GANTT CHART

The Gantt Chart is a visual management control device developed during World War I by HENRY L. GANTT, one of the pioneers in scientific management. It is a linear calendar on which future time is spread horizontally and work to be done is indicated vertically.

In any activity, the only constant is time, and therefore the scale of the Gantt chart is time—future time—the calendar spread horizontally across a sheet. Any suitable divisions and subdivisions of time can be used—months, weeks, days, or hours.

The Planning Chart. There are two basic types of Gantt chart. In the first form, the "planning" chart, the things to be done are entered in symbols and descriptions under the portions of the calendar in which it is planned to do them. (See Exhibit I.) (The standard symbols are described in Exhibit Ia.)

It should be noted that the heavy progress line always starts at the opening angle and never runs beyond the closing angle. The heavy progress line does not necessarily bear any relationship to the *amount* of time actually spent or to *when* it was spent. The chart has no value as a historical record and is usually thrown away after all operations are completed. The important thing in reviewing progress is the position of the ends of the progress lines in relation to the current date (V).

The Progress Chart. This form is used in production control to show cumulative work against time in relation to schedules. In Exhibit II, for example, figures in the upper left-hand corners are outputs in units scheduled for that particular period (in this case charting is done by five-day weeks). Figures in the upper right-hand corners show the cumulative schedule. As work progresses, a light bar is drawn in each period, its length proportional to the percentage of the work scheduled for that period completed in that period. (Note that for week 8-4, 20% more work was done than was scheduled for that week, represented by the double

light line.) In this illustration, "today" is the end of Week 8-4. A vertical chain or weighted string can be suspended from hooks at the top of a Gantt wall chart and readily moved to today's date to show status at any time.

EXHIBIT Ia
STANDARD SYMBOLS FOR GANTT PLANNING CHART

⌜ = the "opening angle," entered under the date when an operation is planned to start.

⌝ = the "closing angle," entered under the date when an operation is planned to finish.

⌜——⌝ = the time span during which the operation is to be active.

⌜—⌝ = the state of progress, as shown by the length of the heavy line compared to the planned. In R&D, the length of the heavy line is determined by reestimating the time still needed for completion and then measuring back (toward the left) from the closing angle—in other words, the open space between the end of the heavy line and the closing angle is the time still needed to complete the work.

V = the date when progress was posted, and is entered at the top of the calendar columns.

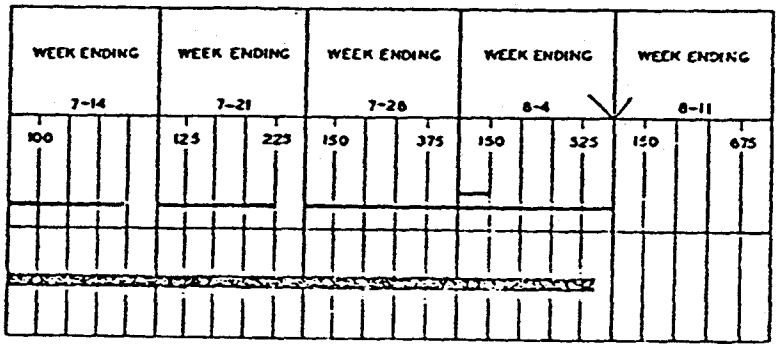
Opening and closing angles are not used. The heavier bar at the bottom shows *cumulative amount finished*. This line is posted at the scale of the week through which it passes.

On individual projects, the chart can be used to show *and watch* expenditures of man-days or dollars in relation to budgets. A project budget might be $1,000 per month, but it can (and probably does) build up to a period of greatest activity and then taper off—e.g., $500 in the first month, $750 in the second, three months at $1,500, then down to $1,000 or $500.

Actual figures are not shown on the chart but are included in an accompanying tabulation, usually bound facing the chart. The actual figures are of little consequence and need not be referred to, except in cases of significant overrun or underrun (end of heavy line to the right or left of the V).

