be difficult to explain to someone else because these interactions occur on many levels. At the same time, a description of each employee's actions would not provide a context for the work of the entire department.

Solution: A network diagram lists each employee's workflow as a horizontal flowchart, including not only each activity but also identifying the exchange of information and documents between other department members and outside departments. Each person's tasks can be tracked along their individual area of responsibility line; overall functions can be reviewed together, including identification of weak links, reports, and the timeline (which corresponds to your department's monthly cycle).

Example 2

Your company is undergoing full automation of several departments currently using outdated manual processes. Your project is to prepare complete documentation needed by systems analysts, showing each and every processing step; to identify input formats and fields and the type of information to be processed; to describe database requirements; and to define and design the desired results.

Solution: The department's processes, when reduced to a network diagram, can be identified quickly and separated into two activity

groups: recurring routines, which are easily adapted to automated processes, and exceptional routines, which may not fit into the proposed automation scheme. Those activities treated as exceptions require a different type of procedural treatment. The network diagram will also identify input as well as output design requirements (e.g., forms, worksheets, or reports).

Example 3

You are designing a marketing tracking procedure. When it is finalized, several departments will use the procedures: marketing management, field offices, accounting, and marketing/sales support groups in various regions.

Solution: To best describe the procedures you are designing, a network diagram does the job well. A narrative description would be confusing, whereas anyone can review the horizontal workflow, get a handy overview of the whole process, and see their part in it.

Besides providing you with a good management tool and a communication device, the network diagram improves feedback. Anyone working on the user end will quickly recognize gaps or flaws in the horizontal flowchart, and no doubt will be glad to let you know that your network diagram contains errors. That provides you with the information you need to fix the problem before it appears during actual execution and use.

Some projects require a written document as well as visual representations. Because people are not accustomed to complete visual help in matters such as internal procedures, the narrative supplement is required in many instances; it also helps to expand on the meaning that a visual representation provides. One drawback to any flowcharting method is that it does not provide the procedural background. It tends to show how work proceeds, but does not tell employees why they are going through the steps. That is the function of narrative support.

The next chapter explores how narrative sections can help expand the project flowchart and make it complete and effective for the people who will execute the tasks—either project team members or other employees.

WORK PROJECT

1. Explain the difference between an activity and an event in the following cases:
   - **a.** Writing a report
   - **b.** Receiving a report from another department and using it to develop statistical summaries as part of a project phase
   - **c.** Summarizing sales activity information from four separate divisions and using that information to describe a reporting problem
2. Explain the flaws of vertical flowcharting and how those flaws are overcome by using a network diagram.
3. Explain why it is essential to identify weak links. How is a network diagram used to ensure continuing schedule control where weak links are involved?