# R & D: TO FUND OR NOT TO FUND

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## ABSTRACT

The U.S. Government spends vast sums of money each year to fund the research and development of electronics for a variety of applications. Commercial enterprises also spend large sums on R & D of electronics and other areas of interest to the U.S. Government and its agencies. The government can take advantage of industrial R & D and thereby maximize the utilization of their own R & D funds.

## INTRODUCTION

In accomplishing any task, we are faced with limited resources such as: manpower, materials, time, and funds. Faced with a given task we must both conserve and make maximum use of ALL our resources. One drop of oil spilled will never be recovered. One second wasted is lost forever. The watchword everywhere should be the maximum utilization of available resources. If we are to conserve, we must not waste one drop of oil, one second of time, or one dollar of funds. As taxpayers we want the government to take less of our income for taxes. More importantly, however, we want the government to spend each dollar they do take as wisely and effectively as possible. This spending efficiency should be applied to the area of Research and Development (R & D) as well as all other areas of government spending.

## RESEARCH AND DEVELOPMENT

Before discussing the funding of R & D let us define and characterize R & D so that we have a common base from which to build.

## Definition of Research and Development

Research and Development can be defined in a number of ways. However, for our purposes I will define it as the process of finding a solution to a problem. The most difficult part of R & D is defining the problem. The professors in my freshman engineering courses (many years ago) stressed that once you had defined the problem, you had it half-solved.

## Types of Research and Development

There are three types of R & D which are pertinent to our discussion: 1. Basic Research, 2. Development and 3. Modification or redesign.

Basic research is the investigation of specific phenomena to further our understanding of the sciences, the world we live on, and the worlds around us.

Development on the other hand, is the application of known or SEMI-KNOWN Technology to solve a specific need or problem. I say SEMI-KNOWN technology because we can generally produce one of anything in the laboratory but producing one hundred or one thousand is a much more difficult task to accomplish.

Redesign or modification allows us to use a currently available off-the-shelf product to solve a new need or problem. The older product doesn't fit the solution exactly, but with a little modification it will do just great.

## SOURCES OF PRODUCTS AND TECHNOLOGY

If we were to determine how many dollars were spent each year on R & D by both the government and private industry we probably would be astonished. Each year thousands of new products are introduced into the marketplace and scores of new technological breakthroughs are realized.

Have you ever wondered how mankind manages to come up with all of these fantastic products and ideas? Both products and technologies come from three sources.

## Problems

Problems are the manifestation of needs. The customer has a specific need or problem which must be solved. Someone thinks he can fill that need and hence, the R & D process is initiated. As a result, a product is created which solves the problem or fills the need.

An example of problem solving is when our customers told us they would like to be able to have Cesium beam frequency standard performance at several locations within their plant or system. However, they could not afford to purchase a multitude of Cesium standards. As a result the 5087A Distribution Amplifier was developed, thereby filling the need and solving the customer's problem.

Solutions

Here we find the R & D Engineer, Physicist, Chemist or researcher that has discovered or developed a fantastic product or process. The question we all would ask is "Does anyone need it?" The solution, therefore, is looking for a problem to be solved. In the early days of Cesium standards it was mainly a laboratory curiosity. Later it became apparent that the Cesium standard was the solution to a number of communications and navigation problems.

Accidents

In Research and Development, the researcher is looking at technologies, processes, needs, and a myriad of other things. Someday, with a little bit of luck, he may discover something that will be useful to someone, somewhere. More than likely if he finds it, it won't be what he thought it would be, nor will it be the solution to the problem he had originally set out to solve. Instead it will be the byproduct of his efforts. Totally by accident he will find something useful to mankind.

Some years ago we had an engineer working on the design of a frequency counter. He became totally frustrated with trying to determine the state of a logic gate. Because of this frustration he designed a device to determine whether the Logic gate had a "1" or a "0" on its output or input. From this first logic probe came a whole series of logic test equipment. Totally by accident was this product concept discovered.

