

The Future of Telecommunication Research in the United States

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INTRODUCTION

Thank you for the opportunity to address this assembly of those keenly concerned about the fate of research in telecommunications.

For the past few years, I have been examining the papers of Dr. William O. Baker, who was vice president for research at Bell Laboratories from 1955 to 1973 – what some consider its golden years. Baker was the personal science advisor to many Presidents of the United States, starting with Eisenhower and including Kennedy, Johnson, Nixon, Ford, and Reagan. Over the years, he said much about industrial research, and I frequently quote from him in this paper.

You can learn more about this extraordinary man (who incidentally grew up on a turkey farm and attended a one-room schoolhouse) at the web site we have created to document his life: williamobaker.org. He died last year.

THE NRC REPORT

Clearly, the report of the National Research Council “Renewing US Telecommunications Research,” edited by Dr. Robert Lucky and Mr. Jon Eisenberg, documents the crisis in research facing telecommunication in the United States. The findings of the report are right on target, and clearly much strenuous effort went into producing it on the part of the committee and staff. Their efforts are much appreciated and add to the evidence of the crisis.

The report defends the essential role of research in the future of telecommunication. Clear substantive evidence of the decline of the role of industrial research in telecommunication is presented, complimenting other studies, reports, and papers.

The NRC report lists some of the innovations and discoveries that came from Bell Labs over the years. But unlisted are radio astronomy (discovered by Karl Jansky); linear predictive coding of speech (discovered by Bishnu Atal and Manfred Schroeder); the electret microphone (Gerhard Sessler and Jim West); negative feedback (Harry Black); high-fidelity and stereophonic sound reproduction; and a host of many other discoveries. Actually, today’s digital era owes its very foundation to research conducted at Bell Labs: namely, information theory, pulse code modulation, UNIX, digital art and music, and other discoveries.

Some discoveries at Bell Labs created entirely new areas of scientific inquiry, such as radio astronomy and solid-state physics. And entire industries resulted from many of the innovations made at Bell Labs, such as cellular mobile telephony, satellite communications, hi-fi audio, and, of course, semiconductor electronics. The payoffs of the research at Bell Labs were new knowledge and also new industries – with many discoveries commercially incorporated into the Bell System and others donated to society.

I would like to mention the report that came from the workshop that was held on May 23, 2003 to discuss the status and fate of telecommunication research in the United States. This workshop was sponsored jointly by CITI, the Marconi Foundation, and the Annenberg School – and some of the participants later were members of the NRC committee. The report of this workshop discussed a variety of solutions – including tax incentives, Federal funding, excise tax, etc. – but failed in achieving a consensus on any one mechanism. There was, however, a strong feeling of support for the industrial research laboratory, particularly because of its close proximity to real-world industrial problems.

THE CRISIS IN INDUSTRIAL BASIC RESEARCH

Research and development span a variety of activities, including basic research, applied research, exploratory development, and specific development. Basic research can be conducted at universities, private institutions, and industrial research labs. It is industrial research – industrial **basic** research – that concerns us today. Baker, in 1967, defined basic research:

“... as what you’re doing when you don’t know what you’re doing.”

At the same meeting of Western Electric executives, he eloquently described the “delicate balance” of:

“... [seeking] to establish, in our small community of scientists, the programs and subjects for science for the Bell System which will have the greatest probability of direct pay-off in the near and farther future. [While at the same time maintaining] during this process of focus and selection, full freedom of the individual, questing mind – freedom to probe and to follow the pathways of greatest challenge and potential for sheer intellectual consequence.”

So what then has happened? We hear that the old times – the days of the “old” pre-divestiture Bell Labs – were great times. Is this just “old” folks (or “senior citizens,” as they are now called) just looking back at a past that always seems better? No, today’s situation in basic research in telecommunication at industrial labs is indeed in crisis – as documented in the NRC report.

However, the crisis in industrial research is much broader than just telecommunication. As early as 1972, Baker wrote:

“Several of our most distinguished contemporaries, instead of sifting, just pushed the dump button on their R&D resources. These are but examples of numerous abdications of responsibility by industry for the future innovation and competitive position in world trade and economic vitality.”

Some of the contemporaries that he was referring to included U.S. Steel, Shell Oil, GTE, Ford Motor, RCA, and even GE.

What was unique about the times of the past? For one, most of these industries had a single dominant company: AT&T in telecommunication, IBM in computing, RCA in television, GE in electricity, Kodak in photography, and so on. These dominant companies were virtual monopolies and had the wealth to invest in longer-term fundamental research relevant to their industrial interests. These companies also had leaders who knew from past experience that payoffs would come from these longer-term investments. They had “faith” based on realism. Baker observed in 1972:

“It is a spirit, a creed of confidence, that we can do new things with big ideas that science and research engender now and forever.”

However, these industries are now fragmented in the name of the “competition” that the government has stimulated. We all know what happened in telecommunication with the breakup of AT&T and the Bell System – the victim was research. But the family of the old Bell System is pretty much still intact – and even stronger than ever – namely, the local telephone companies. In the past, the local Bell companies were the true ultimate beneficiaries of the research performed at Bell Labs. But today they no longer support such research on the levels of the past. Baker observed in 1985 that:

“So far lacking is any evidence whatever that enhanced competition ... has produced new basic capabilities.”