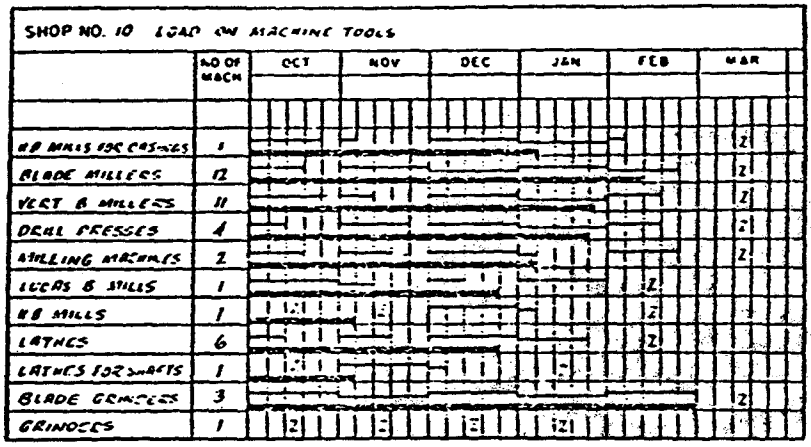
When this form is used for presenting load, the figures represent capacity in man-days or man-weeks. The V is not used here, because all time is future (the chart is redrawn periodically with the first future month at the left.) The light lines show overloads or unused capacity, *in the months in which they will occur*. The heavy line indicates the date when a department or section would be "out of work" if no new work came in. Experience usually leads to discovery of a normal or optimum total load—one in which adequate service can be rendered without idle staff or equipment. Exhibit III, for example, shows how far into the future machine tools in a certain shop will be kept busy by orders in the plant at the time it is drawn up. The heavy bars show the total amount of work ahead of the machines. "Z" indicates months in which no work is scheduled.

EXHIBIT II
GANTT CHART, PRODUCTION CONTROL



Figures in upper left are schedules for the week shown; figures in upper right are cumulative schedules. Light bars are actual production. Heavy bar is cumulative production as of end of week 8-4. Complex schedules covering large numbers of parts and assemblies can readily be controlled.

EXHIBIT III
GANTT LOAD CHART



Light lines indicate portion of month machines are scheduled to be utilized as of day chart was drawn. Heavy bars are cumulative load ahead of machines. "Z" means no work scheduled for that month. (Cf. Clark, Wallace, "The Gantt Chart.")

On Gantt planning charts, new work can readily be added without erasure to take precedence over work already planned—in fact, no erasing is ever required. The charts are "self-adjusting" for delays or inaccurate time estimates.

The use of the Gantt chart makes a definite plan for each project necessary. This is one of its advantages. It forces the thinking through of the things that will be encountered and must be provided for.

Percentage-Complete Progress Measure. The most common method of measuring progress is estimating the percentage complete. If one is dealing with the production of common units—the fabricating of a quantity of identical machines or machine parts—the numerator and denominator for the percentage are readily at hand. A project in research or development, however, is not composed of a number of identical parts—there is no common denominator applicable to both the portion completed and the portion uncompleted. Lacking any recourse other than a "blue-sky" guess, the tendency is to assume that the project is moving in relation to the allotted time plan—until the allotted time is nearly exhausted. Successive periodic reports of "percentage complete" sometimes appear like this: 25, 33, 50, 75, 90, 91, 92, 93, 94, etc. Since the figures were given at equal periods of time, it is fair to assume either that the earlier figures were too optimistic or that unforeseen difficulties have arisen in the later periods. At best, management has no assurance that the next reports may not be 94.5, 95, 95.25, etc.; and it cannot forecast *when* the project will be completed.

Where man-days or man-hours can be pre-estimated, hours can be used as units of measurement, and the percentage complete can be calculated:

$$\frac{\text{Hours spent to date}}{\text{Total hours estimated}} = \%$$

This does, however, require a timekeeping and reporting system. Also, it is accurate only when the original total estimate is accurate. This objection can be overcome by using the formula:

$$\frac{\text{Hours spent to date}}{\text{Hours spent to date} + \text{Hours estimated necessary to complete}} \% =$$

Re-estimating Progress Measure. The status or position versus plan is also secured in another way where Gantt planning charts are in use. This method is: first, to estimate the *time still necessary to complete*; and second, to subtract this time from the planned date of completion. This gives a date, on the plan, to which the project has progressed.

