PERT AND ITS USE AT THE NAVAL TRAINING DEVICE CENTER

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During the past two years, under joint sponsorship with the Small Business Administration, the Center has conducted a number of PERT seminars and workshops for executives from industry. These sessions covered both the mechanics and the management implications of PERT. As a basis for today's short presentation, I have selected the management questions most often asked during these sessions.

First: Why PERT? What's wrong with other methods that have been used over the years for project control? The fact is that PERT has achieved more attention and wider use than all the previous methods combined. Why? Before we attempt to answer that question, let's take a moment to define PERT. As most of you know P E R T stands for Program Evaluation and Review Technique. Of the various definitions of PERT the following three appear to me to cover its major characteristics.

a. PERT is a management control tool for defining, interpreting and interrelating what must be done to accomplish program objectives on time.

b. PERT is a statistical technique, diagnostic and prognostic, for quantifying knowledge about the uncertanties faced incompleting activities essential for timely achievement of program deadlines.

c. PERT is a technique for focusing management attention on danger signals that require remedial decisions, and in areas of effort for which "trade-offs" in time, resources, or technical performance might improve the capacity to meet major deadlines.

Now back to the question: Why PERT? It is impossible for the human mind to comprehend all the interrelations and problems even in smaller projects without some systematic approach. Over the past fifty years there have developed a number of approaches, based on graphic representations, showing the important features of a project, concisely, in one diagram. This is analogous to preparing an electrical wiring diagram to describe a complex circuit. But before PERT, the techniques treated all activities in a project in the same way, giving the same effort and attention to every activity. Thus a decision to speed up a project meant that every task was accelerated rather than the few that would have resulted in the desired outcome. This, of course, meant more time and higher costs than were really necessary.

PERT, on the other hand, points out the critical activities in a project and here lies its major difference and advantage. Basically a PERT chart is a network diagram showing the interrelationships among the various events leading to the attainment of a goal, plus the activities that result in these events. The critical path of the network, i. e., the path of greatest time duration, determines the time required to complete it. Any delay in the completion of activities leading to these events will delay completion of the project. On the other hand, paths shorter in time than the critical path - slack paths - might have resources which could be transferred to the critical activities to shorten the critical path and thus shorten the time for completion of the entire project. The critical path may shift from time to time, but by keeping your eye mainly on the activities along this path, you can maintain control of your project.

WHAT ARE THE LIMITATIONS OF PERT?

Next, what are the limitiations of PERT? The basic limitation is that the output can be no better than the input. PERT cannot be used as a substitute for good

management judgment. Management attention to varying parts of a project is necessary with or without PERT. Too many people expect PERT to be a panacea.

When PERT was first introduced into the Center, we noted two opposite attitudes regarding its acceptance. On the one hand, we had the usual negative reaction when anything new is introduced. A typical comment was: "What, with all the problems I have, now they are introducing another burden to add to my work. Give me a broom and I will sweep the floor too!" Now, this is a wrong attitude which we can all recognize, and I'm glad to say that at the Center, after a series of training courses, most of our personnel have come to realize that PERT, rather than being a burden, can be of substantial help---when properly applied. PERT forces detailed planning. Many activities formerly thought of as sequential become amenable to paralleling. The logical and systematic thought processes required in the construction of the PERT network inevitably deepen understanding of a project and the work to be performed. In fact, most of the project engineers, regardless of initial opposition, were willing to admit that the forced detailed planning required by PERT had given them a better view of their projects than they ever had before.

On the other extreme, we had some individuals become over-enthusiastic without understanding, or wanting to understand, that some work was required on their part. They would say: "This is just what I've been looking for. Now I will be able to concentrate on technical problems and PERT will take care of all the scheduling problems for me." PERT, by itself, does nothing of the kind. How much you get out of PERT depends on what you put into it. How good are your estimates? Do you keep your data up to date? etc. In other words, PERT does not manage for you, but it is a tool, and a pretty effective tool, to help you manage.

HOW LARGE SHOULD A NETWORK BE?

Another question often asked is: "How large should a network be?" Let me lead into this one by telling you of an incident that occurred when we were considering the introduction of PERT as a general approach to project control at the Center. One individual I spoke to wanted me to know that PERT was nothing new to him. He had had a project for some time in connection with which he was receiving PERT charts. Thereupon, he lifted a large bundle and proudly rolled out a PERT chart clear across the room. He received such updated charts, monthly. After a short discussion, it was evident that, with all his other work, this individual did not have the time to make even a dent into those charts or the variety of accompanying reports. I consider that receiving information in this form is worse than receiving no information at all, for at least, with no information, you know that the project is not being monitored whereas in the case under discussion the impression was that the project was under control.

Now back to the question: "How large should a PERT network be?" From the customer's point of view the network submitted should be limited to a size that makes possible adequate review in the time available. The contractor, however, may find it useful, in addition, to prepare more detailed networks for his own use. The phrase "management PERT network" is sometimes used to distinguish the former from the more detailed working networks.

PERT AND THE COMPUTER

Questions are often asked relating to the use of a computer, with most individuals assuming that a computer is essential in PERT. Over the past two decades the computer has become the shining symbol of quantitative analysis and we all know of its fantastic accomplishments. But along with this advancement it was inevitable that in some instances computers have become management status symbols, sometimes misused, and often overused. This has resulted in a few cases of original picturesque terms like "electronic messiah", "miracle machine", and "giant brain", giving way to equally picturesque, but not so complimentary terms, like "electronic garbage", "report strangulation" and "datarrhea".