Today, there is today a strong emphasis on the “bottom line” – on short-term profits. But early as 1958, Baker observed:

“The annual cycle, the annual report, the annual budget dominate our culture. ... In fact, this enslavement to the annual cycle has actually obliterated the reflective functions of American minds...”

And he also observed:

“...there is really no evidence that the mechanism of the human mind has heard that it must create and rear completely new things between annual budget dates.”

We also no longer seem to have industrial leaders who acknowledge and defend longer-term fundamental research at industrial labs. Today’s leaders just don’t seem to have much longer-term vision for research. Baker said in 1957:

*“Technical administration first of all must **want** basic research. Usually it doesn’t, at least in industry, because it is so awkward to handle once you have it.”*

There simply no longer seem to be visionaries, like Bill Baker, who are able to articulate the rewards that come from research. There seem to be no defenders, no advocates, no supporters of long-term basic research in an industrial setting.

Another problem is that what little research that might be occurring is being increasingly required to solve practical design and marketing issues. Baker defended the basic scientist, however, and said in 1979:

“A characteristic failing of modern R&D is over-compression of the span between discovery and use, so that the basic scientist is expected to become a design engineer and the whole system crumbles from internal pressures and implosion.”

NRC SOLUTION: THE ADVANCED TELECOMMUNICATION RESEARCH ACTIVITY (ARTA)

The NRC report recommends an Advanced Telecommunications Research Activity (ARTA) to stimulate and coordinate research, along with “road-mapping” and centralized planning. The details of how this would be done or where housed in government are hazy – and this recommendation is simply just too bureaucratic and conservative, in my opinion.

But what do you expect from a committee. Baker had something to say about this too, when he observed in 1981:

“... the traditional concept [is] that to get anything to work requires a task force. The phenomenon was fortunately unknown to Galileo, Newton, or Einstein, or other masters of classical and quantum mechanics. But it has become a socio-physical requirement of recent years.”

In scientific and technological research, we need diversity in terms of the involvement of both universities and industry. What is **not** needed is the bureaucracy of government and its attempts to “manage” and “coordinate.” This just leads to “pork barrels” and a politicization of science and research. Baker warned in 1979:

“As we face the complexity of science and technology, we must not permit the momentum, visibility, audibility, and majesty of big Government to discourage us from making the innovations necessary for survival and advancement.”

Let us try – please – as challenging as it might be, to learn from history and our past mistakes! Government has enough to do attempting to manage and coordinate **itself** without also taking on telecommunication research!

The NRC report also calls for more academic research in telecommunication. But academic research is far from the practical challenges and realities of industry. Baker had some thoughts on this too when in 1979 he stated:

“... rather than looking to the universities simply as laboratories or centers for the solution of industrial or technological problems, ... they [should] maintain their role as learning and academic leaders.”

VISION FOR THE FUTURE

Yes, it takes faith that research will ultimately lead to big payoffs. But that faith is based on a long history of past discoveries and innovations. In telecommunication, the substitution of plastic for lead sheathing of telephone cables saved the Bell System billions, in addition to greater ease and lower cost of installation, to say nothing of the positive environmental impact. The discovery of polarized radio waves doubled the capacity of long-distance microwave radio systems. In fact, the continued innovation in technology lead to the decreases in the costs of long-distance service over decades – not competition, as is usually assumed.

But all this had to be justified to the sponsors of the research at Bell Labs. In 1968, Baker defended this research to a meeting of the presidents of the Bell companies where he said:

“Research for the Bell System at Bell Telephone Laboratories seeks to create the technical future for telecommunications while at the same time guarding against premature obsolescence of our present resources and the pre-emption of our mission by other competing technologies.”

Baker summarized the justification and vision perfectly in 1988 when he said:

“... the pursuit of excellence in research and development is good for business as well as for progress in learning and in human fulfillment.”

It seems that it requires a crisis for the United States to really move forward. World War II was the crisis that resulted in many advances in electronics, physics, and chemistry. Sputnik was the crisis that lead to advances in astronautics and space exploration. But there is no crisis in telecommunication – and thus it is difficult to focus attention on the fate of industrial research in telecommunication. In fact, the telecommunication and computer industries appear quite healthy. And here the NRC report fails to make a strong case for research, instead pointing to the over-hyped Internet as our future salvation.

HOPE FOR THE FUTURE

Although he had a sobering view as long ago as 1972 of the state of affairs for industrial research, Baker nevertheless had hope and never lost his vision. He wrote:

“... industry is under-playing its role. By asking more from science, from science especially generated in its own laboratories but also from that being created all around the world, in universities and other institutions, and then by applying what is asked with intellectual zest comparable to that of the fine development talent of Bell Laboratories, American industry can reach new peaks of financial and humanistic contributions to world progress through technology.”

And:

“Industrial scientists and engineers working together with purpose, and with systems engineering much more widespread than now, can make this new era if we but work at it.”

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