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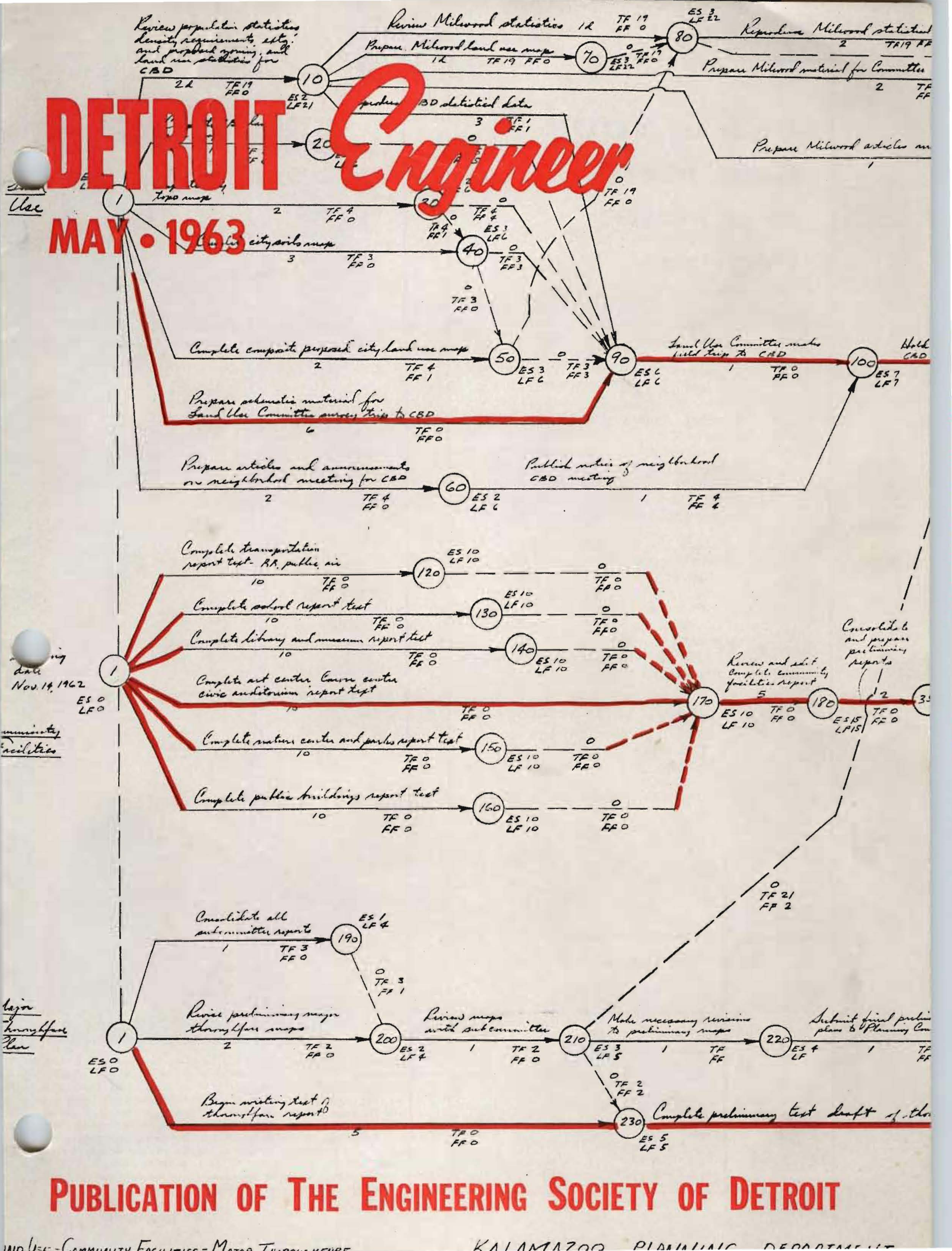

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NETWORK PLANNING: NEW MANAGEMENT TOOL

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PLANNING IS THE APPLICATION OF LOGIC TO ACTION • A NETWORK IS THE GRAPHIC STATEMENT OF THIS LOGIC

THE NETWORK PLANNING CONCEPT (NP) is simple. *A network plan is basically the charting of a series of end-to-end tasks, none of which can start until the one preceding has been completed.* An entire sequence of these tasks makes up a complete project.

