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*PERT/Cost in spite of the excellence of the concept has generally met with a lukewarm acceptance on the part of the very defense contractors required to use it. Is this the fault of the concept or the peculiar nature of defense-government arrangements?*

## **IS PERT/COST DEAD?**

*by Peter P. Schoderbek*

*The University of Iowa*

**O**N JUNE 1, 1962, Secretary of Defense Robert S. McNamara and Robert C. Seamans, Jr., associate director of the National Aeronautics and Space Administration (NASA), adopted the PERT/Cost system as a standard tool for planning and controlling costs and schedules in major weapons and space programs. Thus, a second

useful dimension was added to the already time-tested basic PERT system.

### ***Acceptance lukewarm***

The Army, Navy, Air Force, and NASA are now applying PERT/Cost to several multi-million-dollar research and development pro-

grams. Yet the acceptance of this technique has been relatively lukewarm, even among defense contractors, and the rest of industry has shown little interest in it.

Will PERT/Cost survive? This article attempts to throw some light on that question by means of an analysis of the system's pros and cons, with emphasis on some as-

pects of its implementation. It is assumed that the reader is generally familiar with PERT/Cost concepts and principles.<sup>1</sup> However, its key features will be reviewed briefly.

### ***What PERT/Cost is***

PERT/Cost is a technique for planning, monitoring, and controlling the cost of and progress in attaining technical performance objectives. Its basic elements include the following:

**Work Breakdown Structure** — This is the backbone of the PERT/Cost system. The work breakdown structure, defined in terms of “end items” (performance, schedule, cost), serves as the framework for integrating cost and schedule planning and as the basis for construction of the PERT network depicting the overall project; it defines the tasks to be performed and the interrelationships; and it provides for the summarization of cost and schedule status of the total project.

**Work Packages** — A package is simply a specific task to be performed, e.g., engineering, manufac-

turing, testing. End items in the work breakdown structure are divided and subdivided into progressively smaller units until a manageable working level for planning and control purposes is achieved. The end item subdivisions appearing at the last level in the work breakdown structure are work packages. The work package is the basic unit for the assignment of schedule and cost responsibility to first-level supervision.

**Account Code Structure**—An account code structure allocates number of codes for work packages and summary items to permit the summation of schedule and cost information by product item, responsible organizational unit, manpower skill, and time period. In this way costs can be identified and accumulated both horizontally and vertically.

**Networks**—The PERT/Cost networks, as in basic PERT, portray the activities and events necessary to achieve the project objectives. All activities on the network are related to specific work packages.

**Reports** — Standard reports are provided for as well as ones tailored to meet the specific needs of the entire management spectrum ranging from first-line supervision to top management. These reports are problem-oriented in that they highlight deviations from the plan.

### ***Benefits***

Unquestionably, PERT/Cost has many benefits. It greatly facilitates the assessment of project status with respect to financial planning; it highlights time-cost interrelationships and the financial effects on the project of alternative allocations of resources and possible changes in scheduling; it permits evaluation of progress from multiple information sources; it provides a unitary set of reports for appraising both the financial and the physical status of a project.

PERT/Cost also contributes to better conceptual planning by financially quantifying the project tasks to be performed and by as-

***PERT/Cost is a technique for planning and monitoring and controlling the cost and progress in attaining technical performance objectives.***

<sup>1</sup> PERT (Program Evaluation and Review Technique) was explained in an earlier issue of MANAGEMENT SERVICES (January-February '66, p. 30). Its extension, PERT/Cost, was described in detail in an article by Don T. DeCoster (“PERT/Cost — The Challenge, May-June '64, p. 13) and evaluated in an article by this author (“PERT/Cost: Its Values and Limitations” by Peter P. Schoderbek, January-February '66, p. 29). Other helpful references include the following: *The Control of Schedules and Costs in Major Weapon and Space Programs*, U.S. Army Management Engineering Training Agency, Rock Island, Illinois; *PERT/Cost Manual*, General Dynamics Corporation, Pomona, California, June 15, 1963; *PERT, PERT/Cost and Line of Balance*, National Security Industrial Association, Washington, D.C., April 1, 1964; *Network-Based Management Systems* by Russell D. Archibald and Richard L. Villoria, John Wiley and Sons, Inc., New York, 1967; and *Implementation of PERT/Cost* by Richard E. Matthews, Management Systems Corporation, Cambridge, Massachusetts.

sessing the adequacy of funding requirements for meeting total project costs. It provides a framework for comparing time schedules and resource estimates of various contractors.