R & D PROCESS

The R & D process starts with either a need or an idea. In the case of starting the process with the needs, (figure 1) the company attempts, first, to determine what the customers need. Once we have determined that something is needed, we look at the limited resources available in terms of people, materials, funds, and even in terms of ideas to develop.

If the company thinks it can solve a problem and fulfill the need, then it proceeds to develop the solution.

The product is designed and tested and if everything works, it is put into production. The customers now have a solution to their problem.

If instead we start with an idea (figure 2), i.e. a possible solution searching for a problem, then the process is similar. The R & D Team comes up with an idea. The company then looks to the marketplace to see if there is a need for a product using that idea. If so then the design and development begins and the product developed.

To determine what the customers need, a company will simply ask their customers (including the government) what they think they will be needing sometime in the future, say 5 to 10 years (figure 3). The customers typically respond with a not so simple answer, e.g., "I don't know, what will be available in 5 to 10 years?" This circular questioning continues back and forth. Sometimes we arrive at an answer, sometimes the process continues without resolution.

## ROLE OF INDUSTRY

Industry has specific responsibilities in the R & D process:

### Query Customers for Needs

They must ask customers what they need. Industry needs to know what people will be doing in 5 to 10 years. Companies have to be wizards of fortune telling and be able to forecast the future. They need to watch trends in government, military, and private sector activities.

### Analyze Technology

Industry must also analyze technology. Somehow we need to determine a prognosis for the state-of-the-art. We might examine technologies and ask which hold promise for solutions to problems which may exist in 5 to 10 years. We need to look at what technologies are currently available and which need to be developed before they can be utilized in specific solutions to problems.

### Develop Solutions

Finally, industry must take existing technologies and design products which can be solutions to problems in the near future. And if possible, they need to develop promising technologies to the point of being useful.

## ROLE OF GOVERNMENT

If industry does all that, what is left for the government to do?

### Determine User Needs

First, the government should determine user needs. Requirements for communications, navigation, space exploration, air traffic control need to be examined. The government should look at Military needs for the next 5 to 10 years as well as examine needs of other agencies such as the FAA. The government might even go so far as to look at forecasting the commercial needs for similar products. This would provide a real service for industry.

### Disseminate Information

These needs must then be communicated to industry. In sharing what the government agencies know about their future requirements, industry will be better able to design products which the government can use.

### Look at Available Products

The government's system designers need to look at currently available, proven, off-the-shelf hardware to satisfy as many needs as possible. To ignore off-the-shelf hardware might be related to the NIH or Not Invented Here Syndrome. Nothing is more wasteful then reinventing the same product when an off-the-shelf piece of hardware will do.

### Buy Solutions

A solution may simply be the purchase of off-the-shelf hardware. Or it may be slightly modified hardware integrated into specially designed systems. Or the solution might be to fund the basic research in an area which looks promising, but the need is too tenuous to convince an industrial company to invest its own R & D funds.

## ADVANTAGES OF OFF-THE-SHELF HARDWARE

Why buy off-the-shelf hardware, you might ask. First of all, because its reliability is known; it is not simply computed, but based on real experience. Its early problems probably have been worked out.

Second, it is more serviceable. The bugs have been worked out, people have learned how to repair it, and it is more thoroughly documented. Service information, operating instructions, and test procedures are generally available.

Lastly, you will generally buy the item for less money than a specific design for only one application. The R & D costs are shared by all the buyers, in essence, not just one. Ergo, you don't have to pay ALL of the R & D costs.

FUNDING OF R & D

Both government and industry commit vast sums of money each year to develop solutions to problems. But because our resources are limited, it is important to utilize the resources we do use to get the maximum benefit. The government can greatly improve the impact of the taxpayer's dollars by trying to identify its own needs and by letting industry know what it needs, even to the extent of letting industry know if there is any commercial benefit. If the government can assist in the forecasting effort by letting industry know what lies ahead for future requirements, industry might be able to respond. In this way the government could impact the commercial design efforts to the extent of being able to buy off-the-shelf hardware and not having to fund the effort.

