

Track following means extrapolating the track over a few mm in the film plane, picking up the digitizings in an elongated area covering the extrapolated track, finding the appropriate element in this new area to link to the track, and so on. Each track element is retained simply as one 'average point', equivalent to a coordinate pair from a manual measuring device, together with bubble density information. The elongated area used in track following is analogous to the hardware slit of other measuring devices such as the Spiral Reader. It is wide enough to allow simultaneous detection of adjacent tracks which are likely to cause confusion.

Within an area, two distinct local pattern recognition techniques are used to find track elements, namely (1) stringing or associating together clusters of digitizings such as occur mainly on black tracks (or film scratches) (2) histogramming of distances of digitizings to a line having the same angle as the expected track, usually repeated over several angles. There is an elaborate logic for composing track elements from the results of these

two techniques, as there is also for the linking of elements to tracks.

Leaving aside here some other complications such as that caused by the HPD orthogonal scan, the sets of average points from track images on all three views are then sent to another program called MGTHRESH, for matching and reconstruction in three dimensions. Track-matching for Minimum Guidance has to take into account the fact that, in addition to the tracks of the interaction, an unwanted track or track image may be picked up because it satisfies the criterion of passing near the vertex, and also that a track image may occasionally not be found on one view. These problems are not unique to Minimum Guidance, and the facilities developed in MGTHRESH are also used for the Spiral Reader.

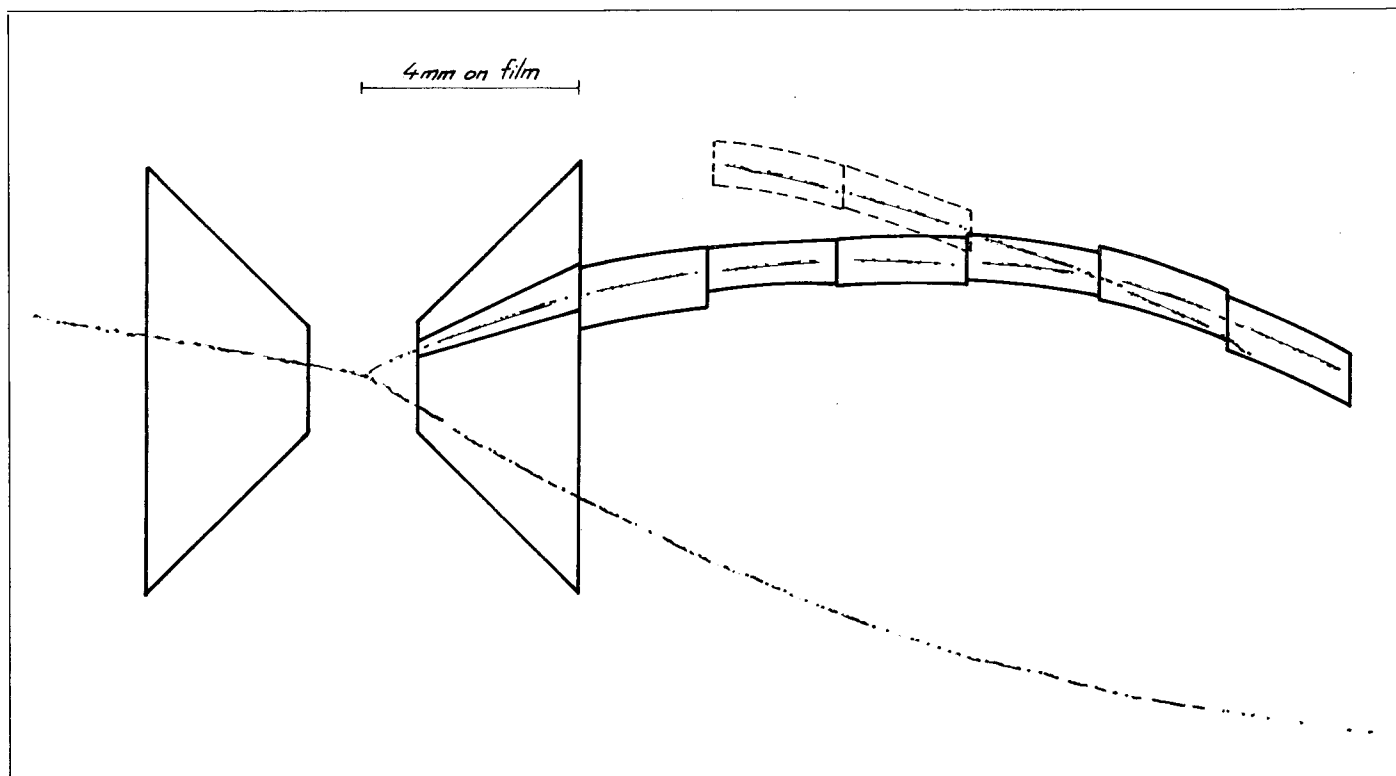
The Minimum Guidance System is in use at the Zeeman Laboratory (Amsterdam), and at Brookhaven, and is under active study at DESY, at the Rutherford Laboratory, and at Saclay. At CERN, it is envisaged that it will be used more and more; in addition, work is continuing

in an attempt to dispense with pre-digitizings altogether, initially on a small angle scattering experiment.

