



BS 6046 : Part 3 : 1981

UDC [651.012.2:519.876.2]:681.3

Use of network techniques in project management

Part 3. Guide to the use of computers

L'utilisation des techniques de réseau dans la gestion de projet
Partie 3. Guide d'utilisation des ordinateurs

Anwendung von Verbindungsnetztechnik in der Projektierung
Teil 3. Leitfaden für die Anwendung von Rechnern

Contents

	Page		Page
Foreword		7. Choice of coding system	12
Cooperating organizations	Inside front cover Back cover		
Guide		Tables	
0. Introduction	1	1. Checklist: choice between manual and computer application	5
1. Scope	4	2. Checklist: selection of a software package	9
2. References	4	3. Checklist: choice of coding systems	15
3. Definitions	4		
4. Purpose, structure and recommended use of the guide	4	Figures	
5. Choice between manual and computer application	4	1. Flow chart for the coding process	13
6. Selection of a software package	8	2. Example of the structure of a code	14

Foreword

The aim of this guide is to be of practical use to the manager who wishes to use project network techniques as a tool for project management. A project manager meets many problems of which only some can be foreseen; even those familiar with planning and controlling projects will encounter unexpected difficulties and will often be forced into 'management by crisis'.

This guide is designed to draw attention to the problems that project management can resolve in advance, and does this by helping those involved to ask the right questions. Although the use of project network techniques is not a prerequisite for project management and many of the aspects discussed apply whether or not such techniques are used, the guide is principally concerned with their use. The guide deals in some detail with the circumstances under which project network techniques are appropriate and stresses the management problems that arise in their application.

The guide systematically examines the area of application of project network techniques in project management. It guides the less experienced reader logically through the more fundamental questions, while the structure enables those more experienced in project management to progress rapidly through to the more advanced topics. The best way of using the guide is for the reader to acquaint himself with its structure and the sequence in which various problems are approached.

The guide concentrates on practical problems and possible methods of solving them. Being a guide to practice and application, it does not discuss theoretical aspects, neither does it provide detailed explanations: for such a purpose a number of textbooks have been written for a wide range of possible users. The reader's attention is drawn mainly to the questions that arise during project management and the use of networks. In particular, the general problem of communication (i.e. between different parts of the same organization and between different organizations) is stressed as is the importance of knowing the right questions to ask. The answers given here are a good guide, based on long and wide-ranging experience; they are, however, opinions and not absolute facts. As such, the views expressed should be examined critically in

the light of the particular circumstances to which they are applied, as should all general interpretations. The main value claimed is that widely discussed and agreed answers to frequently met problems tend to be well suited for most situations and provide an authoritative basis, not to be disregarded lightly, for inter-organizational project management arrangements.

This guide will be published in the four following Parts.

***Part 1. Guide to the use of management, planning, review and reporting procedures.** The important functions and organization of project management, as distinct from general management, is emphasized. Descriptions are given of the involvement of management as the project develops from the initial planning of the project and review systems to the procedures to be adopted in setting the stages and frequency of project review and methods of reporting.

***Part 2. Guide to the use of graphical and estimating techniques.** Practical considerations for the estimation of values needed for the analysis of project networks are discussed. Guidance is given on the factors to be considered in choosing between activity-on-arrow or activity-on-node techniques. Network drawing methods for the presentation of the two types of network are discussed and recommendations given for the conventions to be used and the level of detail to be included as well as practical hints.

Part 3. Guide to the use of computers. Guidance is given on *when* and *when not* to use computers in conjunction with project networks. The different ways in which a computer may be used for processing project networks are described and assistance is given on how to select the actual computer package. This Part then refers to the purpose and significance of coding systems for use with project networks.

Part 4. Guide to the use of resource analysis and cost control. This Part covers the use of resource analysis and project cost control as a natural extension to the use of time analysis in project network techniques. The two techniques are treated separately for the purpose of providing more effective management information.

* In course of preparation.

British Standard

Use of network techniques in project management

Part 3. Guide to the use of computers

0. Introduction

0.1 General. Although this guide concentrates on the use of project network techniques, project managers can, and often do, make use of other techniques covered by operational research, work study, organization and methods, quality control, production control, data processing using electronic equipment, value engineering, etc.

It is the responsibility of project management to make use of these facilities as appropriate but to balance their impact on the project so that this is not jeopardized by over-enthusiasm on any one aspect or by conflict between opposing objectives. For example, equipment should not be over-designed at the expense of failing to meet a delivery date with items that perform quite satisfactorily.

