A preliminary man-machine interactive system for project scheduling is described in which computer graphics facilities are combined with a heuristic program for allocating resources to activities in a project network. The user can quickly generate feasible schedules and graphically display the results on a cathode ray tube. By means of a light pen and tablet, he can adjust resource levels, change scheduling parameters or modify program heuristics, and readily determine the effects of these changes on the project schedule. The combination of man's intuitive skills and the computer's computational powers enhances the effectiveness of both in searching for good project schedules.

Introduction: Problems in Using Network Techniques

Network techniques, since their introduction in the late 1950's, have undoubtedly helped many managers in the planning, scheduling and monitoring of projects. Over the years of their use, shortcomings and weaknesses of the methods became evident, were widely discussed, and sometimes were alleviated. Many man-years of effort were expended in trying to solve these problems and in other ways to extend the usefulness of the techniques.

Some of the problems were conceptual in nature (see, for example, 8, 13, 21), but mostly they were pragmatic. The probabilistic feature of PERT and the time-cost trade-off capability of CPM were largely abandoned because of difficulties in securing reliable data necessary for their use. Another problem was the models' early focus on time scheduling only. Eventually this focus was widened to include resource scheduling (4, 16, 24), and many heuristic scheduling programs were developed which took into account limitations...
on the availability of needed resources. While these models have increased in power and the range of their application, a number of basic problems remain which somewhat limit the managerial usefulness of these techniques:

1) Projects differ considerably one from another, and the heuristics of one resource scheduling program may work well on one project but not so well on another. With most heuristic programs, it is inconvenient to try various heuristics on a given project because of difficulties in changing the program, problems of computer turn-around time and evaluating the printed output, and so on.

2) Another computer-related difficulty that has bothered managers from the inception of network-based techniques is the "problem of the paper flood." The mere size of some projects invites voluminous output, and ingenious programmers have found almost unlimited ways to "massage" the data and expand the output from a PERT or CPM run. While much of this information may be useful, especially at the operating level where men and machines are actually assigned to jobs, for the manager who is concerned with overall planning and control, a thick stack of printed output from a single computer run can be bewildering and frustrating. The endless tables of data are virtually impossible to comprehend and interpret for purposes of managerial decision making, without considerable condensation and analysis. And even if the data were greatly reduced, printed tabular output is not an ideal form for human comprehension. Most programs are not well-engineered for managerial use.

3) A further deterrent of most network-type computer programs is the awkwardness of managerial interaction. Once a manager has finally waded through the output, if he has any "what-if" type questions (What if we combine these two operations? What if we hire some more engineers, or rent another bulldozer? What if we delay the start of this job?), the answers usually require repunching of data cards, resubmission of the program (with turn-around requiring hours at best and sometimes a day or more), and rewading through reams of output. Somewhere in the process, much of the potential usefulness