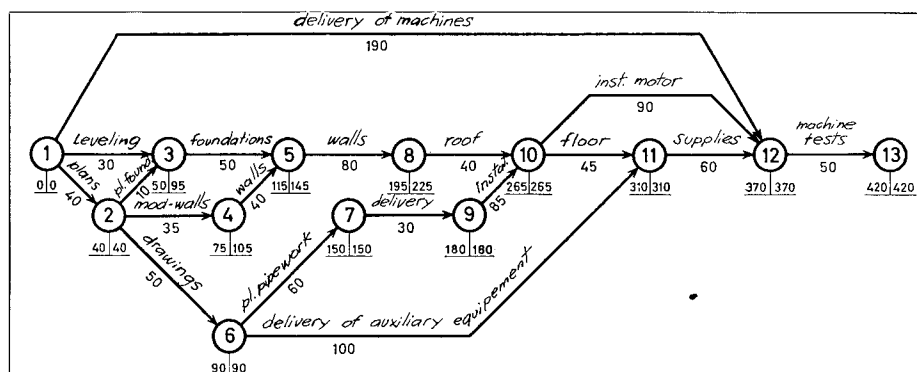
PERT at CERN

Project planning becomes more necessary, as the number of operations evolving one from the other increases and as time limits are reduced. Methods of planning have progressed a great deal since the time-honoured Gantt graph. The need to deal with extensive problems of logistics was the starting point for a development which, with the parallel improvements in computers, reached the point about 1960 when methods (often known under the generic name of PERT — Project Evaluation and Review Technique — or the 'critical path' method) were devised for dealing with large industrial projects.

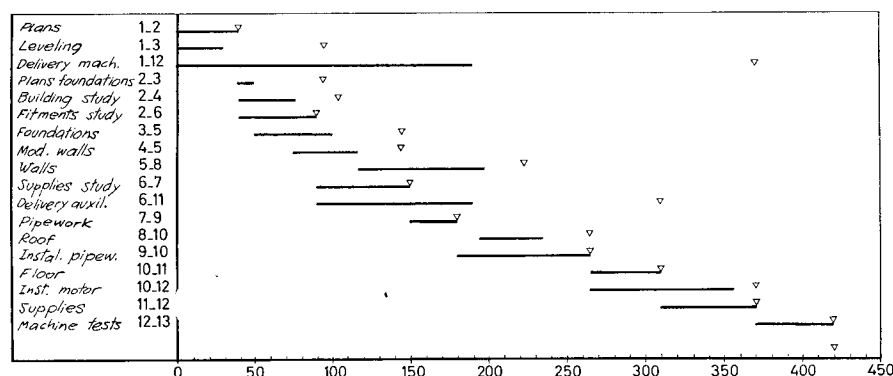
PERT is used for both the evaluation of time-schedules and, particularly, for the revision of programmes. If, for example, a project must be completed by a certain date, and it appears in the course



Planning a project by PERT begins with a 'network' (figure 1) in which each operation is shown in the form of an arc which runs in the direction of time. The arcs connect up series of 'nodes' which represent the various stages of advancement. Each operation is assessed to determine its completion time and the 'critical path' (i.e. the longest chain) is then found, since this dictates the time required to complete the programme. These operations are 'critical' because the lengthening of any one of them will delay in the programme. Once the starting date has been fixed, the dates at which the various events should occur are determined and the programme completion date assessed. If, however, it is the completion date which is fixed, the calculations are made by working backwards, and the latest commencement date obtained. If these two dates are fixed and the completion time between them is exceeded, this leads either to a conclusion of impossibility (if the available resources cannot be increased) or to a revision of the programme; the merit of PERT is that it provides great flexibility in this respect. The dates can be met either by re-arranging the available resources among the various operations or by providing additional resources. An example of PERT applied to plant installation (MBLE graphs) is shown.



1.



2.

of the programme that some part is behind time, it is possible by carefully studying all the operations, to save time on some of them — possibly by employing extra-labour, by using a sub-contractor, or even by omitting an operation if it is not absolutely essential. PERT can show where the pressure needs to be applied.

PERT is based on a particular type of graph which forces the planner to spell out aspects of his programme in detail by illustrating each of the operations, the time each requires and, above all, the way in which the operations are inter-related. In the case of simple programmes, consisting of a hundred or so operations, these graphs can be dealt with manually. As the complexity of the programme increases, however, the computer comes into its own. It can extend the method to projects involving thousands of operations.

When the PS improvement programme and the ISR construction project were about to be tackled, CERN considered applying PERT. In 1966, J. Pollock, an American PERT expert working at the time at Argonne and now engaged in planning

at Batavia, adapted his existing computer programs for CERN. Since then, PERT has been used for most large CERN projects (Booster, European bubble chamber, ISR, experimental areas and large buildings) for both the civil engineering work and the installation of equipment. One example of a typical application of this 'CERN PERT' was the installation in December 1969, of the fast ejection 16 (see CERN COURIER vol. 10, page 148). This was a programme involving about 150 operations to be carried out during the short period of the PS shutdown and worked very well.

Since 1966 CERN has trained its own PERT specialists who, in 1968 and 1969, rewrote the programs with the aim of producing a simpler program adaptable to a wide variety of cases. It is, to-day, the only one in use at CERN, and can encompass a maximum of 2000 operations.

PERT is an 'individual' tool. While there are competent PERT specialists in several Divisions who can provide advice, it is only exceptionally that they can do the preparatory work for others. However, the method is quickly learned (within a

few days) but its efficient application does require some experience and a great deal of judgement. It is often difficult to assess timescales, especially when other people's work is concerned, to ensure that they are kept, etc. But such problems are common to all large projects.

A yellow report (70-15) on PERT and a 'PERT Manual' are available for those interested from the CERN Scientific Information Service.