Of course the government has a problem when it tries to provide industry with information. They would like some information in return. They would like to know what the companies are developing and if they will commit to development of a specific solution. However, the government will encounter resistance on the part of industry to commit to a specific project. Companies, in all areas not just PTTI, are not likely to disclose what they are developing or when it will be available in the marketplace. Generally, a company doesn't want its competition to know what it is doing; this allows the company that invents a new product to be first in the marketplace with that product. A company needs to be able to protect its investment on each product and thereby maximize its return on that investment as its shareholders expect.

GOVERNMENT FUNDING

So what should the government fund? Primarily, they should fund the purchase of off-the-shelf hardware. After what I have said earlier you would be disappointed if I didn't list this one first. Secondly, they should fund minor modifications to off-the-shelf hardware. Thirdly, they should fund elementary R & D only if the product is not currently available. And, of course, they should fund basic research in unknown but promising areas. The results of these efforts should be made available to all potential industrial users to maximize spread of technology funded by taxpayer dollars. This will result in more technical solutions being available at an earlier time than if all associated funding was left to the government.

BENEFITS

Definite benefits can be obtained by government participation in the R & D process. Because the government will have provided information and shared in the forecasting process, industrial firms will be able to better consider incorporating the needs of the services and agencies in their future product developments. This will result in the government being able to purchase off-the-shelf equipments to satisfy more of its needs. R & D funds will be used more efficiently in the few most critical areas, and fewer taxpayer dollars will be wasted.

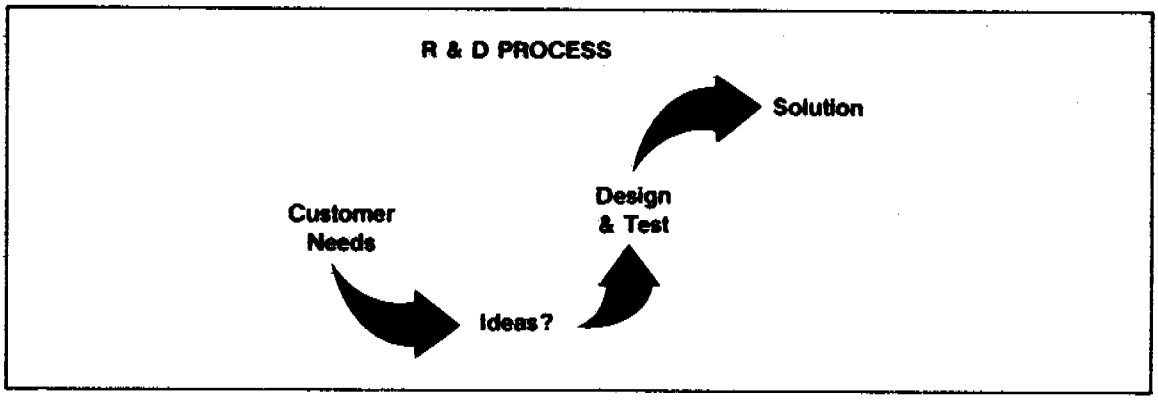


Fig. 1 - R & D Process (Needs)