When the project is diagramed by task sequence, the first phase of a network plan is complete. The second phase is the assignment of time values to each task, and the third phase is the allocation of manpower and material resources. Completion of the network plan comes with the preparation of a schedule and a control system from the graphic diagram.

Development of network planning as a management tool dates back to 1957. Initial work on the technique was done by a duPont Corp. operations group assigned to speed transition of new products from research into production. Out of their studies came the Critical Path Method (CPM).

Simultaneously, the Navy was devising a system to plan and co-ordinate the work of nearly 3,000 contractors and agencies on the Polaris missile program. From the Polaris project came a Program Evaluation and Review Technique (PERT), which is credited with helping advance Polaris development by at least two years.

Today many Detroit industries are using networks to plan complex projects. For example, Chrysler's Mexico Project Group, with assistance from the company's Operations Research Staff, recently planned their new engine plant in Mexico with NP. Procurement and installation of tooling, building facilities, and machinery is being scheduled under network control.

The NP method has many applications. It can be used to plan design operations, construction projects, administrative programs, maintenance operations, model changeovers, and practically any other series of actions that, when combined, form a complete program having a start and a finish.

The multitude of different names applied to network methods, such as CPM, PERT, PACT, LESS, PRISM, and PACE merely distinguish the application techniques. For example, CPM has traditionally been considered activity-oriented and PERT event-oriented. However, these differences are gradually melting away, and the generic term Network Planning is now commonly used to describe this type of operational programming.

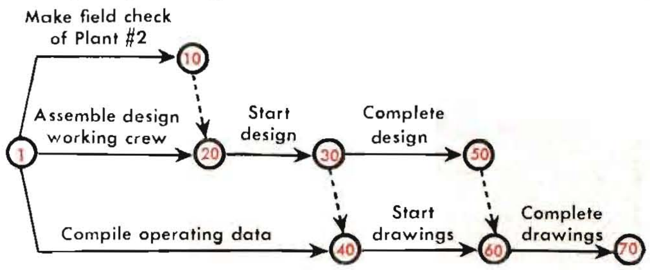
Phase One: Diagraming Task Sequence

Let's look at an example of network planning.

The Vice President in Charge of Operations for an automobile company calls his Production Manager one morning and says, "Frank, the Board's given us an OK to install that new production line at Plant Two. Let's get started." Using nodes (circles representing the start or finish of an activity) and arrows (each representing an activity), we can translate the Vice President's instructions into graphic form as:

From this simple statement of the plan of action evolves a more detailed interpretation by the Production Manager. Frank calls in his Chief Engineer and says, "Joe, we're installing a new line at Plant Two. I want you to handle the job and to do it in three stages—design, installation, and testing—in that order." Graphically, he is saying:

Joe takes the project to the manager of the design group, who then plans the first stage in more detail. The Design Manager's plan might look like this:



From here on, the plan for each task can get as detailed as desired, or as needed.

In this first phase of NP, we have developed a complete and specific action plan for the project. In the second phase, times are assigned to each task in the action plan. Notice, by waiting till now to assign times, we have separated planning of the project from the influence of time and encouraged each echelon of management to concentrate on how it can best accomplish the job assigned to it through development of an effective action plan.