The project network techniques described in this guide enable the overall management (planning, monitoring and control) of projects to be conducted in an efficient and logical manner. To control a project, rather than merely to monitor what is actually occurring, it is necessary for project management to make decisions; for these decisions to be effective they should be based on the best information available and this requires an adequate communication system together with defined objectives and procedures. The methods used should also be dynamic, so that they can be adapted to suit changes in the environment, and also rapidly reflect changing situations anywhere on the project, so that corrective action can be taken.

This guide concentrates on the parameters of time, resources and hence costs in general. It deals with the basic requirements of project organization and management, with project planning, where the datum conditions for the future conduct of the project are set down, and finally it deals with methods of controlling the subsequent performance of the project and some ways by which control may be maintained when changes occur.

It is desirable that the use of a network-based project management system receives full management backing within the company. There should be adequate training of all persons in contact with networks.

The procedures and methods described in the various Parts of this guide are generalized and are not necessarily applicable to all types of project. Methods of handling project network information vary according to the

environment in which these techniques are applied. Some typical areas of application have been identified and current practice within them is indicated. These areas are as follows:

- (a) *strategic long-term planning*, e.g. economic development at national, local government or company level (see **0.2**);
- (b) *research and development*, e.g. space flight, military weapons, large-scale equipment, pharmaceuticals, etc. (see **0.3**);
- (c) *administrative or procedural projects*, e.g. setting-up of a new organization, centralization or decentralization of administration; introduction of major administrative or organizational changes (see **0.4**);
- (d) *capital plant for manufacturing industry*, e.g. chemical plant complex, oil refinery, etc. (see **0.5**);
- (e) *major engineering undertakings on dispersed sites, and usually occurring irregularly*, e.g. railway line, service distribution scheme, etc. (see **0.6**);
- (f) *major engineering undertakings on a localized site, and often regularly recurring*, e.g. power station, ship construction, etc. (see **0.7**);
- (g) *planning and controlling change-overs, interruption of services or functions*, e.g. metrication, traffic diversion during rebuilding operation, factory or office move, computerization of financial operation (see **0.8**);
- (h) *one-off building construction*, e.g. hospital, office block, library, etc. (see **0.9**);
- (i) *repetitive building construction*, e.g. housing, particularly at the design stage (see **0.10**);
- (j) *new product introduction*, including marketing and distribution (see **0.11**);
- (k) *major overhauls and planned maintenance*, e.g. blast furnace, chemical plant, ship refit, refinery areas, etc. (see **0.12**);
- (l) *production planning*, e.g. fabrication, assembly (see **0.13**);
- (m) *key operation of short duration*, e.g. aircraft turn-round (see **0.14**);
- (n) *emergency planning*, evacuation of building after fire or flood warning, restoration of services after power failure, rescue operations after natural disasters (see **0.15**).

0.2 Strategic long-term planning. Project planning in this environment is often developed backwards from an agreed target. Once a network has been developed, however, the techniques of analysis are not unlike those described for research and development. Probabilities, related both to activity durations and to alternative strategies, will have to be assessed, and various outcomes considered. The use of gross resource and cost analysis is more appropriate to this area than the detailed approach.

At the national and local government level the time scale can run up 25 years or more, but company time scales rarely exceed 5 years, or 10 years at the most. Activity durations will normally be expressed in months or even longer time units.

0.3 Research and development. The uncertainty in both the sequence and the duration of activities is a common characteristic of research and development. The sequence often depends on results achieved at earlier stages of the work. It is necessary, therefore, to attempt to pre-think all possible alternatives, using network drawing techniques to display them. These networks tend to contain 'decision nodes', where alternative strategies are presented and a choice has to be made, i.e. the network is 'probabilistic'. The simplest approach is based on time analysis only. More advanced versions of the technique embody cost calculations, both in the form of 'cost gates' and 'background costs'. Cost gates highlight the need to invest in special buildings and equipment before a new chain of work can be started. Background costs reflect the day-to-day running cost of doing the work.

Resource calculations, if performed at all under these conditions, are usually aimed at summarizing total resource requirements for the establishment covering all projects. Estimates and calculations, therefore, need to be only approximate, usually based on a monthly or quarterly analysis.