Where Gantt charts are used, the estimated weeks necessary to complete are counted back from the planned "closing angle" (⁀) to a point at which the heavy progress line is to be terminated. The advantage of this method is that it does not, in itself, alter the original plan.

but compensates for inaccuracy in it (based on latest knowledge). Progress is indicated ahead of or behind the plan, and by how much.

Rescheduling. Where formal methods of planning have been introduced, the tendency has been to change schedules almost as soon as performance fails to meet the schedules. It is obvious that this will lead to complacency with any performance. It is possible to be "on schedule" always, if the schedule is changed to conform with current progress. The habit of frequently revising schedules also leads to lack of thoroughness in thinking through the original plan for a project.

Of course, a change in direction, objective, area of investigation, or general method requires a new plan. However, changing schedules because of overoptimism in the original planning or failure to pursue the plan with vigor destroys the very usefulness of planning: It accomplishes nothing—that is, it does not expedite the project; and it weakens the confidence of management in information furnished for its plans.

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Information References

Camp, William E., "Executive Direction of Projects," Ch. 8 in "Handbook of Industrial Research Management," Heyel, C., 2nd ed., New York, Reinhold, 1968.

Clark, Wallace, "The Gantt Chart," 3rd ed., London, Pitman, 1952.

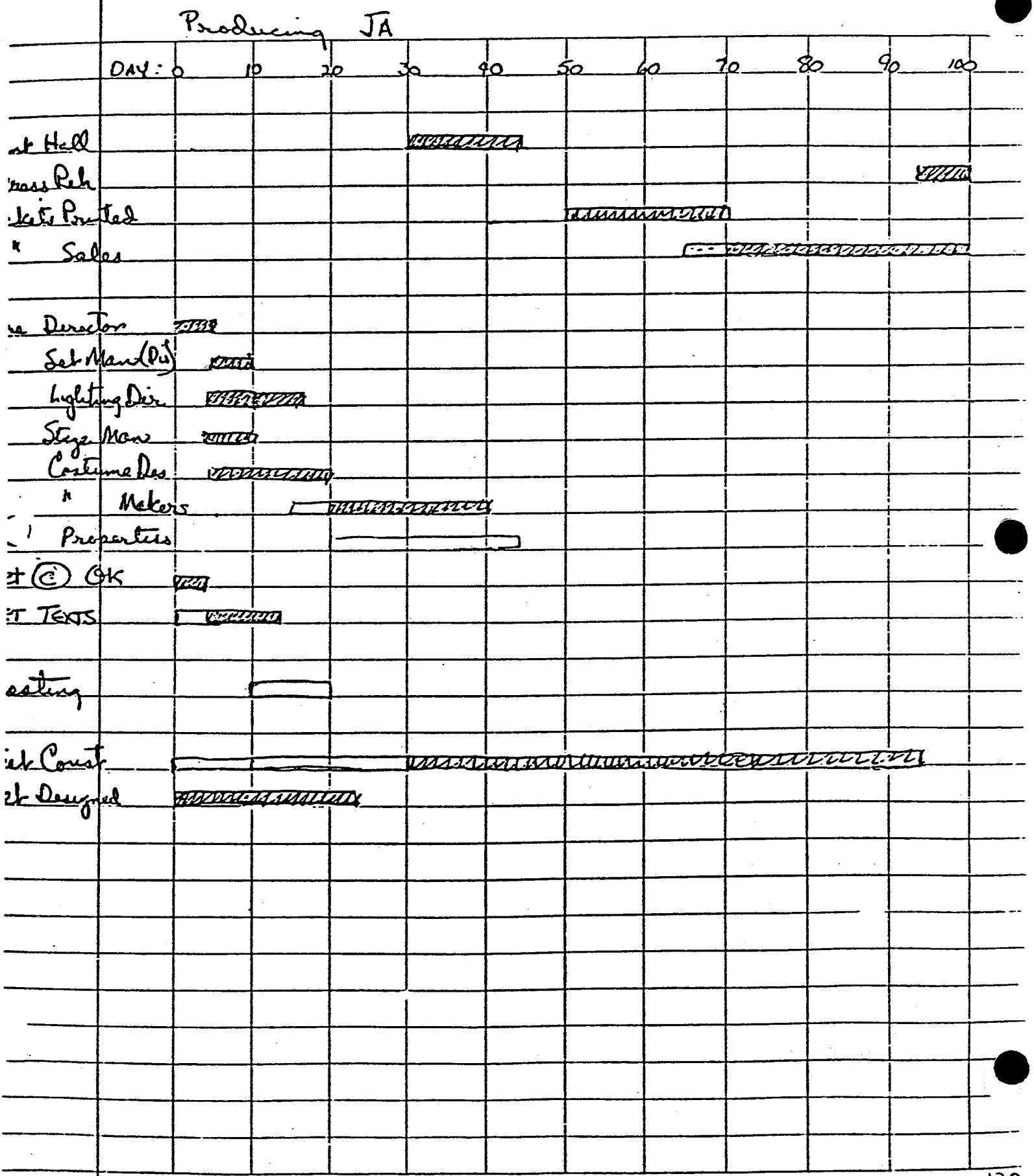
Clark, Mrs. Wallace, "The Gantt Chart," Ch. 7–3, in "Industrial Engineering Handbook," Maynard, H. B., ed., 2nd ed., New York, McGraw-Hill, 1963.

