

Project management and the engineer

D. D. PATERSON

Mr R. J. Livesey, Babbie, Shaw and Morton

In § 18 Mr Paterson implies that the bar chart is of limited value. The human eye and brain work efficiently as an analogue system to assimilate information presented to them in this form. The bar chart is essentially a statement of information, time related, in an analogue form. On the other hand, masses of data delivered from a digital computer frequently require to be interpreted with some type of digital-to-analogue conversion, before the engineer can make use of the information.

43. The dimension of time is fundamental to civil engineering projects both in terms of the Client's need for the works and in relation to the engineering design and construction processes. Analogue data presented in a time matrix must at some stage be used in the planning stages to define the principal events around which details can be resolved. In fact, the planner may well draw up bar charts for this purpose before data can be presented to the network analysis specialists, and vice versa.

44. A good bar chart shows the activities and events for a project and the time matrix permits comparisons and relationships to be worked out and readily inspected. Planning networks can also be plotted on a time base to make a more advanced form of the simple bar chart. It is the engineer who determines the time scales and not the planning machinery. Whereas the bar of the chart represents the activity and its terminations indicate events, it is also useful to prepare a diagram on which all important events are sequentially ranked in order of time and plotted against a time base, the subsequent activities being added as bars on the chart.

45. The bar chart, skilfully handled, is a very useful tool for determining and displaying vital programme data and should not be dismissed. It is the Writer's view that part of the time and expenditure entailed in detailed network analysis in some projects is quite unjustifiable in comparison to the speed with which the time-oriented bar chart can be built up to give, at a glance, the required information. The method of programming adopted should itself be the subject of cost-benefit analysis related to the project in hand, to justify the means as well as the end.

46. Bar charts which fail to take account of the interdependence of events are useless, but this is a failing on the part of those who have prepared the charts and not the fault of the charts themselves.

Mr R. A. Matthews, Brian Colquhoun and Partners

In his introduction, Mr Paterson says that 'an immutable programme for completion' is required on a complete design and construct programme, whereas in § 31 he says that the programme should be revised by the Contractor 'as often as required by the Engineer'. Surely there is a practical course between these extremes.

48. Regular revision of programme is bound to be necessary, but it should not be required so often and in so much detail that an army of programmers is kept constantly at work and a high proportion of management time is spent providing data for this

DISCUSSION

purpose alone. Too often network analyses are drawn up in great detail, are superseded by changing circumstances before the ink has dried, and are too complex ever to be up-dated in time to catch up with reality. Far better a simple bar chart which is easily up-dated and understood by those who need to work to it, than a detailed network which is always chasing events and may only be understood by those who compiled it.

49. A second point concerns progress meetings (§ 29). If all they do is to provide a head count of active participants they are indeed serving no useful purpose, which is a pity as they can be very valuable. It may be that the Engineer will not be able to make impromptu decisions at such meetings, but that does not prevent a useful airing of problems and possible solutions while all parties involved are present. Precirculated agenda and good chairmanship are two aspects which can help to ensure that such meetings are worth the time spent on them.

Professor S. H. Wearne, University of Bradford

This Paper is, I believe, the first to attempt to relate the function of project management and the duties of the Engineer under the ICE model conditions of contract. Particular problems and various views on tackling them have been more thoroughly aired in the discussions of the Institution's Management Group and in the growing mass of publications on project management.

51. Many statements have been made on how projects *should* be managed. What is needed is more evidence on how they *are* managed. In a study of contractual responsibilities for design and safety at the School of Technological Management, University of Bradford, the published reports of technical or financial failures in different branches of engineering have been drawn on. These failures certainly should not be thought to be typical of practice, but they are well known and engineers are expected to learn the lessons indicated by them. What is difficult is learning from all the projects that go well. It seems that many engineers and their employers do not review completed projects for that purpose, and those that do, do not usually publish the conclusions. It would therefore be valuable to know what is the evidence supporting some statements in the Paper.

52. Is an 'immutable' programme (§ 1) better than one that has flexibility in anticipation of market changes, government decisions, and other independent variables that cannot be controlled during a project? Is there evidence that a policy of immutable planning successfully forces all parties to make better initial decisions?

53. What success has the Author had in defining a 'firm' estimate? Are not the concepts of probability and variance accounting valuable in attempting to predict and control costs?¹

54. Many engineers perhaps recognize the term 'project management' from experience of its value, but is it true (§ 2) that engineers are forced to have regard to modern management techniques? By whom?

55. Do employing authorities (§ 3) 'consult and decide broadly' on a desirable time-scale, and officials and consultants produce realistic programmes? Do they integrate time, cost, cash flow and choice of type of contract all to meet objectives in terms of project quality and flexibility? If so, the members of the Wood Committee and the wise men meeting in Whitehall can rest contented.² Some engineers have the impression that it continues to be very difficult to get inexperienced clients to take their advice and draw all the interested departments, etc. together so as to launch a project with agreed and understood objectives, or to get the single channels of communications which the Author confidently states in § 37 are generally provided by participating organizations.

56. From comparisons between projects I doubt whether there is one right way of managing them. To generalize from studies in other industries and another country,³ I believe that the evidence indicates that choices should depend upon the relative complexity, novelty and urgency⁴ of the project. It would be valuable to know from

Mr Paterson what differences are to be seen between various projects undertaken by his Passenger Transport Executive.

Mr E. L. Barron, Consultant

In referring to an immutable programme for completion (§ 1), I assume the Author means an immutable completion date. If the project is complex, the programme will usually change considerably to accommodate changes in delivery dates for materials and plant, design changes arising from ground conditions not being as expected, etc. Often, the design will be continuing after construction has started, as mentioned in § 27. Regarding the firm estimate, the employer must realize that there is an element of risk in a contract which he must bear, and ample allowance must be made in his budget for such contingencies, particularly in civil works where a fixed price lump sum contract would result in unduly high tenders.

