

The Economic Club of New York

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Business Needs Basic Research

I'll begin by showing you two or three things and then I want to talk about something else. This may seem like a double-jointed way to give a talk but I promise you it isn't as irrational as it sounds.

First, here is a short length of what in the telephone business we call a "wave guide." It does just what its name implies. In radio relay systems, which carry thousands of telephone conversation and also TV programs, this kind of structure guides radio waves in and out of the amplifying equipment at each relay tower. Someday, we are confident, new forms of long distance wave guides will carry hundreds of thousands of conversations, and hundreds of TV pictures, across the country underground.

Here is another piece of hardware. This part of what we call a "pulse code modulation terminal." But never mind the name. This is new transistorized equipment. It takes samples of voice currents in pulses of millionths of a second. Many sets of these samples, each with its own code, can travel over a telephone line only millionths of a second apart. So for all practical purposes

they go over the same wires as the same time. This system is so efficient, we are sure we can use it to multiply talking paths over many short routes more cheaply than by installing more cables. Thus we can begin to do within local telephone exchanges what we have been doing on long distance lines for many years.

Now I'm going to ask you to listen to something for a moment. It is a tape recording of a test of an entirely new kind of telephone call. This call, like most others, starts with the sounds of dialing.

(A short recording of a test of data phone service was played).

You have just heard one clerk call another and transmit data over a regular telephone circuit. This is "data phone service," and data phone means just what it sounds like – sending data by telephone.

A data phone instrument is associated with a telephone. You make a call in the usual way – local or long distance – through the regular telephone network. Then you push a button. The data phone instrument accepts electrical impulses from different kinds of data-producing machines, and sends them over an ordinary telephone connection. At the far end, the tones you heard are converted back to impulses which reproduce the data. When your business is done, you simply hang up the phone.

Now back to the call you heard. It had only 20 seconds of data transmission so as not to bore you, but the information sent in that 20 seconds is equivalent to the inventory position of 150 items in a supermarket. To say it another way, the supermarket's entire inventory of some 7,000 items could be sent in 16 minutes. Here's what we sent. The entire inventory listed this way would be 194 feet long. Data phone service is brand-new. But we think it has tremendous possibilities for usefulness.

As I said at the start, however, these things I've been showing you are not what I'm here to talk about. My subject is rather the fundamental, underlying effort which makes all such progress possible. This is the search for new knowledge – the effort to increase our understanding of nature – the probing into the unknown that we call basic research.

If it were not for basic research, none of these things I have shown would exist. The services we provide would have nothing like their present and potential usefulness. For that matter there would be no telephone system comparable to what we know. These examples merely illustrate that general point.

The wave guide of today was born of mathematical thinking that started 30 years ago, and the wave guides of tomorrow are being born of new equations that men are laboring with right now. The process of sending information by pulsing and coding grows out of entirely new

fundamental theory as to what communication really is. Data phone service is only possible because of the reliability which new knowledge, step by step, has built into the telephone network.

So we in the Bell System are deeply committed to basic research. This has been essential not only to provide universal service, but to cope with inflation, reduce the effects of rising costs, and increase our markets in competition with other industry.

Now perhaps in the past we telephone people have had more need for research than others. However, I question if this is any longer true. One reason why I question it is that today all industry in the free world faces a new kind of competition. Soviet science is moving with tremendous mass and terrific momentum. It has stepped out into space ahead of us and it would be sheer folly not to recognize its driving will to step ahead in every other way. This is not just a matter of missiles and satellites. It is much, much more. It is a matter of markets – of leadership in trade and commerce – of the power of free industry to strengthen the public welfare and to win and keep world-wide esteem.

In the past, American industry has led the world largely because we have used existing knowledge with great ingenuity, developed new products, and introduced all kinds of innovations in organizing people and machines. But now, as I have said, we face the new and

might competition of science and new knowledge in the hands of determined men who have flatly told us they mean to rule the world.

Can competition on this plane be successfully countered by purely industrial and productive skills along? Not in my judgment. No more than the competition of the telephone could be met by the most artful ingenuity in the development, design and mass production of megaphones; no more than the internal combustion engine could be matched by giving the horses an extra quart of oats and putting a ball bearing on the buggy.

It seems clear enough that the country as a whole is waking up to the need for science that will bring new knowledge in abundance. And we are getting more of it – much more – than we were getting 20 or even 10 years ago. The part I want to touch on is only the part of industry. Many businesses today must be asking: “Should we be doing more basic research? How should we go about it? And what is our risk?”

Therefore what I shall mainly do here is lay out a few facts and judgments growing from our Bell System experience, and hope they will be helpful to other industries in coming to their own good answers.

Take first the question, “Is the quest for new knowledge something that really belongs in industry? Or does it belong rather in the universities and in government, with industry applying the results?”