0.4 Administrative or procedural projects. Such projects involve activities, the need for which does not become apparent until the details of logical links between the major activities are worked out in full. A logic-only network (i.e. without activity durations and hence incapable of time analysis) has been found a useful tool for the complete planning of successful projects in this field. For smooth operations, it is then relatively simple to use hierarchies of timed networks. The main resource requiring careful planning tends to be key administrative personnel.

0.5 Capital plant for manufacturing industry. This environment is often a forcing house of experience in the use and development of advanced techniques of planning and control. This arises because the supplier is often his own designer, manufacturer and erector, and because he is continuously passing plant after plant through his factory. He thus builds up a great deal of experience very rapidly, because of the need for regular and frequent updating.

He will apply time analysis for the total project. The timing from the networks will be used to prompt his cost control accountants in regularly recalculating the estimated cost to completion, cash flow, etc., for each project.

In parts of the workshops, particularly those concerned with fabrication and assembly, he may use advanced resource allocation techniques. He may also apply the

same techniques at the site, during erection work. Resource calculations will be used as a basis for manpower control, since man-hours are much more meaningful than costs to foremen and supervising engineers. Budget levels and actual expenditures are, therefore, expressed in that form.

0.6 Major engineering undertaking on dispersed sites.

In this environment there will normally be a series of subnetworks, with an overall master network linking them all together. Quite often, each subarea of work is the responsibility of a particular contractor, who can be expected to run his own network. At that level he may employ all the available techniques of time analysis, resource allocation, and cost control.

The many subnetworks will be brought together in one of two ways:

- (a) a main contractor (or client) will exert such a strong influence on subcontractors that they all use the same computer program for processing their networks, and subscribe to running all networks together from time to time in true multiproject fashion; or
- (b) reports from subcontractors will be manually summarized and combined to form input to a master network.

Time analysis will normally be common to all levels, but resource analysis will relate locally to each subcontractor. Occasionally, however, when one subcontractor handles several main sections of the work, e.g. stations on a railway line, he may run the networks for these together to enable him to deploy his resources economically from site to site.

Cost analysis will be generalized by the main contractor or client and a common system of reporting enforced on subcontractors to fit in with the client's scheme of financial control.

In this environment, projects of this kind are not regularly recurring. The client, therefore, seldom carries an experienced team to handle the work. He thus tends to employ consultants or rely on a main contractor for planning and control.

0.7 Major engineering undertaking on a localized site (regularly recurring). The localization of the site tends to cause planning and control to be based on one large network, broken down into subnetworks by area of work, which are routinely interfaced, i.e. processed together. Furthermore, projects in this category, e.g. power stations, ships, etc., tend to repeat, so that the client maintains his own team of experts.

The client's control is normally much tighter than in 0.6, and based primarily on time analysis and cost control. The client will not normally concern himself with resource analysis, but at some local parts of the project the contractor may use resource allocation as the key technique, e.g. in manufacturing, assembly and erection.

0.8 Planning and controlling change-overs. Frequently, the overriding requirement for projects in this area is that the existing organization function or services should be interrupted or interfered with as little as possible. There is a tendency therefore that the networks for such operations have to include many apparently extraneous activities. Whilst the detailed logic analysis often reveals unexpected complications, the implications of such logic constraints on timing may be even more profound.

planning and preparation for operations in this field often takes much more time and resources than the actual operation itself.

0.9 One-off building construction. At the client level, planning and control will be based on time analysis only, but at the contractor level, networks will tend to be used for time control, resource control, and budgeting. Unlike the capital plant type of project (see 0.5), these building projects contain modules of work that repeat again and again in different constructions, e.g. walls, floors, foundations, drains, etc. A benefit of the use of networks can be the availability of lists of information requirements for the design team.

An experienced contractor may have used networks at one time to plan such work but, after a few projects, he finds he can recognize an optimal pattern of work. He may, therefore, reuse segments of plans derived from previous projects. This approach is quite valid provided he can be sure that methods are not changing, or, more likely, that the staff who came to know and understand the earlier work have not moved on.

0.10 Repetitive building construction. The comments about reusing old plans (see 0.9) may also apply here, but the contractor may do special preliminary analyses for each new project. He may analyse, by means of networks, different ways of doing the work, and the impact on costs and timing of the use of such prime equipment as concrete mixing plants, tower cranes, etc.

