U.S. Industrial R&D: The Good News and the Bad News

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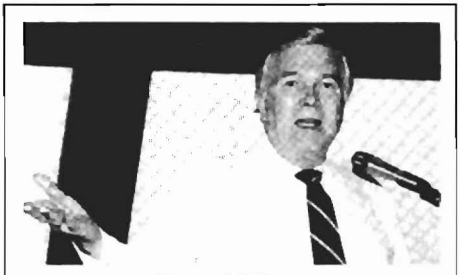

Donald Frey

What is the state of industrial R&D in this country? It is a good news/bad news story. There are a lot of things going on, and change is occurring very rapidly. Some people are very aware of the situation, but others are woefully ignorant. With apologies, I'd like to first review the history of industrial R&D. This is not academic or government R&D, but R&D in the private sector. These are presumably profit-making, shareholder-owned industrial companies. Industrial R&D is undergoing quite a revolution right now - some bad, some good. These changes are relevant, in a societal sense, to the fundamental purposes of the Fermilab Industrial Affiliates members, which is why it is important to consider the subject here.

Industrial R&D began in this country around the turn of the century. The first significant, recognizable, organized, serious, budgeted research center was probably at the General Electric Company (GE). GE established a laboratory from the legacy of Charles Steinmetz, who had created some of the fundamental technology at that time in the electrical generating business. At the turn of the century, a laboratory was based upon a very simple principle, one that is no longer relevant

in the real world. This simple principle, which was followed by other companies such as DuPont and Bell Labs, was this: Given the then state of applied science, a company at that time was justified in assuming that they could derive a proprietary, competitive edge in the marketplace from the work done in their R&D laboratory. It was true for the General Electric Company, it was true at Bell Labs, and it was true at DuPont. As I shall explain in a moment, it's not true today.

There was a paradigm at that time (I call it a sequential or linear paradigm), which said, "I will derive, in the R&D laboratory, scientific knowledge that is proprietary to my company because I did it. Then I will obtain a competitive edge, scale it up, develop the processes that go with it (if that is relevant), and take it to the marketplace." In other words, the model is a linear, stepwise process from the R&D lab to commercial success. Some of you may be old enough to remember Coolidge and his pioneering development of ductile tungsten for the filaments in electric light bulbs, which then became a core business for GE and which, to this day, is still very good science. As a result of that research, GE owned the incandescent light business in the first one-third of this century.

During World War I, there was a blip in the development of industrial labs because in the conduct of that war, research work was used to a great extent to further the war effort. There was a steady, slow growth in the number of companies that had industrial R&D laboratories, and surprisingly enough, there was almost no blip during the Great Depression of the 1930s. But the great kicker for industrial research came as a result of the Vandevar-Bush report of 1945, called *Science, the Endless Frontier*, which was published by the National Research Council of its time at the behest of President Franklin D. Roosevelt. Roosevelt asked for a report which would treat science as an effective peacetime economic driver, as it had been in the Second World War. (I remember it personally very well, because I was just out of the army and I read it. I decided at that point to become an "academic," and I went on for the doctorate.) The assumption was this: Any country that wanted to become a continuing economic power in the world had to have an ongoing, R&D-based, basic scientific tradition. This was a further extension, at the national level, of the linear paradigm of old. Much of the subsequent science-funding apparatus of the federal government occurred as a result of the Vandevar-Bush report. It was also assumed by industrialists, who

were not yet in the game, that the same paradigm applied to them. As a result, the industrial-research laboratories enjoyed a huge increase in budgets, numbers of people, and numbers of locations in the 1950s and 1960s. Any company that wanted to present itself to the investor world as being worth its salt had an industrial-research laboratory of some sort. As a result, today we have a history of the linear paradigm, which incidentally still prevails as the federal government's paradigm. The assumption is that any country that invests its resources to some degree in R&D will assure its economic success.