I'll mention a few of the things our Bell scientists think about that, and reserve my own comments for later. They say: Certainly basic research must be done by the universities and government, but there is great advantage – and great need – to do it within industry as well. For this there are several reasons.

The first is that the interaction of basic research with the other phases of an industry stimulates everybody. Basic researchers and development engineers working fairly close to each other in a dynamic atmosphere sharpen each others' wits. Why then should an industry choose to do without this stimulus – in fact, how can it afford to do without it?

A second reason is that the technical organization which includes a basic research group thereby takes out insurance against possible costly mistakes. The cost of development is far greater than the cost of research, and if a big undertaking gets off on the wrong foot the price is terribly high. Granting that any careful organization will try to guard against this – still there is no precaution quite as sound and sure as having basic research people right in the organization who are working at the deepest roots of the problem.

A third reason is that at any particular time, university scientists may not be working on the things that would do your business the most good. No matter how important their work is to them or to others, it may not be getting the new knowledge that you most need. A good example is the work which produced the transistor. University physicists were busy on other things. Our Bell System research opened up the field.

Well, the scientists no doubt have other reasons; but these are enough for the moment. I said I would reserve my own comment and I will make it now. As a business manager, I think these points make sense. I think this for the very practical reason that these are some of the ways in which our basic research has worked well for us. How it may be for others, only they can decide.

Now let's think about costs. Of course the cost of research is a business risk. But in any field of business, if we face new problems we must take new action. If we face new danger we must take new chances. And if the danger we face is to fall behind in knowledge, then it seems to me that taking the new risk becomes imperative.

Moreover, while we shouldn't underestimate the cost, we shouldn't over estimate it either. The fact is that a large business can do a lot through expenditures which, in relation to total volume, ought not to frighten anybody.

Someone may say, “That is all very well, but you in the Bell System have a pretty stable business and you don’t have to meet the same kind of competition that other businesses do.” I won’t argue the point because I don’t think I need to. The fact is that we work under regulation and on a much lower profit margin than most big industry. We do basic research on a thrift basis and we get back far more than we put in. Others who have more ample resources would in my opinion get back at least as much as we do.

Really I think most of the hesitation about going into basic research is due to a worry that all the money may go down the drain. If you go at it the right way, however, and I’m coming to that directly – this ought not to happen. And even if it does take time to get results, when you put the cost into perspective with everything else a big business does, I don’t, as I’ve said, see much cause for alarm. Finally, if you will accept the proposition that we surely do have a new kind of competition to meet, and must have new knowledge to meet it, then I think it ought not to be hard to show the stockholders that knowledge-building dollars are a good risk against the ultimate calamity of having commissars run your business.

Now I shall summarize some of the principles we regard as necessary to the success of basic research in the Bell System.

The first is to get the best possible people. Getting new knowledge takes a special brand of brains. And they must be well and deeply trained. Without this combination, nothing will be accomplished.

Second, you have to have an objective but you also have to give the brains full freedom. Maybe those two things will strike you as mutually exclusive. That hasn't been our experience. We have the broad objective of improving electrical communication. This is a perfectly clear goal. At the same time it gives the research scientist full scope for the exercise of his creative power. If you question this, I suggest you ask our scientists.

Now what is meant by freedom for the researcher? For one thing he must be free to do what he wants to do in keeping with the broad objective, and knows he can do best. If a line of work is proposed and he says "no," take his word for it. He knows more than you do.

The scientist must also be free to plan his work in his own way. You cannot plan it for him. This means there are no schedules. There is no program by the clock or even by the calendar. After all, Isaac Newton was musing under a tree when the apple dropped on his head. The laws of gravity were not formulated on schedule.

The research scientist should also be free to publish his findings without undue delay. And you should also let him carry his work up to the point where he is sure its meaning is fully grasped by those who will go on with the development.

But it is right at this point that we bump up against the third and most difficult essential in maintaining basic research. This is to keep the researcher from becoming a developer. And this is the mistake that every research scientist will warn the business manager against. When basic research is swallowed up by development, then basic research stops. The only assurance of getting new knowledge is to insist that the research group stay a research group. When one piece of research is done, the results must be given to others for development and the researchers must turn to a new basic problem.

Finally, basic research today needs adequate equipment. To give just one example, in our Bell Laboratories research we study the basic characteristics of all manner of materials. To do this we must look at them in every possible way. This requires using many different tools, and they represent a not inconsiderable investment.

There is one thing I ought to emphasize particularly in this list of essentials. That is the disposition and temper of the manager who holds the purse strings. Of course he is itching for results. But he will have to be patient. And if you will let me speak personally for a moment, I will say just this: Whenever I get impatient, there are two thoughts I use to restrain myself. The

first is that research requires no more patience on my part than it does on the man who is doing the work. And the second thought that helps me is – thank heaven we have the research that I can be impatient about.