Cross References: *Integrated Project Management (and cross references there given).*

GANTT, HENRY L.

Henry Laurence Gantt (1861–1919), a pioneer American industrial and management engineer, taught natural sciences and mechanics, worked as a draftsman, and held a succession of increasingly responsible technical and executive positions in industry from 1887 through 1901. From 1902 until his death he served as a consultant. In 1917 he relinquished his private activity to accept a Government assignment in the Frankford Arsenal, and later in the building of ships for the Emergency Fleet Corporation. A contemporary of Taylor in the MANAGEMENT MOVEMENT, Gantt was one of the earliest to give major attention to human-relations aspects in industry, as distinguished from Taylor's primary emphasis on financial incentives. At the Midvale Steel Co. in Philadelphia (1887–93) he became Assistant to the Chief Engineer (F. W. Taylor) and then Superintendent of the Casting Department. There he made his first original contribution to management with his "task and bonus" system wage payment, which worked successfully at Midvale Steel earlier than Taylor's differential piece-rate system, and won acceptance long afterwards because it was simple, generally applicable, and less severe than Taylor's when the worker failed to attain standard. The GANTT CHART for which his name is now so widely known, was a revolutionary improvement in the planning and control of production in terms of time as well as quantity. But more enduring than his techniques is the new outlook he brought to bear upon industrial leadership. "In his later years, his influence in bringing American industry, and particularly the American engineering profession, to accept the new concepts of management was enhanced by his success in insisting that the training of workers should become a responsibility of management. In 1908 he was putting forward views not generally accepted until the end of the First World War. By then he was already thinking further ahead, to 'democracy in industry' and the humanizing of the science of management. In his later writings he rose to philosophical stature in his proposals for equality of opportunity in industry, and for the identification of the interest of employers and employed on the basis of scientifically ascertained facts" [1]. Gantt's books include "Work, Wages, and Profits," 1910 (Engineering Magazine Co.): "Industrial Leadership," 1916, (Yale Univ. Press): and "Organizing for Work," 1919 (Harcourt, Brace, and Howe, New York). Important among the papers he read before the American Society of Mechanical Engineers are, "A Bonus System of Rewarding Labor," 1902 (*Transactions*, vol. 23); "A Graphical Daily Balance in Manufacture," 1903 (*Transactions*, vol. 24); "Training Workmen in Habits of Industry and Cooperation," 1908 (*Transactions*, vol. 30); "The Relations Between Production and Costs," 1915 (*Transactions*, vol. 37); and "Efficiency and Democracy," 1918 (*Transactions*, vol. 40). Gantt was a prolific writer and