By integrating PERT/Time with PERT/Cost, one can determine whether the various-level managers are meeting their schedule commitments, the cost estimates, and the technical performance standards and, if not, decide how resources can be best recombined so as to minimize costs.

In measuring the progress of a specific project, the sum of actual costs to date can be compared directly with the funds authorized and the estimated cost of completion of the project. Such comparisons will reveal potential cost overruns and under-runs and will pinpoint those work segments requiring cost control action.

### Problems

In spite of these impressive advantages of PERT/Cost, the technique has generally had rough going in defense companies. Some of the problems that have arisen are, no doubt, inherent in the system itself, but others have been created by factors peculiar to the defense companies. At any rate, they jeopardize the technique's effectiveness and erect barriers to the realization of its full potential.

### Lack of contractor support

PERT/Cost was met with less than enthusiastic acceptance on the part of major contractors as well as small subcontractors. Principally the reasons are twofold: (1) a reluctance by contractors to divulge internal cost data, and (2) the lack of a profit incentive to use PERT/Cost.

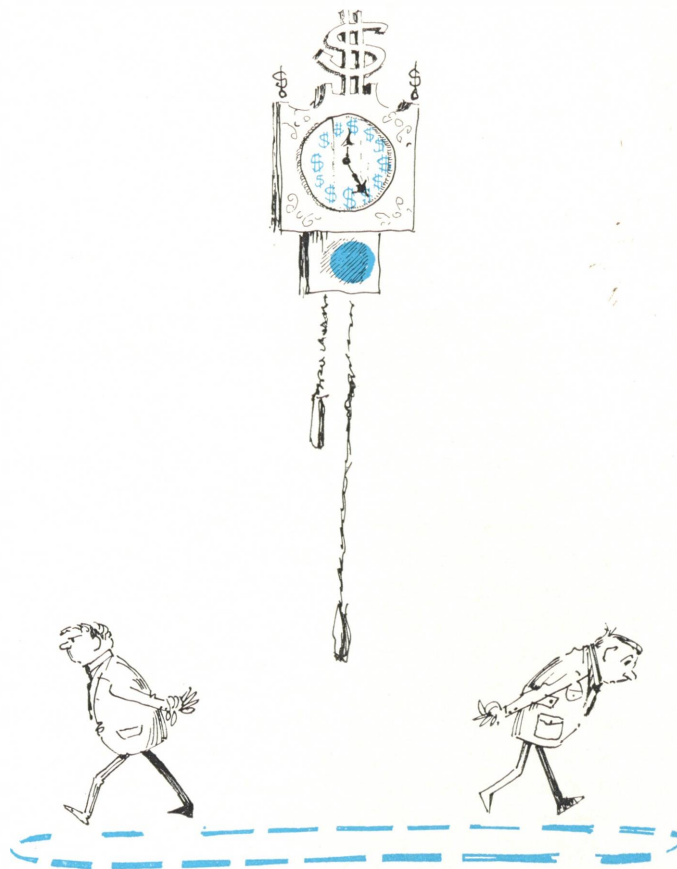
There is great reluctance on the part of contractors and subcontractors to reveal internal cost data to outsiders, not because the data are sacred in themselves but because they may provide a measure of efficiency as compared to competi-

tors. Traditionally only top management was endowed with the privilege or responsibility of managing this information. To disclose such information to government officials or to prime contractors is alien to hallowed business principles. Subcontractors are especially reluctant to divulge cost information to prime contractors, falling back on the "confidential" company policy label. Prime contractors, on the other hand, sympathize with this attitude, knowing full well that these subcontractors may be and often are prime contractors on other projects. The situation may be reversed, and the primes will be in the same position, i.e., subcontractors that will have to reveal their own cost structure.

One of the present areas of disagreement about the revealing of cost data is the required level of

disclosure. The government, to ensure efficient use of its funds, desires detailed information down to the work package level; industry, on the other hand, feels that cost summarizations down to the fifth floor level should be sufficient and that any details beyond this would represent an unnecessary expenditure of effort with but marginal utility. Both positions are understandable, legitimate, and incompatible.

