

bombers in other ways. Calculations of this kind frequently reveal spectacular potential gains from research or development, out of all proportion to the costs of the research. And the calculations can serve a useful purpose even though they are merely first approximations, and sometimes require radical modification.¹⁷ Even where they fall far short of coming up with a specific value of a specific development, they may indicate areas of critical need where the value of any successful research is likely to be high. They can, in short, provide some guidance for the formulation of requirements for research and development — specific or general.

2. At a more detailed level, *in planning specific development projects*. Any complex development project must be undertaken in steps or stages, the later stages depending upon the results of the earlier ones. It is therefore a problem in sequential decision making. At each stage it is possible to make use of economic calculus in comparing the costs and gains from various alternative ways of proceeding. The costs in this case are the costs of the next stages of development, not the costs of procuring and operating the developed system. For example, should we try one or two or three suggested methods of making beryllium ductile? If one, which? If two, which two? An analysis of the expected costs, times, and chances of success of the three methods may help in making a rational decision. Also, this analytical process may result in designing new tests of components and new sequences of "breadboard" models to be considered.

AN EXAMPLE FROM CHAPTER 8

Explicit quantitative analysis has been used most frequently for the first of these purposes — to provide some clue to the value or utility of a development project. *If* the development is successful, how much would it be worth to us? This usually involves comparing the cost of attaining some desired capability by procuring and operating the newly developed hardware with the cost of attaining it by some alternative program — for instance, by procuring and operating hardware already developed. If the difference in cost is large in relation to the estimated cost of development, a case exists for a detailed examination of possible development programs.

It is important to realize that this kind of quantitative analysis — the kind used to compare *procurement decisions* — while of some use in making development choices, is incomplete and inadequate as a guide to such choices. Assume that the HC-500 and HC-600 aircraft in the Chapter 8 example had not been developed, and that the question had been: Should we develop one or both; if one, which; and by what development procedures or techniques? This is a far more complicated

¹⁷ They raise all the familiar difficulties associated with criteria, uncertainty, sub-optimizing, time, and enemy reactions.