Having completed these analyses before the work starts, he may then be content to control one or two key resources throughout the job, since he has found from past experience that, by controlling these resources closely, all the rest will fall into line. He may also use other techniques for day-to-day detailed control.

Cost control will normally be exercised in the form of repetitive calculations of rates per unit of construction (e.g. per area of brickwork, per volume of excavation, etc.) and matching these against company standards.

0.11 New product introduction. Network planning in this environment is applied, but is usually minimal in form. The use of logic only networks, i.e. without timing, is seen as a worthwhile way of forcing crisp thinking and decision making into what is all too often a very unstructured approach. No time calculations are made, but attempts to draw a network for the project force their own discipline.

Some firms use time analysis as a means of planning and control of publicity, advertising, printing, etc., and rough timing of initial product manufacture and actual launch on to the market. Resource allocation is rarely carried out, and cost control is normally based on orthodox budgeting and accountancy routines.

0.12 Major overhauls and planned maintenance. The network logic stage is very important in this environment as it involves:

- (a) a study of current plant performance as a means of forecasting the work required during the overhaul;
- (b) the embodiment of scheduled maintenance jobs;
- (c) discussions on ways and means of taking the plant off stream and putting it back into service again;
- (d) safety aspects;
- (e) minimizing shutdown time and interference with production.

Typically, the overhaul of a particular plant is repeated at regular intervals, and so repays detailed development of the logic. Time analysis will be crucial and resource allocation will normally be applied, but networking cost control methods are rarely used.

After a few overhauls of the same plant, the staff will have become so familiar with the routines that major effort is then often concentrated on manpower control and the development of technical short cuts.

0.13 Production planning. Project control by means of network techniques is rarely applied in an environment of batch or quantity production, except up to prototype stage. These techniques are used, however, for fabrication and assembly of major plant items or for the cyclic production of small quantities of complex items.

Emphasis should be given to resource analysis rather than time analysis alone and consideration should be given to the constraints of manpower, machines, factory space, special tools, etc. A network will be required for each small batch or item and multiproject computer runs will be used to plan the week-by-week shop floor schedule.

Activity durations need to be derived and outputs will be required by the shop floor and management to enable them to review, in advance, delivery dates and resource availability; these will probably be obtained by work measurement techniques.

0.14 Key operations of short duration. Project network analysis is used to plan in detail (with time scales in minutes if need be), with the resulting network and resource schedule used as the basis for the control procedure rather than directly as the control tool.

0.15 Emergency planning. Projects of this kind often can and should be planned in considerable detail even though the exact nature of the operation cannot be known. The use of networks has been found particularly useful in making evident the need for some of the logical linkages (e.g. communications) that might otherwise be overlooked. The network's main function is as the basis for working out procedures to be activated should an emergency occur, but rarely as a control tool during the actual emergency; also it allows minimum resource needs to be estimated for the following:

- (a) minimum material stockpiles;
- (b) supplies during and after the emergency;
- (c) number and training of personnel.

1. Scope

This Part of this British Standard gives guidance on the application of a computer to project network analysis. The advantages and disadvantages of computer application compared with manual analysis are discussed. Advice is given both on choosing a suitable software package and on the selection of computing facilities for processing the package.

Guidance is given on the choice and use of coding systems with project networks. The importance of significant coding systems is discussed together with the different approaches to the use of significance within the code and how the design of the code may be affected by the organization of both the project network and the company.

2. References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3. Definitions

For the purposes of this British Standard, the following definitions, together with those given in BS 3527 and BS 4335, apply.

3.1 acoustic coupler. A device allowing any normal telephone to be used to couple a remote computer terminal to a computer. It embodies the features of a modem (see 3.4) but is connected to the telephone acoustically (and not electrically by permanent wiring).

3.2 dedicated line. A Post Office telephone line permanently connected between two points (i.e. not part of the normal telephone switched system serving all 'dial' telephones).

NOTE. Dedicated lines are normally rented from the Post Office on a mileage basis, and can be of different qualities, i.e. capable of transmitting at varying speeds, most of which are higher than the speeds available over a normal dialled connection.

3.3 DP. An abbreviation for 'data processing' or occasionally 'data preparation'.

3.4 modem. A device necessary when using a normal telephone line to communicate with a computer.

3.5 multiplexer. A device generally installed by computer services bureaux to allow users who are a long way from the computer (e.g. more than 50 miles) to have access to the computer by merely making a local phone call to the multiplexer unit which then transmits that call to the distant computer installation.