In a way, industry has asked for much of its troubles by operating under cost-plus contracts where the rule rather than the exception was to understate proposal costs. In cost-plus contracts there is no penalty for underestimation of costs. Thus, contractors tended to understate costs in order to win contracts and then exerted little effort to control costs, knowing full well that



PERT/Cost highlights the relationship between time and cost.



Subcontractors are especially reluctant to reveal cost data and prime contractors are sympathetic, since they may be tomorrow's subcontractors.

they would later have the opportunity to increase the dollar value of the contract at renegotiation time. R & D contracts are typically written for a year at a time, and the work to be performed is defined in a general tasks form extending over a several-year effort. When new one-year contracts are written, tasks not completed in the previous year are included among the new tasks. Thus, it is rarely easy to relate costs incurred to progress achieved. The project manager is frequently not in a position to see the difference between the actual costs and the original estimates until the project is well under way or near completion. Then it is too late to do anything other than find the money to complete the project at the higher cost or cancel the project.

Contractors have little incentive to make the PERT/Cost system ef-

fective since it means fewer dollars in their pockets in addition to extensive government control over their financing. The fulfillment of the stated objectives of PERT/Cost makes it more difficult for contractors to conceal anticipated cost over-runs and schedule slippages; previously these over-runs could be masked until the government was so deeply committed that the only realistic alternative was to grant the money.

### **Over-reporting**

One of the most common weaknesses of PERT/Cost is the over-reporting of data. The PERT/Cost system is capable of producing reports at any desired level of detail, from the activity report at the detailed network level to the management summary report for the entire system. Although the DOD PERT Coordinating Group (now defunct) had specified the requisite formal reports, the particular level of detail varies with each of the project management levels.

Because of the computer's capabilities, there is a strong temptation to generate a vast number of reports that management neither needs nor utilizes. This increase in the quantity of data generated does not necessarily lead to better-informed decisions. The very redundancy of inputs, and more often of outputs, can in fact reduce the manager's effectiveness. A great

deal of the useless information flowing across the manager's desk reaches him only because it is standard practice or because of a misinformed directive. It is not uncommon for some managers to operate under the erroneous assumption that the more data available the better must be the decision reached. But even the continuous updating of information will not of itself lead to better decisions. What is needed is a clear understanding of the type of information actually required by the decision maker at his own level. It should be fairly obvious that even now information must still be carefully filtered at the various levels just as was the case a decade ago when computers were first coming into use in the business world.

### **Data problem**

It is a common misconception that in the PERT/Cost system summarization of data is all that is required to manage the many parts of the program. While this summarization may be adequate for the collection of cost figures, it is often inadequate in terms of relevance for decision making, for evaluating alternative strategies, and for assessing future changes in the entire system. Too often PERT/Cost is expected to replace internal control systems or, for that matter, the accounting system. It does neither; it is not an account-



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out the United States and has appeared on numerous executive development programs. He is a member of the Academy of Management and the American Economic Association. Dr. Schoderbek formerly served on the faculties of Michigan State University and the University of Michigan.

ing system in the true sense of the word, nor does it replace conventional control systems. Its chief effect is to supplement the firm's internal operating practices.

The information needed by managers at the various levels of a project is not a simple summarization of costs but a penetrating analysis of the technological state of an element of the program or a functional grouping of relevant data. Because summarization reduces or eliminates data, it does not of itself provide the intensive visibility for micromanagement.

### **Suitability of reports**

Much has been written about how easy it is to adapt PERT/Cost to a firm's accounting structure. This simply is not generally true.

Although many large contractors have accounting system which allow for the collection of costs by contracts, end items, functional cost categories, etc., most systems do not fit PERT's data needs. Current accounting systems for the estimation of manpower costs, skill classifications, time/cost tradeoffs, and optimum schedules are still generally inadequate for compliance with the requisite PERT/Cost reports. Most current accounting systems were developed to accommodate the needs of contractors and are related to the firm's particular products, methods of production,

Schoderbek, Is PERT/Cost Dead? internal structure, and the like. In fact, it has been strongly recommended by the accounting profession that different treatments be mandatory in different business situations.

Thus, any attempt to apply uniform regulations in regard to PERT/Cost reporting is inimical to sound project management. This is not to imply that industry would or should be given free rein in its reporting procedures but rather that the PERT/Cost system should provide for flexibility by taking account of the notable differences between organizations with various product mixes and organizational structures.