58. The Author appears to imply (§ 2) that all engineers are wedded to some traditional methods of contract administration which he describes as paternal, and are opposed to the adoption of any modern management techniques. I doubt that this is generally so, but the Paper should at least remind engineers concerned with contract administration to review their procedures continually and consider if the adoption of some new management technique might be beneficial.

59. A method of analysing the multiplicity of progress reports (§ 10) is vital to obtain project management by objectives rather than crisis. The SHINDICA method (Symptoms, History, Investigation, Diagnosis, and Corrective Action) is described elsewhere.⁵

60. To say that cost monitoring is now required for cost prediction (§ 13) is to say that monitoring has become forecasting, which is hardly an innovation. Whatever the type of contract and the degree of accuracy for cost forecast, it is important to forecast costs as accurately as possible at least each month and to consider ways of reducing costs even if underexpenditure is forecast.

61. The Employer is entitled to and should undertake certain duties under the contract (§ 38) in addition to making payments (e.g. approval of the contractors, insurance, and notice of forfeiture) and may have other responsibilities (e.g. for carrying out work on the site with his own workmen, or the issue of permits to work in hazardous areas).

62. Decisions on some contract matters (§ 29) can, of course, be made by the Engineers' representative if the Contractor has been notified in writing of the delegated powers. If he has not been authorized to make the necessary decisions, then the paternalistic Engineer must surely attend the progress meetings himself. Rapid, if not impromptu, decisions may have to be made to avoid delay in work and consequent claims for substantial additional payment.

63. For some projects a bar chart may be quite sufficient (§ 31). In many cases it is desirable to require a programme to be submitted with the tender, and it may be useful to stipulate that this should be in the form of a specimen programme included with the documents issued for tender.

64. For tracing the total effects of delay (§ 32) it is vital for the Contractor to have declared the build-up of his tender. Again, it is useful to stipulate that this should be submitted with the tender. While there may be some virtue in uniform standard of programme (§ 34), this is unlikely, by itself, to avoid delays: insistence may actually cause delays.

65. The extent to which the Engineer should undertake project management (§ 41) must obviously depend upon the type and size of project and the availability of staff with management skills. At a recent informal discussion at the ICE⁶ a useful distinction was made between project engineering, management and direction. These roles could be combined in some projects, but project direction invariably lies with the Client. That the other functions are well handled is more important than

DISCUSSION

who does them. If the consultant is nominated Engineer in the contracts and also acts as Project Manager, he would expect financial reward for undertaking the latter.

Mr Paterson

I am grateful that the discussion on this modest paper does not appear to oppose the suggestions made regarding the role of the Engineer but centres on the techniques and on the lack of recorded cases which only more acceptance of practice will rectify.

67. The continued use of bar charts is recommended and is not likely to disappear (or develop) in the future. Bar charts have the simple merit of being easily understood. They also have the demerits of being incapable of separating sequence and duration, and therefore do not show plainly the available duration (or float time). They also require a person to remember the relationships and this is possible only to a limited extent. Bar charts are still very adequate for submission with tenders or where other abstracts are required.

68. My use of the term 'immutable' has been cavilled at but it cannot be disregarded. In semantics 'immutable' is admittedly a thoroughly absolute word. Similarly in law the performance of a contract is immutable although the means are rarely so.

69. In practice it is well known that unless the date of commencement is immutable the Employer loses money. Then there is the programme date, which is a condition of contract, being jeopardized because it is dependent on the uncertain duration of an activity of creative thinking such as the architectural treatment. In these cases two different scales of realism apply, one of which remains immutable and leaves the project manager little discretion.

70. Little is written on completed projects, successful or otherwise, possibly because the Engineer is too frequently involved at the end in the time-consuming duty of adjudicating on contractual claims, which is surely the least rewarding of jobs, delaying him from moving on to the next project. An exception is the impartial review of 50 completed contracts carried out for Sir Kenneth Woods' Report to the National Economic Development².

71. Yet judging from the reception of the Wood Report at a recent conference at Glasgow, attitudes still remain paternal. Few of the delegates appeared to want to accept any of the new teachings arising from these case studies.

72. In the present stringent economic conditions while the needs for controls and budget/cost monitoring are so great, it will remain difficult for the Engineer to develop his management techniques and improve the state of their practice. Even current costs of cost monitoring are not insignificant. Nevertheless he should make the effort and begin perhaps by analysing the cost of delays, the budgeting for contingencies and perhaps the documentation of variations, and so proceed towards drafting the needed code of practice on project management.

References

1. WEARNE S. H. *Control of engineering projects*. Edward Arnold Ltd, London, 1975.
2. NATIONAL ECONOMIC DEVELOPMENT OFFICE. *The public client and the construction industries*. EDC for Building and Civil Engineering. NEDO, 1975. See also NEDO reports for 1964 and 1968.
3. MIDDLETON C. J. How to set up a project organization. *Harvard Bus. Rev.*, 1967, **45**, March-April, 73-82.
4. SCHOOL OF TECHNOLOGICAL MANAGEMENT. *Management of an urgent public works project*. Report TM4, School of Technological Management, University of Bradford, 1975.
5. SHAH R. P. Project management: cross your bridges before you come to them. *Mngmt Rev.*, 1971, **61**, Dec., 21-27.
6. AMOS W. and WORTHINGTON P. M. Multi-disciplinary project management. *Proc. Instn Civ. Engrs*, Pt 1, 1975, **58**, May, 305-308.