THE ROLE OF QUANTITATIVE ANALYSIS AND THE COMPUTER IN PROGRAM BUDGETING

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Program Budgeting, or the Planning-Programming-Budgeting System, is sometimes described in terms that picture a host of mathematical models, millions of algebraic equations, and numerous computers grinding out cost-effectiveness calculations and related computer products. For many of you, if you are at all like budget officers in the federal, state, and local government context, this is a picture to be viewed with dismay and perhaps alarm. One reason for this, is that something over a third of you completed your education before World War II and another third in the years between 1940 and 1950, when mathematics, econometrics, operations research, computers, and mathematical modelling had not had their present impact on courses in economics, business administration, and public administration. As a result, when presented with a way of doing things that involves new techniques and modern technology, there may be a tendency either to throw up one's hands in alarm or to just dismiss the idea as not worth serious consideration.

On that premise let me start by saying that in program budgeting there is an emphasis on quantitative analysis, and the development of computers has made it possible to handle large quantities of data. In addition, PPBS studies may make use of techniques like symbolic logic, war gaming, queuing theory, and mathematical modelling. Complete understanding and ability to apply these techniques require extensive training

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and study. However, "complete understanding and ability to apply" are not required of you as state budget officers or of the state decision-makers for whom you work. All that is needed for persons in these capacities is a determination that the application of such tools is appropriate to the kind of study to be made.

When applied properly these techniques can be expected to provide new insights and to extend our understanding of many problems. Neither you nor the decisionmaker needs to be able to do mathematical manipulations, develop mathematical models, or write the programs required to feed data into a computer. You can obtain the advantages that these tools make available by employing experts in these specialties. All that you want is to be sure that the results of the studies and analyses are delivered in a form which is understandable to you.

You are all familiar with the need to make assumptions in dealing with complex problems where the outcomes are highly uncertain. I think we all have had the experience of learning that the use of assumptions is appropriate provided that they are clearly stated and we can identify their importance to the results. When we quarrel with the assumptions, unless satisfactory explanations can be obtained, we reject the results. So also with quantitative methods and computers. They should be applied and used only when appropriate to the problem regardless of how fancy the algebra or impressive the computer runs appear to be.

Using quantitative methods does not necessarily make a product good. On the other hand, the use of a mathematical model and a computer run does not necessarily make it bad. What is required is that the model builder, mathematician, statistician, or computer specialist tell you and others involved in the decision process just what the quantitative technique is intended to do and what its use means when applied to the situation being examined.

In short, PPB is not just a mathematical or computer operation. Computers can be helpful from time to time and they give us a capacity and capability that we could never have anticipated if it had not been for the development of this extraordinary tool. However, let us not impute to either the computer or mathematical and statistical techniques the essence of program budgeting.

PPB is not decisionmaking by computer. Decisions will continue to come as they should from the political process in which social and economic change leads to conditions in which value judgments will always be as important as quantitative methods. Systems analysis is not an esoteric process dominated by econometricians and mathematicians preoccupied with running "out-of-this-world" models through high capacity computers. Economists, statisticians, and mathematicians do make significant contributions to systems studies; but engineers, physicists, political scientists, sociologists, and politicians are also major contributors, depending on the nature of the problem under examination.

Quantitative analyses are made, but that does not mean that numbers can or should be assigned to every part of the problem. Computers are used but their role is largely to facilitate computation, especially when large numbers of alternatives must be examined or when it is necessary to test the sensitivity of final results to the values that can be assigned to key inputs.

My colleague Gene Fisher has stated it well in a recent Paper:*

> Contrary to what some of the more enthusiastic advocates of quantitative analysis may think, systems analysis should be visualized as playing a somewhat modest, though very significant, role in the overall decisionmaking process. In reality, most major long-range planning decision problems must ultimately be resolved primarily on the basis of intuition and judgment. I suggest that the main role of analysis should be to try to <u>sharpen</u> this intuition and judgment through the more precise statement of problems, the discovery and outlining of alternatives, making comparisons among alternatives, and the like. In practically no case should it be assumed that the results of the analysis will 'make' the decision. The really critical problems are too difficult, and there are too many intangible (e.g., political, psychological, and sociological) considerations that cannot be taken fully into account in the analytical process, especially in a quantitative sense. In sum, the analytical process should be directed toward assisting the decisionmaker in such a way that his intuition and judgment are better than they would be without the results of the analysis. And in many instances a small amount of sharpening of intuition and judgment can have a high payoff.

The Assistant Secretary of Defense, Systems Analysis, said much the same thing several years ago in a national weekly magazine:

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*G. H. Fisher, <u>Some Comments on Systems Analysis</u>, The RAND Corporation, P-3677, September 1967, p. 4.