Phase Two: Assigning Time Values

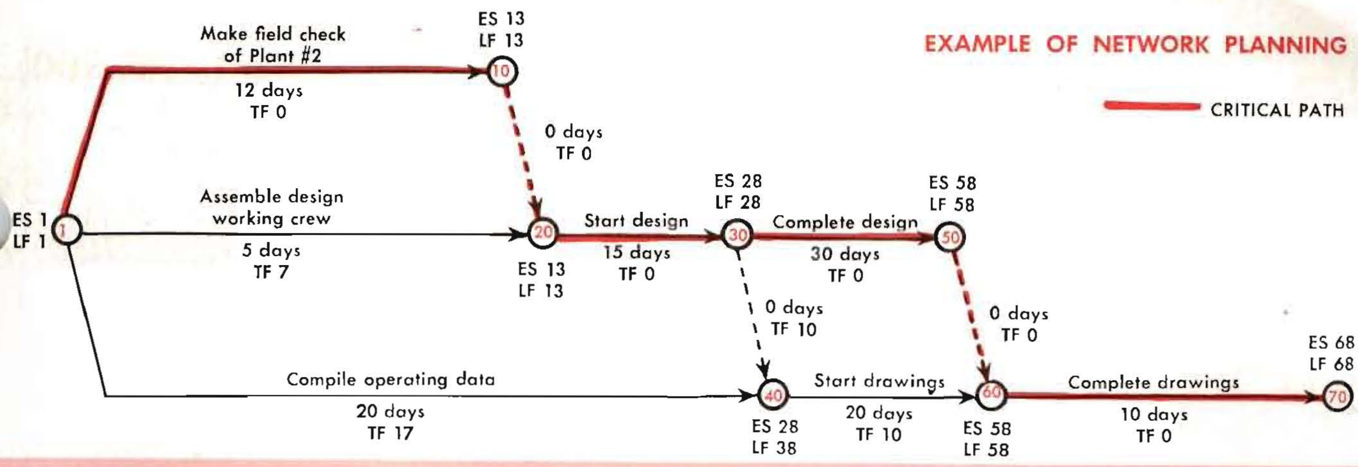
The time values assigned to each task are estimated as realistically as possible and represent the best judgment of the group actually doing the task. Sometimes, when probability factors are a consideration, three times—optimistic, pessimistic, and most likely—are selected and a weighted figure used.

In our example, we have selected only one time value for each action. Broken-line arrows, called dummies, are given a time value of zero and indicate that no action occurs along them but that a relationship exists between the tasks they connect.

By a series of simple computations, we can determine the Earliest Possible Start (ES) and the Latest Allowable Finish (LF) time limitations for each task in the action plan. *ES is the earliest possible time a task can start, assuming all previous tasks were completed on time,* and is figured from the beginning to the end of the network plan. The earliest start at the last node is the duration of the project. *LF is the latest allowable time a task can finish without affecting the completion time of the entire project.* Figuring back to the beginning along each path gives the latest allowable finish times at each node.

In the example, the longest sequence of tasks through the project is along nodes 1 — 10 — 20 — 30 — 50 — 60 — 70, a path which takes 67 working days to traverse. The tasks on the other paths have spare time, since none of these paths take as long to travel as the longest sequence. *Total Float (TF) is the amount of time that any task can be delayed without delaying the entire project.* To compute it, Total Float = Latest Finish – Earliest Start – Duration (length of time required to complete each task). For instance, task 1 – 20 could be delayed as long as seven days without delaying the entire project. (Path 1 – 20 takes 5 days. Path 1 – 10 – 20 takes 12 days. 12 – 5 = 7 days). Therefore, task 1 – 20 is said to have seven days Total Float.

The path (or paths) through the project plan which take the longest time to complete is the Critical Path. Knowledge



GROUND RULES FOR NETWORK DIAGRAMING

1. Each solid arrow must represent a single activity or task.
2. Arrow length has no scale.
3. Arrow junctions, indicated by nodes, are events and signify the start or completion of a task.
4. Tasks originating from a node cannot be started until all tasks terminating at that node have been completed.
5. If a relationship exists between tasks, but no activity connects them, a dummy is used to show the relation.
6. Nodes should be numbered so that all arrows proceed from a lower to a higher number.
7. No two arrows may have the same set of nodal numbers.
8. The logic must be explicitly stated. Constant reference to Rule 4 will help prevent errors in logic statement.

of the specifics concerning this critical path gives management first-rate control potential over the operation. As a working definition, we say that the tasks within any project that have a minimum total float time available (usually zero) fall on the critical path.