### **Variations must be accepted**

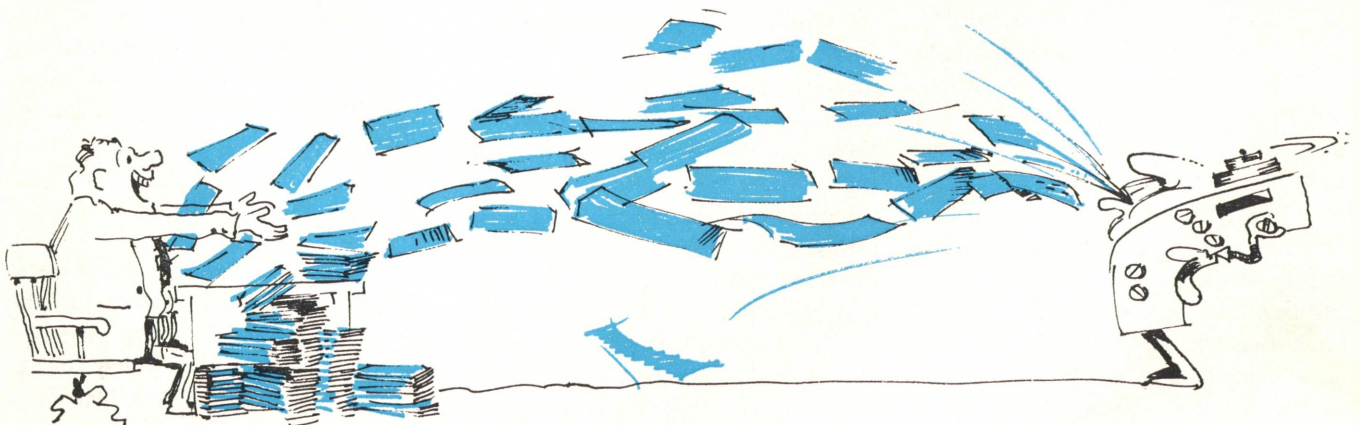
Firms should not be coerced to adapt their internal accounting systems simply to comply with regulations. Rather, the variations in company practice should be accepted in the initial stages of involvement. The attempt to apply uniform procedures to all firms would vitiate the PERT/Cost concept. Entirely new thinking is required to adapt PERT/Cost into operating reality in terms of budgeting, scheduling, reporting, valuing, and controlling. Only the passage of time and accumulation of more experience will permit the development of a truly compatible system.

One widely touted advantage of PERT/Cost is its timely and accurate reporting. However, careful scrutiny leads one to question whether it is fast enough to be useful or accurate enough to be reliable.

### **Timeliness of reports**

It is relatively easy to gather historical costs; it is much more difficult to estimate the costs of physical progress for work packages in various stages of completion. The rule of thumb—that the value of work performed to date is to be measured by the actual costs, divided by the latest estimate to complete, times the budget to date—is not an accurate guide for evaluation, especially when progress is not on target or when the "approved interim changes" that have been made are not reflected in a new contract value. In the latter case, the value of work performed would be much less than the actual amount spent. The fact that this formula has already been subjected to much adverse criticism in the literature indicates that a complete re-evaluation of its usefulness ought to be undertaken.

For the sake of timeliness, contractors and subcontractors are often required to submit "estimated actuals" for the preceding month's work. This procedure could conceivably be worthwhile if the



Many managers operate under the erroneous assumption that the more data that crosses their desks, the better must their decisions be.



Estimators often "play it safe"—pad their estimate so their final figures are bound to look excellent.

prime contractors and their subcontractors used the same accounting cut-off dates. Seldom is this the case, and the result is a proliferation of dates on which information becomes available. This practice coerces the use of "estimated actuals" by subcontractors, which typically provide less accurate data. Realistically, most contractors can only supply their cost information to the next tier in about fifteen working days after the cut-off date. Consolidation, analysis, and evaluation by management may take another seven or eight working days. When several tiers of major subcontractors are involved, it may take up to a month to present the desired information. By requiring early monthly reporting of estimates to complete just for the sake of timeliness, PERT/Cost may be responsible for the accumulation of data that are close to two months old and, more important, have little accuracy and even less timeliness.

