

THE CRITICAL PATH METHOD (CPM)

by

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The use of computers in all phases of the highway industry has grown tremendously in recent years. One of the newest uses is in the area of project scheduling and the critical path method, commonly referred to as CPM, is probably the best known technique used in performing this function. Basically this method of scheduling while relatively new to the computer is as old as the industry itself because the importance of minimizing the time and cost requirements on a project has long been recognized. For many years, appraisals of the time required to complete various phases of the work have been employed. However, systematic methods for considering the joint and inter-related effects of the time requirement for each phase is a new concept. The Critical Path Method offers this systematic approach. It also provides important information needed for project control. Specific examples of the information provided by the CPM and some of the resulting applications are as follows; (1) It pin-points the activities whose completion times are responsible for establishing the overall project duration and; (2) It gives a quantitative evaluation of the amount of leeway or float time that each of the other activities possess. Within the limits of float time the non-critical path items may be started later or completed more slowly than the original schedule indicated without having a detrimental effect on the overall project completion date. This presents management with the necessary information required to actually "manage" a program so scheduled.

The history of CPM is relatively short. Since it was first developed in 1956 by two separate pioneering efforts; one by the Navy who used it as a control tool for construction contracts for the Fleet Ballistic Missile Program and the second by the combined effort of Dupont and Sperry-Rand Corporation. Its existence in the Kentucky Department of Highways is much shorter. At the insistence of Commissioner Ward, the Department began investigating the use of CPM early in 1963. A model network of pre-construction activities was compiled and a computer program written to perform the scheduling, but little use of this method was made until a little less than a year ago when the Office of Program Management became acutely aware of the need for a faster and more accurate method of project scheduling. Since then the basic model network of activities and the computer program have been revised to reflect recent policy and procedural changes within the Department and several projects in an early stage of development have been completely scheduled by this method. The technique presently employed utilizes a listing of individual activities and the estimated number of working days to complete each. The computer converts this information into calendar dates and provides a print-out of the entire schedule.

Each of you has been given a handout consisting of the model network of pre-construction activities now in use in the Department, a copy of a CPM schedule on a project already under construction and the schedule of another much more detailed project still in progress. When the two pages of the model network are properly aligned, you have displayed the entire operation of the Department for a project beginning with its conception and preliminary investigation and ending with the construction work order being issued. This network is considered accurate with a couple of minor exceptions caused by recent policy changes regarding the federal programming of route study and the holding of the public hearing at an earlier date than that shown. To illustrate the fact that some of the schedules developed are reliable and are completed in the prescribed amount of time, examine the CPM print-out on the Nelson-Bullitt County Secondary project. It was prepared the 18th of January, 1965 in the very early stages of the project and predicted that the right-of-entry would be available by October 8, 1965 for an October 10th construction letting. The project was let October 10, 1965. The second schedule is for a portion of I-275 in Campbell County now in progress and for the most part on schedule. The information contained on each print-out schedule consists of the project description, a listing of each activity and its activity number involved corresponding to the model network, the time required in working days, the earliest starting date, and the earliest finishing date, the latest starting date and the latest finishing date, along with the amounts of "float" time available. A second sheet contains only those items considered to be on the critical path and obviously have no "float" or leeway time available. A graphical representation of the entire project schedule is also included.

The time consuming and error producing portion of this process occurs in initially developing the estimated number of working days for each phase. Personal prejudices and a poor recollection of past projects performance produces a schedule of activities either unacceptably long or unattainably short. The present technique has two primary disadvantages; (1) the development of the estimated man-hours required is too time consuming and, (2) As I've said before, the estimates once developed are subject to considerable error because of the inability of the Divisions concerned to make an accurate estimate. Additionally, conflicts arise because the projects are scheduled on an individual basis with little or no regard for the remainder of the existing or proposed program.

Regardless of the manner in which the project schedule is developed the most difficult task of all still remains and that, of course, is to meet the schedule prepared. Our attempts, in the Office of Program Management, to bring about completion of the pre-construction activities on the schedule developed have met with both some success and some failures. But most important our efforts have pointed out the unquestionable need for a realistically developed initial schedule. In an effort to achieve

more realism, it appears that the most practical approach would be to rely on the actual recorded history of completed projects, tempered with a judgement factor regarding the particular project involved. With this in mind, steps have already been taken in the Department to begin accurately recording the man-hours and cost incurred in the more detailed phases of the pre-construction activities. A year or two's accumulation of this information will provide data-bank that will help immeasurably in developing a more realistic project schedule. Our present plans call for continued usage of the Critical Path Method for scheduling projects, presently using our best educated guess regarding the working time required but making increased usage of our developing data bank.

The future of the Critical Path Method, as far as the operations of the Highway Department is concerned, appears to me to be very bright. Our most immediate goal is, of course, development of a data bank that will enable us to develop a more realistic CPM schedule. In the mean time we hope to expand CPM into the area of its origin, construction, and I am hopeful that within the next couple of years we will have progressed, as some other states already have, to the point where we can have all phases of a project included in a single CPM network. The final step required to implement a fully controlled computerized management system would be the development of a master critical path method for all individual projects in the Department's program. This CPM would balance the funds available for each road system, the man-power requirements, and the proposed program of projects, arrayed by priority, including cost and time duration factors, as indicated by the data bank. The result of this analysis will be a program that is fiscally sound, feasible as far as the man-power is concerned and that is realistically scheduled. The application of appropriate monitoring and control techniques to this beginning should provide the type of management for the Kentucky Department of Highways that will be needed to complete the tremendous program ahead.