> Ultimately all policies are made ... on the basis of judgments. There is no other way, and there never will be. The question is whether those judgments have to be made in the fog of inadequate and inaccurate data, unclear and undefined issues, and a welter of conflicting personal opinions, or whether they can be made on the basis of adequate, reliable information, relevant experience, and clearly drawn issues. In the end, analysis is but an aid to judgment .... Judgment is supreme.*

In short, by systematic analysis (in which quantitative methods and the computer are important tools) we facilitate the policy debate by making more clear the objectives, the assumptions, and the facts. Let me emphasize this further by saying that, although the computers are very helpful, the thinking obviously cannot be done either by machines or machine-like analysts.

Most problems of public importance are not susceptible to solution simply by introducing highly abstract mathematical or economic techniques. The quantitative methodologies can contribute to solutions of important parts of the problem but, at the present level of the state of the art, there is no likelihood that they can deal with the totality of the major and most critical problems.

Actually, the objectives of PPBS were achieved in companies like Dupont and General Motors and in the federal government (the Controlled Materials Plan used by the War Production Board in World War II) without the sophisticated mathematical methods and computer technology that we have available to us today. The concept of systems analysis was developed by engineering firms and in institutions like Bell Laboratories long before 1950. So there is nothing inherent in the concepts or the methodology which make the new advanced techniques and the computer all that important.

What the improved mathematics and statistics and computers do is to provide us with greater capacity than was available before 1950. Since the name of the game in program budgeting is "alternatives," quantitative methods and computers enable us to treat of a much greater

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*A. C. Enthoven, quotation contained in an article in Business Week, November 13, 1965, p. 189.

range and variety of possibilities. In the past, although we could have written all of the scenarios that we can think of today, it would have been an exercise in futility because of the physical impossibility of treating more than a small fraction of them with the methodology and calculating devices that were then available to us.

To be sure, we managed to do some heroic things in analysis before the computer and its master, the mathematical model, were developed in present-day form. But what required a truly Herculean effort a decade or more ago, has become almost child's play today.

Let me cite from some of our experience at RAND. In 1956, to calculate the resource implications of a United States Air Force total force structure, 60 man-weeks of very arduous and intensive work were required. And this total effort just could not be accomplished in a time span of less than three to six weeks, no matter how much priority was placed on the task. Today, with our models and related computer programs, we can do 25 or even more total forces in two to three days, with an expenditure of five to eight man-days of effort.

Think for a moment of what this kind of an increase in capacity can mean in your ability to provide additional information on the issues confronting a decisionmaker, whether bureau head, member of a committee, or governor. If you have individuals who are skillful in the new techniques, you can overnight--or within a few days--prepare studies which will help in illuminating the difficult issues which confront the decisionmaker. This is in contrast to the very few calculations that you could have made in the same elapsed time, even using overtime, Saturdays and Sundays under the constraints imposed by the old methodology and its tools--the desk calculator, the listing adding machine, and the other pre-computer-era business machines.

Now this does not mean that the state budget officer or the decisionmakers must themselves become highly skilled in mathematics, mathematical modelling, or computer technology. It means rather that you should have a tolerant attitude towards the application of these tools, and this tolerance should be developed easily when you visualize them as tools and tools alone.

Let me repeat my opening remarks. PPB is not decisionmaking by mathematical model, mathematical and statistical techniques, or computing machines. PPB has these essential characteristics:

- o Careful specification and systematic analysis of objectives.
- o A search for the relevant alternatives and the different ways available for achieving the objectives.
- o An estimate of the total costs of each alternative--direct and indirect costs, and both initial costs and those to which the alternative commits us for future years.
- o An estimate of the effectiveness of each alternative, or of how close it comes to satisfying the objective.
- o A comparison and analysis of the alternatives, seeking that combination of alternatives that promises the greatest effectiveness, for given resources, in achieving the objectives.

Program budgeting has other and probably equally important features. But it also is not a number of things frequently imputed to it. It is not a statistical litmus paper, mechanically sorting good projects from bad. It is not a substitute for experience and judgment. It is instead a way of bringing to men of experience and judgment both a wider range of knowledge and implications, and greater detail about each of the alternatives than otherwise would be available if we did not make use of quantitative methods and computers.

It should be clear at this point that I have strong convictions about the utility of PPBS, but each of you must make his own decision about how useful it would be in the special context in which you work.

As state budget officers you are imbedded in a political process. The state must always try to serve its citizens' demands and do so in the way that will permit the revenues required for these services to be obtained through the least onerous kinds of taxes.

As conscientious state budget officers, it is worthwhile for you to explore the potentials of the program budget method for application in your state. Although you may be neither knowledgeable about nor expert in quantitative techniques and computer applications, you can find people who have these skills and who can handle that part of the

task. The important issue is to find out whether program budgeting can in fact help your state develop the substantive aspects of major issues in a better way. If your investigation indicates that it can, then it appears that in the interest of better government a decision to adopt program budgeting in some form is unavoidable.

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