3.6 remote job entry (RJE). The creating of data, initiation and execution of the job from a computer terminal.

3.7 software package. A suite of integrated computer programs, often written in-house or by a computer manufacturer, or by a software-house.

3.8 turn-round. A general term covering the time to complete computer or manual processing.

NOTE. The term is generally used in the context of service and/or time taken (e.g. 'a quick turn-round', 'the turn-round time is only 20 min').

3.9 visual display unit (VDU). A computer terminal with a cathode ray tube as the means of displaying the input and output to the computer.

4. Purpose, structure and recommended use of the guide

This guide has been compiled to serve two purposes. It is intended to assist the inexperienced user of project network analysis (P.N.A.) to understand the implications of applying a computer to assist with both the analysis of a project network and the application of the results of that analysis. In this respect, comment and advice are offered on the advantages and disadvantages of using a computer and, as a result, the user may possibly decide to postpone the use of computer until a later date.

The other purpose behind this guide is to assist the experienced user to select a P.N.A. software package when he feels that the use of a computer would be of assistance, or, alternatively, to remind the experienced user of the points to be considered when changing to a different software package.

Clause 5 relates to the initial decision regarding the use of computers for P.N.A. Clause 6 is of assistance in choosing an actual software package once the decision to use a computer has been made. Clause 6 may be used without reference to clause 5 but it does in fact draw attention to the basic reasons behind the decision to use a computer. Clause 7 gives information relating to the choice and use of a coding system for use with project networks.

The user is recommended to start at item 1 of table 1 and work through each of the questions given in the tables, each question of which postulates a number of alternative answers. The factors affecting the user's choice of answer are given, together with comments. Whilst the logical arrangement used to construct the sequence of questions is thought to be reasonable, it should not be regarded as definitive and the user may find he needs to return to earlier points as he proceeds through the guide.

NOTE. Although the guide may appear categorical in places, it should not be regarded as a rigid set of rules; when numbers are quoted they should be taken merely as an indication of approximate magnitude.

5. Choice between manual and computer application

A checklist for the choice between manual and computer application is given in table 1.

NOTE. This checklist assumes that there is agreement to use network techniques.

Table 1. Checklist: choice between manual and computer application

Item	Possible alternatives	Comment
1. What type of network technique will be used?	Activity-on-arrow	If not sure, <i>either</i> : (a) read Part 2 of this standard; or
	Activity-on-node	(b) proceed through this checklist and then see if 'best' program for your problem is tailored to any particular method.
2. What is the approximate number of activities in the network?	General comment	See the section on project planning in Part 1 for advice on size of network.
	0 to 100 activities	Calculate manually, unless updating is required at weekly intervals (or more often than weekly). (See items 4 and 6.)
	100 to 500	Use of a computer would be advantageous unless updating is only monthly, or even less often.
	500 to 3000	Use of a computer is advised for this size of network. If you are an inexperienced user, it is recommended that you only update monthly.
	3000 or over	This size of network is <i>not</i> recommended for inexperienced users, because of the difficulties likely to be encountered obtaining feedback information to update the network.
3. What time unit will be used in the networks for activity durations?	Less than a day, e.g. shifts or hours	(a) As a guide to activity durations, try to avoid any activity being less than 1 % of the total project duration.
	Days	(b) Inexperienced users should avoid too short a time unit as this generally implies too much detail in the network. (c) Where a computer is to be used, check that this program can handle the chosen time limits.
	Weeks	
	Longer than a week	The use of a computer is not recommended unless overall time span of project is a number of years. (See section on project planning in Part 1.)
4. What will be the frequency of updating?	General comment	The period of time elapsing between updates should be not less than the minimum activity duration.
	Daily	Examine the objective behind the use of the network to reassure yourself that this degree of control is both necessary and possible.
	Weekly or monthly	This frequency of updating is common amongst experienced P.N.A. users who are using computer packages.
	Longer than monthly or never	A computer is unlikely to be worthwhile unless complex resource analysis is required or the project is of a long duration, e.g. three or more years.
5. How will activity start and finish times be expressed in output reports?	Time units (e.g. day no. or week no.)	(a) Check on general company policy and/or need (it often is the case that people concerned with 'customers' will want to quote calendar dates, but those concerned with the internal organizations will prefer to work in 'week numbers').
	Calendar dates (e.g. 4 June 1982 or 1982-06-04)	