But in industry, and especially in universities, there are strong centrifugal forces to match the centripetal ones.

TOO LITTLE EMPHASIS ON EARLY STAGES OF RESEARCH AND DEVELOPMENT

It is very difficult to say whether too little or too much is being spent on military research and development as compared with the procurement and operation of forces in being. Some general considerations — the undervaluation of future outputs in government and the tendency of all bureaucracies to avoid risky ventures — would lead us to expect that too little is being spent. But there are some countervailing factors — the fascination of high performance hardware, and the very general tendency (for reasons we have examined) for the Services to be excessively confident and optimistic about the prospects of uncertain weapon system developments. On this issue of the total research and development budget no confident conclusion is possible.

It does, however, appear extremely probable that precisely the same tendencies — to undervalue distant gains and to shun projects that are risky or have no direct or obvious military payoff — have led to an excessive concentration within the research and development budget on the final stage of research and development, weapon system development, at the expense of earlier stages. Here there seem to be no countervailing tendencies of any importance. Fascination with high performance hardware reinforces the emphasis on weapon systems. So does optimism about the prospects of advanced weapon systems. It is allegedly much easier to get money from Congress for the development of impressive weapon systems with undoubted military utility if they succeed, than to get it for components with no highly specific end use in mind, or for basic or applied research that is even further from practical military applications.

But it is in research and exploratory development that spectacular advances in the state of the art are discovered; and it is there that we can afford not to stint. In most instances, we could develop weapon systems more cheaply and in less time if we placed more emphasis on the more or less independent development of critical components, and on getting them quickly to test; and, as a general rule, did not try to "marry" them in a weapon system until a set had been tested.[14] If we shifted our emphasis in this direction (from our present development practices), making a stricter separation between "inventing" and "marrying," we could probably release substantial resources for inventing.

[14] There would certainly be exceptional cases where the utility of a new advanced system and its time urgency are so great that it would be worth early matching — at high cost — to have some chance of getting the system a little sooner *if* the required inventing did proceed on schedule.