So much for basic principles, but I daresay, some of you would have liked to stop me right after the first one – that is, that success begins with getting the best and the best-trained men. Your questions might be, for example, “How do we find them” Isn’t industry already taking too many of the best scientists away from the colleges” Are not these great difficulties?”

Certainly they are difficulties. Everything about research is difficult. Nothing is easy. And I don’t say for a minute that industry is going to march ahead in research if public opinion and education and industry’s own support of education don’t march too. Nevertheless our own scientists are convinced – and I am too – that if good men are genuinely and urgently wanted, step by step and year by year good men will be forthcoming.

In the Bell laboratories we spend time and money training men of promise who do not yet have the depth of training needed for research. We make arrangements with nearby universities for additional training. Moreover there is no telling how many men with the capacity for basic research are now doing development work in industry because it is in that field, rather than in the search for new knowledge, that the most opportunity today is offered.

In short, the only way to begin is to begin. And I might remind you that there is more than one useful and thriving company at work today which literally got born doing research within the last few years. Their experience also throws light on another question, which is: “How long should it take, starting from scratch, to make real progress in basic research?” When I ask this of our own research people, their confident answer is that 10 years’ effort will produce real accomplishment.

Now I shall close by inviting leaders in industry, and leader also in government, to consider a single question. It is simple and short, merely this: “What is our responsibility?”

For man years now big business has been under the necessity of justifying its existence. This is perfectly natural. Big business does affect the lives of everyone and it must continuously prove by its actions that everyone benefits. To me and I daresay to you, the evidence of the benefits is overwhelming:

In the capacity to take on big jobs that depend on big investment.

In the creation of new opportunities for small business.

In the sheer ability to produce in vast quantity at low price.

In the strength that armed ourselves and our allies in two world wars, and but for which this Country today might be an overseas province of, let us say, the Third Reich.

Our need to prove ourselves will never end, but I want to make this observation: It seems to me that at no time in this century has the man in the street had more reason or instinct to look

hopefully and even prayerfully to big business than he has right now. He has thunderclap awareness that it is big and mighty effort which has rocketed a living creature up out of the atmosphere and into the silence of space. His instinct and acknowledgment must be that the Soviets' kind of bigness can only be countered by another kind of bigness, and I mean our kind, which mixes bigness and freedom. So I think today we have the potential for a new degree of public understanding of big business, and new public awareness that the future depends very largely on big industry and on keeping it sound and strong.

To say this, however, is only to say that our responsibility grows accordingly. And if it should be – and I am putting the question to you – if it should be that industry should fall short, not in skill or ingenuity, or organization teamwork, or productive or marketing savvy – not in any of these things, but in getting new knowledge – then what degree of public understanding and approval should we expect, say, ten or twenty years from now? And is that the kind of risk we want to take?

In our own case, as a public utility, to do the most effective research job we need the full understanding and support of the regulatory commissions. We are regulated in every state, and in some of them you would almost think the sole purpose of the regulation is to keep us from earning enough money to do a better job. In the postwar period as a whole this paucity of earning power has limited and circumscribed our effort. We have done a great deal, and I am only stating the fact when I say that this has opened up prospects for the future of

communications that are beyond all calculation. Nevertheless I think we would have done more, and be somewhat further into the future than we are today, if the conditions imposed on us had been less stringent.

Finally, let me address a few remarks to those people both in and out of public office who for reasons best known to themselves seem dedicated to the effort to harass and attack big business, and to cut it down to some other size of their own choosing.

I ask them to stop, look and listen. A few minutes ago I was saying that the cost of basic research is nothing for a big business to be scared of. However I didn't say it was free. It is in fact big enough to require big resources. For one thing, the research group needs to be large enough for its members to spark each other, and to attract the top-notch people who want to work in a scientific community that draws others of equal caliber.

So if basic research within industry is really going to grow, it is going to have to grow in big organizations. I don't mean there isn't room for it in smaller ones, especially when they are doing work for the government and the cost gets paid that way. But if industry as a whole is going to get up a full head of steam in acquiring new knowledge, the impetus has got to come from big business which has the means to pay for it.

How can those who continually attack big business expect us to accept this new kind of risk if they keep us forever preoccupied with the effort to keep ourselves whole? This is simply not the way to get on with the vital tasks that we must get on with.

So I say sincerely and urgently to those in public life: By all means, hold us in big business to our responsibilities. But give us, also, the freedom to build strength that we need to meet them. The next generation – and the time may be shorter than that – will surely be decisive in the future of our country and the world. Let it never be said in years to come that we failed because this man had a pet theory, and that man was thinking of votes.

I hope I have made myself plain. I have said to you tonight that we in the Bell System have found basic research essential to progress in one very important field. I have urged others in business to take note of the threat we all face and to accept whatever responsibility properly belongs with them in their fields. I have reminded members of government, finally, of their responsibility to allow us in business the freedom and the resources we need to do our job. For the stakes are high and the concern not any single group, but the welfare of the nation and of all free people.