In the early 1980s, some clouds appeared on the horizon. First of all, the so-called thinkers, both industrialists and governmental officials, were puzzled by the phenomenon of Japan. Here was a country that had become a major economic power in the world, and it had no R&D history, no R&D tradition, and certainly, up until quite recently, no particular support infrastructure that related to what we would consider to be industrial or governmental R&D. The recession of the early 1980s was caused mostly by the high cost of the dollar, but also by the increasing incursion of the Japanese into well-known markets, such as automobiles and television sets and video-tape players. These Japanese successes continued to impress and bother us industrialists.

Something else began to present itself, and it wasn't comfortable information. There began to appear scholarly studies pointing out that the R&D labs were infrequent sources of innovation for industrial companies (keeping in mind that, speaking as an industrialist, the end game of R&D is innovation in the marketplace that makes a return on capital invested). Not frequent, *in*frequent. As a matter of fact, some of the scholarly studies by Professor Souder of the University of Pittsburgh discovered that successful industrial innovation came most frequently from a *salesman*. Hardly reassuring to R&D experts, but let's face it, that's a studied academic conclusion, and that was a problem.

We also became painfully aware that science had grown up throughout the world, and in contrast to the early days of industrial research, is now the universal good. Science is best described as a kind of pool. Any given company can dip out of the pool what they want. Industrialists became aware of the fact that the real difference between companies is their relative success in dipping into that science pool and taking out what is relevant, be it current science or Newtonian science, and innovating technologically.

Here is the bad news: In recent years, the net result of all of this has been a succession of major reductions, closings, and decentralizations of industrial R&D labs. Painful as it is, that is what is happening. Any number of big companies have announced reductions in budgetary allocations for centralized, serious R&D, or even its absolute abolishment. A not untypical example, to bring things full circle, is the General Electric Company, which closed up the RCA Sarnoff Laboratory and gave it to SRI for a dollar and some subsidy for a period of time. Just as those scholarly studies had pointed out, commercial success in the marketplace has too infrequently resulted from serious expenditures at the R&D level by industrial companies. To repeat, that's the bad news. It's going on every day. I happen to serve on quite a number of public-company boards and to my dismay, four straight annual meetings in a row at four different companies have dissolved the central R&D laboratories. These are large companies which are known for their R&D.

What are the drivers here? First of all, the most common failure, from an industrialist's point of view, is that R&D is too far from the marketplace. Take the case of Eastman Kodak, which is renowned throughout the world for its central research laboratories. For many years, Eastman Kodak managed to miss the video age, the magnetic-tape age, electronic cameras. They managed to miss the whole bloody thing for whatever reason (that's a separate debate). As a result, they got themselves into deep trouble in their traditional markets. The heavy breathers in the company missed all these new markets. Shame on the management and shame on the R&D labs. I think Kodak split their central R&D lab into something like 27 entities and dispersed them to the operating divisions.

The disciplines of the marketplace are iron disciplines: Will the customer buy a product for a given price, and can you make a profit on your invested capital? In too many cases, the R&D lab has drifted off and become too far removed from the marketplace. Whether the R&D personnel like it or not, they had better talk to a salesman. That's a milder version of what I mentioned earlier. The salesman may not be very well educated from an R&D point of view. He probably doesn't have a doctor's degree. But the salesman has one characteristic that is absolutely vital for industrial innovation and commercialization: He talks to real customers who spend real money. And the real customer doesn't give a damn about academic degrees or the origin of something that the salesman is trying to sell. The

customer has to pay real money, which he had to work hard to get, for what that company is trying to sell him, and the customer wants his money's worth. That product had better work and be of value from the point of view of the customer, not from the point of view of the purveyor. That gap between R&D and the customer is a serious problem and what's happened, as a reaction, is that companies are taking the R&D functions and moving them toward the operating side of the company. That's called decentralization.