Under the PERT/Cost system,

work packages in progress are required to be updated at least once a month, at which time new time and cost estimates to complete are made. The summarization of cost data at the various levels is supposed to provide top management with the needed visibility to control the project. In practice, this updating works fairly well, although a few problems do occur. One not unusual difficulty experienced is the revision of estimates to complete for tasks extending far into the future. Obviously, estimates to complete for tasks with a time duration of only one, two, or three months are much more meaningful than ones involving nine or ten months. Actually, submission of estimates to complete work of a long duration should not occur too frequently. The DOD and NASA Guides to PERT/Cost clearly specify that the lowest work package should not exceed \$100,000 in cost and three months in elapsed time. However, many work packages require more than 90 days simply

because the activity involved does not have a recognizable event within that time span.

### **Frequency of updating**

Another complication experienced in the updating of estimates is their frequency. Little is to be gained by continually re-estimating work packages on a monthly basis unless trouble is being experienced or it is desired to manage a program element by exception. Re-estimation done in a mechanical fashion is neither economical nor practical, especially when carried out in areas where costs are not currently affecting overall performance. In fact, the adulteration of critical data with routine data tends to diminish the effectiveness of the "management by exception" reporting capability inherent in the PERT/Cost system.

### **Invalid estimating and allocation**

An earlier article by this writer<sup>2</sup> pointed out that the effectiveness of the PERT/Cost system (and for that matter any scheduling and budgeting system) depends upon the validity of the information fed into the system. Too frequently time estimating is done by personnel who are not thoroughly familiar with or responsible for the tasks to be accomplished. Even when the estimator is experienced, he is often unable to apply this experience if there is not a clear item definition in the work breakdown stage or clear identification of work packages. Consequently, time estimates and estimated dates of completion can often be less than realistic.

### **'Playing it safe'**

Frequently there is also a desire on the part of estimators to "play it safe." More than one engineer has confided to this writer that he attempts to deviate very little from

<sup>2</sup> See Schoderbek, *op. cit.*

## Reporting based on misleading . . . premises is likely to prove . . . erroneous.

his ("padded") estimates because of fear of reprisal. One engineer put it this way, "I got chewed out something terrible when I missed my estimate by 40 per cent, and I can guarantee you that I won't miss another one." Many department heads are aware of the resulting duplicity and try to take appropriate remedial action. In one instance, the department head cut down an estimate that he considered out of line. When the engineer was asked in confidence what he thought of the fact that his estimate had been cut from 27 weeks to 20 weeks, he replied, "I kinda expected that, so I built up my estimate in the first place. This job should actually only take about 18 weeks, which still gives me about two weeks to play around with."

So long as the above attitude prevails, PERT and PERT/Cost will definitely not realize their full potential. It is unfortunate that this posture is still present in many companies today.

### Department heads guilty, too

In the same vein, department heads do not want to incur cost over-runs that reflect adversely on their performance, and, as a result, they too are tempted to pad estimates in an effort to compensate for possible errors in time estimates.

### Budget manipulations

In many work packages that are of long duration there is frequent budget adjustment to eliminate over-runs or under-runs although the scope of the work to be performed has not changed. In an effort to stay within allotted budgets, the reporting of labor classifications for work packages is likely to be manipulated. For example,

suppose that a manager in an engineering department has one work package in which he expects to have an under-run and another in which he will experience an over-run. One can be reasonably sure that a tradeoff of resources will occur that will not show up in any reporting system. After all, the department head is often indifferent as to which accounts these costs are charged to so long as he stays within his own overall budget.

### Misleading assumptions

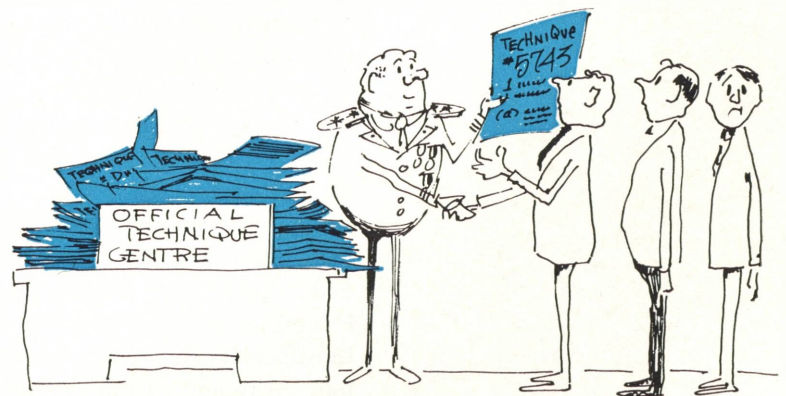
Similarly, there may exist budget pools from which allocations are made to conform with the work effort regardless of the precalculated costs. Too often PERT/Cost reports are constructed simply by taking the elapsed time that an activity consumes and multiplying this by the number of personnel in the department to arrive at a payroll cost. Too often this does not reflect the true man-hours required to perform the work packages. In some instances there may even be use of a composite rate that does not differentiate skill or salary

ranges. Obviously such reporting based on misleading or at best dubious premises is likely to prove misleading—and often highly erroneous.