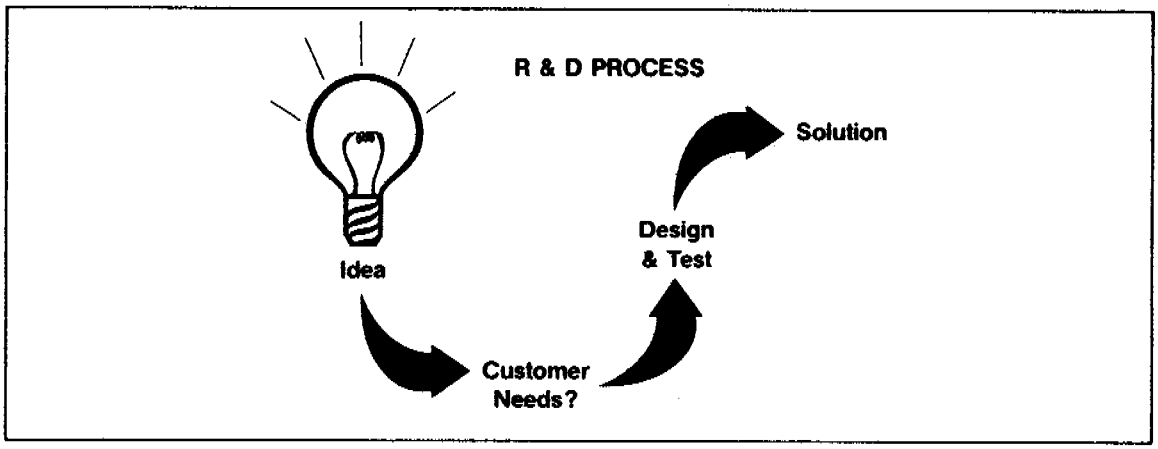


Fig. 2 - R & D Process (Ideas)

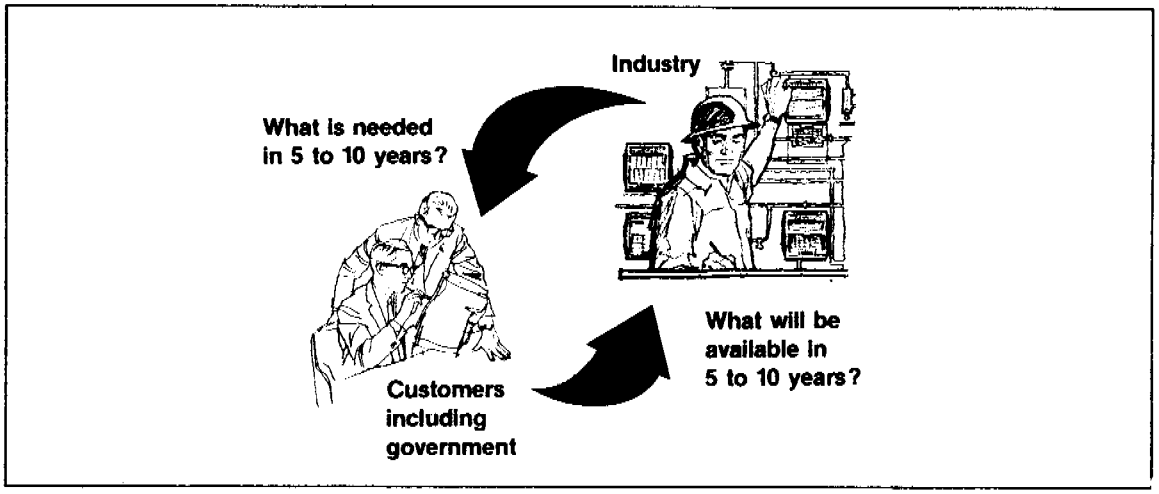


Fig. 3 - Forecasting the Future

## QUESTIONS AND ANSWERS

CHAIRMAN STOVER:

Your request that the government tell you what they need may be, in many cases, unreasonable. The government is no different from other people, and many times they don't even know they need it until they have used it. I think that is even more true in the government than it is in the public in general. If you haven't used it, you don't really know you need it yet.

I think the government has a great deal of that problem: not knowing what they need because they don't know what it will do for them. How do you propose to solve that problem?

MR. OSTERDOCK:

I think that is part of that circular questioning that I describe; basically trying to figure out what happens, and by all of us continuing to communicate that way, maybe we will get some answers. I don't have a specific solution for that part of it.

Forecasting is the most difficult part of the process. I don't think that anybody can really say what technology is going to be like in 10 years any more than we could have back in the '60's.

CHAIRMAN STOVER:

If you go to a Field Commander and ask him what new technology he needs next year, what is he going to tell you? He has to have a shopping list of some kind, right?