As I said, as far as PERT is concerned, there has grown up in many minds a direct association of PERT with computers, and from there the conclusion that PERT is useful only on large weapon systems or complex industrial projects. The fact is that PERT can and is profitably being applied to smaller projects and in many cases the PERT computations are done manually. As a rule of thumb, projects up to 200 events can be easily handled, manually.

WITH WHAT TYPE OF PROJECTS CAN PERT BEST BE USED?

PERT was developed for application to R&D projects, and R&D remains the most significant PERT application. PERT can also be used almost as successfully with Production Prototypes and those Applied Research projects that end in a piece of hardware. It is difficult to apply PERT to Basic Research projects. Although PERT has been applied on occasion as a management control technique to Straight Production Runs, there are better methods for this purpose, for example, the Line of Balance Technique.

It may be of interest to note that PERT also has applications to a wide variety of other tasks, for instance, planning such a conference as we are holding here this week or even writing a book. As a further example, let me tell you of a personal experience. Some time ago, I was reading a book on PERT at home; the letters P E R T on the book cover attracted the attention of my wife and two daughters; and they asked me what they meant. I decided the best way to explain PERT was to demonstrate it, and, as they were preparing a meal at the time, I drew a diagram, paralleling a number of the activities such as setting the table and preparing the dessert while the roast was in the oven, and so forth. I showed them how they could have prepared the meal in a half-hour less time by this method. As a conclusion to this short story, let me say, their response, and the wounds I still carry, leads me to recommend that although PERT works, even in this area, I wouldn't advise anyone else to try it in this context.

ESTIMATING

We sometimes received the argument during our PERT sessions for industry that since it is based on estimates, PERT can't be of very much use. Now, of course, if the time estimates for the activities in a PERT network are far enough off, the results will not be meaningful; but the answer is to try to get better estimates and not to discard PERT. The fact remains that many valuable results, not only in such systems like PERT, but also in many other scientific endeavors are based on estimating. Also important is "evenness of effort." There is no point in one estimator calculating the time element in PERT in terms of hours for his activities, while other estimators on the same project are calculating in terms of weeks.

Many of the questions related to the use of one-time vs three-time estimates for each activity. In some areas, such as the construction industry, where time factors are comparatively well known and the major problem is the sequential integration of large number of tasks, single-time estimates are used. The three-time estimates (most likely time, optimistic time, and pessimistic time) are the basis of the calculations of the probability of project completion in specified periods of time. These probability calculations are one of the features of PERT, which was originally developed for use in R&D projects where, unlike construction projects, there is usually only limited previous experience. Today, however, one-time estimates are being used even in some R&D. The NTDC instruction on PERT permits the Center project engineer to make the determination as to whether he requires one or three-time estimates on each project.

NTDC APPROACH TO PERT

When PERT was first developed, it was considered a tool for projects over a million dollars and the Navy-wide specification on PERT was prepared with this in mind. At the Center comparatively few of our projects are over a million dollars, but our Technical Director saw PERT as an equally effective tool for smaller projects. However, it was necessary to develop a streamlined approach. We feel we have accomplished this

and have issued a requirements bulletin on PERT/TIME Management Information System for Planning and Control. The basic mechanics of PERT remain the same, but by controlling the size of the network and limiting the monthly reports to a single form, we believe we have obtained most of the benefits of PERT/TIME with a simplified reporting system that is certainly more effective, and perhaps even simpler than previous non-PERT reporting systems.

Besides preparing the PERT requirements bulletin, we have also conducted workshops in PERT for practically all the technical personnel in the Center and periodically hold additional sessions for new personnel. Our work in this area attracted the attention of the Small Business Administration, and as I stated at the outset, we have also conducted seminars and workshops for approximately 200 scientific, engineering, and management executives from industry.

NTDC PERT REQUIREMENTS

To round out the picture, at this time, I would like to give some key points from the simplified NTDC PERT requirements.

1. The NTDC PERT Requirements were designed to cover tasks up to $1,000,000. Projects over $1,000,000 may require more elaborate treatment and are handled individually.

2. The Project Engineer furnishes the following information for the Contract Schedule:

   a. Whether single or three-time estimates shall be used.

   b. The maximum and minimum number of events to be included in the network.

   c. A list of those events which the Project Engineer considers essential in any PERT network that might be developed and a statement to the effect that the PERT network shall include but not be limited to these events.

3. It is not considered that PERT is applicable to every project. Therefore, where a Project Engineer believes that individual circumstances in a particular project do not make it practical to use it, PERT may be omitted with the approval of the appropriate supervisor.

4. The NTDC requirements call for:

   a. The submission of a PERT network with the proposal.

   b. The adjustment of the PERT network to reflect mutually agreed on events, activities and time elements to assure that the method of accomplishing the work as displayed thereon is in conformance with the overall plan and that the entire project or program is broken into manageable segments that will permit realistic progress analysis. This network will serve as the first network for management and control of the project.

   c. A PERT event report, usually, to be submitted monthly.

   d. Updating of the PERT network, usually quarterly.

In conclusion, let me warn you about the occasional individual who gets so enamored by the logic of PERT, that it becomes an end in itself. He forgets that the purpose of PERT is to see that the hardware gets done on time. In fact, in some cases, he even tries to get the hardware changed to fit the PERT chart. We call such an individual a PERTNICK. If you have one in your organization, reorient him quickly, or give him a new job.