Because of the complexity of internal structures of firms, especially in the R and D field, it is extremely difficult, if not impossible, to assess on a uniform basis the cost of installing and operating PERT/Cost. Much of the present effort in this respect has resulted in duplicative measures, and the substantial cost of the system is primarily an additive cost for most firms, i.e., firms operate with their traditional reporting systems and then adapt the data for PERT/Cost reporting. This is not too dissimilar to what occurred in the early days of PERT, where in a few instances PERT was actually applied *post factum*.

### History in action

Some progress, however, has been made. The cost of PERT/Cost can be broken down into two segments: (1) the initial cost of installation, which would be a one-



All too often, PERT/Cost was adopted through sheer expediency; the DOD insisted on it.



cost, which would be the cost of maintaining the PERT/Cost system less the cost of the traditional accounting system of the firm.

In principle, this sounds quite convincing; in practice, PERT/Cost has been rather expensive. Actual data from test cases have not provided the necessary spectrum of costs at various levels of contractor responsibility. It is highly doubtful whether an accurate cost differential between the firm's conventional accounting system and PERT/Cost can ever be obtained. Other sensitive questions can also be raised, e.g., are implementation costs to be charged only to the project in question; are they to be treated as a fixed overhead; or are they to be pro-rated and applied to later projects also?

#### **Experience with PERT/Cost**

Although PERT/Cost has been operational for about five years, actual experience with it has been somewhat limited. In the three major test cases it has been a qualified success.

The Mauler Weapon System can be cited as one of the most successful applications of the concept (although the project was terminated after expenditures of \$300 million because of technical problems). In this case the Army controlled the time and cost elements of the project but could not adequately control the technical performance aspect. In fact, the application of the PERT/Cost technique did highlight the technical difficulties. The cost of using PERT/Cost on the Mauler project was not insignificant although the actual figures are still unavailable.

The controversial F-111 (TFX) also employs PERT/Cost. However, this project exhibits many of the problems often encountered in the operational aspects of the system. Although from a technical standpoint this project cannot fail by edict of the Secretary of Defense, cost over-runs in the magnitude of two billion dollars are cur-

rently expected. It would be a truism to state that adequate cost control measures are lacking in this instance. The Navy is also testing the PERT/Cost concept with its missile SUBROC (W 30-A), but little external information is available about the results.

It is well known that many available management techniques are accepted only because of some dictate or sheer expediency rather than because of their true value. Such was the case with PERT, which has taken close to a decade to become fully accepted on its own merits. DOD obviously hastened its acceptance in the defense industry.

Much of the impetus for the acceptance of PERT/Cost was provided by Thomas Morris, who several years ago was the Assistant Secretary of Defense for Installations and Logistics. When he resigned to accept a position in industry, his replacement, Paul Ignatius, allowed PERT/Cost to remain offstage, and little was done to prove or sell this technique to defense companies. With the death of the Secretary of the Navy, John McNaughton, Mr. Ignatius was appointed to fill this position. Mr. Morris, who meanwhile had accepted the position of Assistant Secretary of Defense for Manpower, was reappointed to his old position. Thus, while PERT/Cost has lain somewhat dormant for several years, its revival can soon be reasonably expected.

#### **The future**

Is PERT/Cost dead? Hardly! Even without the impetus supplied by the government it has sufficient momentum to go it alone. Despite its limitations, there is little reason to doubt that PERT/Cost has added a new and worthwhile dimension to the field of operational control. As the technique matures through more imaginative use and guided experimentation, the refinements that are bound to result will bring management within close range of its desired goal.

***Although the controversial F-111 (TFX), which also employs PERT/Cost, cannot fail from a technical standpoint by edict of the Secretary of Defense, cost over-runs in the magnitude of two billion dollars are expected.***