By taking the total duration of the design phase and adding to it the times for the installation and testing stages (for which similar network plans would be made up), the Production Manager can give the company Vice President the total time it will take to get the new facility into full production. Now everyone up and down the management line knows exactly what they're to do, when they can start, when they must finish, and how much float time they have for the non-critical tasks.

Phase Three: Allocating Manpower and Materials

The third phase of network diagram utilization is applying the information to allocation of manpower and material resources. The goal of this resource allocation is to accomplish the project at a minimum cost in project expenditures, downtime, and other business-out expenses.

For instance, we see in the example that if the field check were speeded up by authorizing overtime, we could reduce the total time of the design phase and, consequently, get the new line into production faster. If the overtime costs were less than the gain from earlier production time, the move would be justified. On the other hand, it is obvious from the network plan that speeding up the compilation of data by overtime work would be useless. Actually, it might even be possible to reassign some personnel from the data compilation crew to the field check crew and eliminate overtime expense on a crash program.

Our example is a simple one, and its analysis is quite easy. But visualize how complex the analysis of a plan could become if it contained several hundred or several thousand individual tasks. In such cases, we usually resort to a computer to furnish us the multitude of arithmetical and logical conclusions needed to make decisions. For networks up to a hundred tasks, however, hand computation methods prove to be adequate, although slow.

Controls Are Essential in NP

Control of a completed network plan is essential. A decision to use NP without providing adequate control of its execution is neither effective nor complete. Therefore, concurrently with the preparation of a network plan, policies should be established to insure its proper control.

Controls are generally of two types: secondary and primary. Secondary controls are those imposed by routine progress reviews. They may appear as minor changes in the plan-time-cost network but do not affect final completion dates or final project costs. Primary controls are those exerted through major progress and policy reviews concerned with time and cost revisions.

A job schedule and a reporting method must be established as part of the control system. The need for such a schedule is apparent from our example. In the diagram we have defined clearly what happens to the tasks on the critical path. However, we have not directed how the remaining non-critical tasks are to be fitted into the action plan, except to say that they can be done between this point in time and that point in time. A schedule is now needed to tell everyone *how* the entire job is to be performed.

Hand-in-hand with scheduling goes form control for record keeping. Form control with network systems is far simpler than with most other planning methods. The reason is that, since so much information appears on the network plan, it is convenient to report almost totally by reference to the diagram and to maintain records directly on the network.

Those working with network planning now are pioneers in a brand new field of management science. Network planning, correctly applied, makes possible sizable benefits in time and money for an alert organization. Potential applications are vast: the only limitations on NP's usefulness are those imposed by the user's imagination.

ADVANTAGES OF NETWORK PLANNING

• Makes you think about a project in more detail, tending to prevent omission of tasks • Tells you accurately how long a project will take and what jobs must be kept on time to meet the schedule • Simplifies advance work assignments and helps improve communications between those responsible for a project • Assists you in evaluating and forecasting the outcome of alternate plans of action • Focuses attention on potentially troublesome tasks and allows you to pinpoint corrective action • Fixes responsibility and provides a permanent record of assignments • Insures continuity of action, even with changes in personnel • Encourages personnel at all management levels to contribute to effective job planning • Simplifies periodic re-evaluation and rescheduling • Provides a uniform system of planning, scheduling, and reporting • Measures proposed changes against time, money, and manpower yardsticks. • Shows proper relationships between all tasks • Provides a graphic picture of the work that encourages making accurate and prompt field decisions where needed • Shows what to expedite • Encourages accurate and continuous control of buying operations and subcontractor performance • Separates planning of the task sequence from assignment of time values to each task, making project scheduling less susceptible to time distortions.