Sample Gantt Chart



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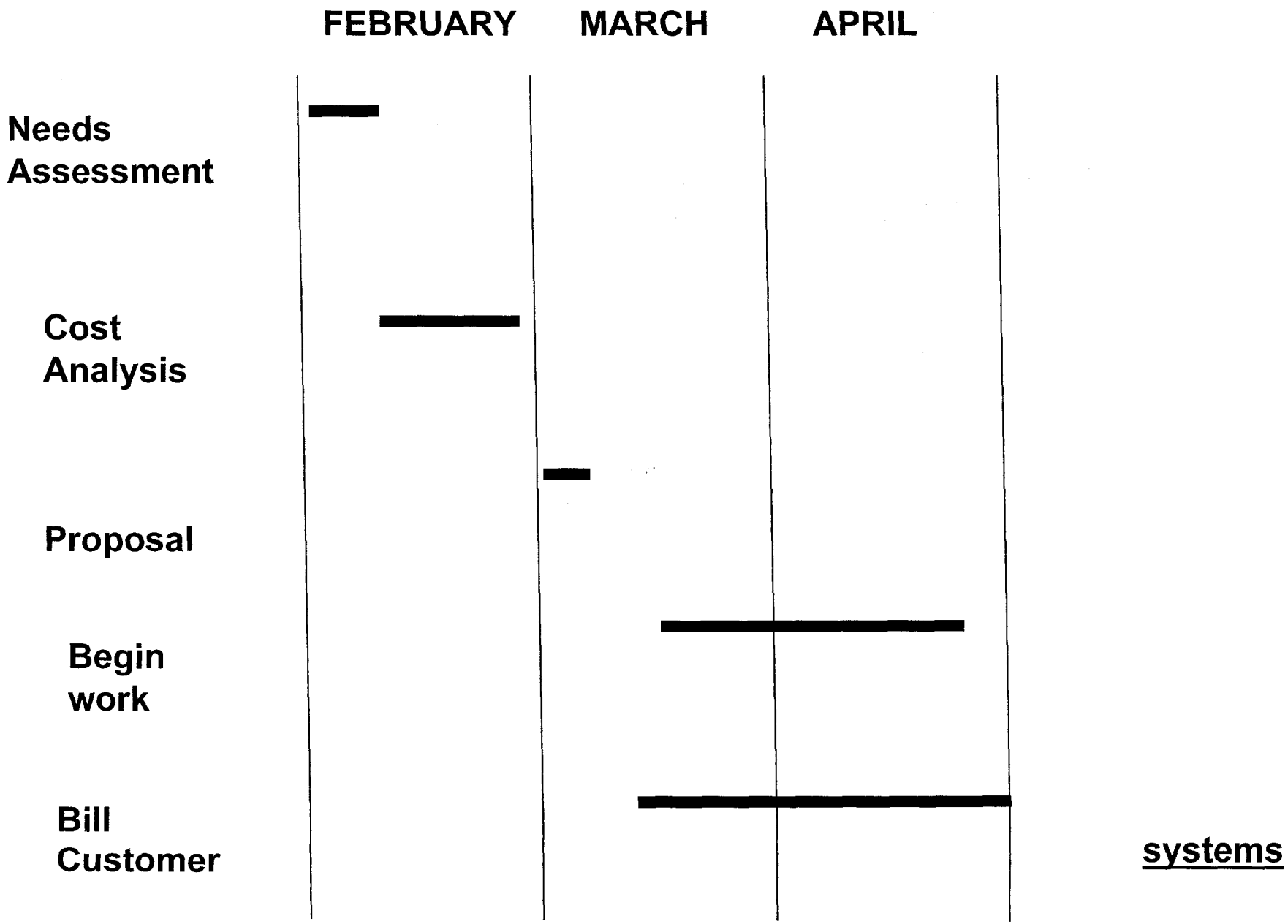

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