The next thing that has happened is that, inevitably, as you decentralize R&D towards the operating ends of the company, it becomes more D than R, and the D becomes, by its very nature, shorter and shorter term. And that brings me to my last external influence. Short-term behavior in America today - underline America - is driven to a great degree by what I'll call the "Wall Street Syndrome": quarter-to-quarter results. It takes a brave chief executive officer of a company to increase his investment in some sort of innovative activity when that activity reduces his quarter-to-quarter earnings report and puts him at risk to the raider, the merger and acquisition takeover group, or some form of recapitalization. I am sure you can recognize this process; all you have to do is pick up tonight's paper and an example will be in there. That short-term behavior of the capital structure of America is absolutely and totally antithetical for long-term investments. A number of different academics, including my good friend James Bryan Quinn of Dartmouth, have gone to great ends to point out that the average length of time between the initiation of an innovative idea and the commercial success of that innovation (success being defined as the return of the cost of capital at the then market rate of the capital invested) is seven years. The average tenure of chief executives these days is five years. You can figure it out: The mismatch is devastating. The average Wall Street player is looking from quarter to quarter, or three months.

One of the great ironies, which I have observed many times, is that the stock market today, mainly common stock, which is still the principle capitalization of private industry, is controlled by institutions. Forty per cent of the national equity market is owned by institutions. The little old lady from Dubuque is long gone. The performance of those institutions is measured in terms of return on their portfolio, because most of those institutions have as their role to manage the pension funds for all our retirements. (I'm referring to the private sector,

not the public sector.) I've often observed that the heavy breathers of a company on which I serve as a director will hire and fire their pension-fund managers on a year-to-year basis because they didn't produce an adequate return relative to the Standard & Poor 500. But you should hear the same heavy breathers scream bloody murder when they are selling out the stock of the very company whose pension funds are being managed. The irony is profound, but that's the world in which we live. To repeat, it is a rare chief executive who would knock his quarterly earnings down and risk his personal recompense (his bonuses are tied to his stock price), and his company's rating. If he kicks his stock price down because it didn't meet the expectations of the street with respect to his common-stock return, he puts himself at risk with the rating and playing public out there.

There are some chief executives who worry about these developments. There are some, believe it or not, who are not players in the Wall Street game, although there are plenty of players, too. They know that, in the pressures of the short-term events surrounding them practically every day, the reduction of the long-term investment, be it R or D or both, is putting their company at risk in the fundamental social sense, not the Wall Street sense.

Having said all this, and having described the bad news, namely that industrial R&D is becoming short-term, more D than R, which in the long run is totally devastating to the economic health of this country, there *is* some good news. There is a growing number of chief executives who know all of this and who are quite interested in strengthening their relationships with universities and other broad-based research organizations as an increasing source of R. These relationships have some economic advantages to industrialists. Starting at the university level, with which I am most familiar, the plain fact is that R at the university level is a lot cheaper than the industrialist's R. In fact, my university friends complain a bit when I say that the universities can play the Kelly Girl role for R: as needed, no permanent overhead at the industrialist's level, and all the fringe benefits that go with it. This is an opportunity and it is growing, it's not a minor trend. Increasingly, the industrialist who knows about this opportunity and thinks about it, realizes that the best thing to do under the pressure of the circumstances is to turn to his local university or, in some cases, a research organization *exparte* to a university. I can think of the Batelles, the Ar-

thur D. Littles, the SRI's of the world. I may even suggest Fermilab. Turn to them and say, "Can you do this job for me?" There's a certain amount of give and take here because the industrialist is not interested in a Nobel Prize. But he *is* interested in getting to a more broad-based place than he could ever expect to be if he had the old R. By tapping into the universality and the depth and the constant growth of science, and getting a sense of what is going on in some defined field on a much broader base than his organization can ever achieve, he can get a perspective available at no other place.

So the research organizations and industrialists are increasingly turning to the non-private, and in most cases non-profit, sector. My own company, which is not out of the mainstream, is an example. It is decentralized. I closed up the central R&D laboratory; I gave up on them years ago because they never did understand they had to talk to a salesman. Now we have seven R&D centers in the world today, and all seven by deliberate policy are located next to a major university somewhere in the world. That's the future and that's the good news.

So have fun, guys, when you try to commercialize some of these things. There are at least a few people who would like to help you.