John D. Hague, President, Indiana Corporation for Science and Technology

ADDRESSES AND CONTRIBUTED PAPERS

LUNCHEON ADDRESS

Centennial Address Given To The Indiana Academy of Science

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Mr. President, Members of the Indiana Academy of Science, Distinguished Guests, Ladies and Gentlemen—I am most pleased to have the opportunity to meet with you in this centennial celebration for the Indiana Academy of Science, and to think together with you about future roles of science, technology and industry in Indiana.

The generally accepted definition shows science to be "The branch of knowledge or study dealing with the body of facts or truths systematically arranged in showing the operation of general laws", and technology to be "The branch of knowledge that deals with the industrial arts, applied science, engineering, etc."

Today, we are going to think a bit about the future roles of science, technology and industry. We are going to take a "bird's-eye view" of a grand experiment on the part of Indiana to harness some of the energy in that triumvirate for the benefit of the residents in Indiana for generations to come . . . an experiment in which you, personally, can be an important element.

Much of our population gains only a veneer-like understanding of scientific progress by their observations of industrial outputs that utilize the technology products of the scientific endeavor. For example, today a person needs only to visit a toy store to see the results of achievements in the areas of semiconductor research, computer architecture, software research, mercury and lithium storage cells, plasma physics, bistable liquid crystalography and dozens of others. They can also witness engineering achievements in the areas of increased complexity and capability per dollar of their investment, and they will be aware of the increased quality of the products and an increased application of the technology of juvenile ergonometrics.

You and I, however, realize that semiconductor research has now resulted in our ability to utilize computers in our low-cost toys that are more powerful than some of our large mainframe computers of only a few years ago; applications in which these computers are powered by a single, small battery. We realize that the reliability of that computer is orders of magnitude better than that of the old mainframe computers. The cost of the computer chip to the toy manufacturer is considerably less than the user will pay for batteries to power the toy during the first six months of its use.

But a few of us stop to realize that today's toys represent not only a few months or years of intensive design work by engineers and technicians, but also represent hundreds of years of scientific achievement, which each generation identifying new levels of scientific laws, building upon the foundation provided by the efforts to previous generations. In each generation, these new laws are passed on to the engineers and technologists, who again build on past achievements of others to develop and innovate new applications and controls for technologies. Then, the resulting designs flow into the industries and into the market place for a relatively short time until consumer acceptance of that technology and that design are relegated to the category of outmoded . . . having been replaced with something stronger . . . or less expensive . . . or faster . . . or more efficient . . . or more reliable . . . and the cycle goes on.

Today, the consumers know well that we are in a period of dynamic scientific growth and technological change. In an automotive example, which is on the market for the first time this year, the 1986 Buick Riviera has an optional electronic display instrument panel with only computer driven, "touch screen" controls on the car. The traditional knobs and switches are gone. While that car may not appeal to a number of the buyers in the market, it is likely to be very appealing to those who have "grown up" with computer screens and those who feel very comfortable in dealing with bank machines and other manifestations of that technology. Either way, it is an example of technology flowing into today's products in areas that were not possible only a few years ago. We need not dwell on the area of computers, because I think that there is a great deal of awareness of the advancements made in this computer age; the advances made in computing power, speed, and the reduction of computing costs during the last two decades.

But, if we look also at medical instrumentation, office equipment, and manufacturing and quality control processes, we see dramatic roles of technology in those fields of endeavor. This is equally obvious in many areas of biotechnology in which we are now witnessing an explosion of research and technology achievements in gene splicing, monoclonal antibodies, and so forth. And there are dozens of other important areas that are employing new technologies in the market place.

A dramatically increasing percentage of us are involved in businesses in which change is no longer an option; but a requirement in order for the business to survive and to prosper. In the high technology environment in which I live, one of the most frightening problems I see is the high percentage of engineers, scientists and managers who are not aware of the technological threats to their company's future and the technological opportunities that are there to deal with them. They have not taken a good look at their future. They have not left the playing field and climbed up into the bleachers, and looked down on the game to see who is doing what to whom . . . to see what the opportunities are and what the problems are . . . to evaluate what their competitors are likely to do . . . to evaluate what changes in other industries might reduce or obviate the need for their business or their industry.

In that context, I had the pleasure last week of participating in the dedication of a magnificent new technology building at Vincennes University. That building was built in the early 1800's. It is a five-story building with brick walls over three feet thick, with four inch cork installation in the center of those walls. It was built initially as an ice and cold storage facility in which ice blocks were cut from the river to serve the city for the rest of the year as a source for ice and a location for food storage. It is interesting to note that this company was put out of business, not because someone else in the area had developed a better way to cut ice and store it to provide cooling, but it was put out of business by the invention and advancement of the mechanical refrigeration industry.

There are many examples today of areas in which companies can be totally decimated as a result of technology advances in what appeared to them to be a totally unrelated industry. Our managers today need to be very aware of that potential, and the need to determine the probability of threats in that area. They need to identify action options for their companies. They need to evaluate their positions and make trade-offs. But, too many persons today are preoccupied with today's problems to take only five percent of their time to look at the future and what it means *to* them instead of *for* them, as the case may be. Many believe that high technology is for someone else, and not for them.

Due to the capital intensive nature of our business operations today, most in-

dustries and businesses depend upon their engineers and scientists to lead the way through the technology maze that confronts them. They expect these engineers and scientists to lead the way; to avoid the untimely or wrong decisions; but, more important, to identify the *correct paths* at the *correct times*. But, with rapidly changing technology, many of our engineers and scientists are ill-equipped to provide this leadership. And, maybe even more serious, many managers do not realize that they are, in effect, piloting a corporate Titanic and some technology icebergs are dead ahead.

Indiana is working hard to deal with this problem . . . by providing more accessible scientific and technical education . . . by stressing that technical education cannot stop after graduation from school, but must continue at an ever increasing pace throughout the lifetime of the worker or manager . . . by attempting to make more managers aware of the threats and opportunities relative to their businesses . . . and by making high technology more understandable for our people and our industries, including our important argiculture industry.

Now regarding that grand experiment in Indiana, the State took a major step over two years ago when it created three new corporations . . . the Indiana Institute for New Business Ventures to deal with the need to educate and train the medium and small business sectors regarding general business and financial matters . . . the Corporation for Innovation Development to deal with our long standing venture capital shortage for support of new businesses and expansion of existing businesses . . . and the Indiana Corporation for Science and Technology, a $150 million commitment by the State of Indiana over a 10 year period to enhance the long-term economic base of the State through the development and infusion of high technology into Indiana businesses, industries and agricultural operations.

In reading the history of the Indiana Academy of Science, I noted that the purpose of this organization as recorded in the 1880's was as follows: "The objects of said association are scientific research and the diffusion of knowledge concerning various departments of science". It is interesting to note that the definition in the 1880's utilized the word diffusion, and "technology diffusion", in contrast to "technology transfer", has very recently been determined to be a more descriptive and appropriate term for use in the 1980's.

When I look at your most recent constitution by-laws, written in 1985, they say in Section II, "The objectives of the Academy shall be to promote scientific research and the diffusion of scientific information: to encourage communication and cooperation among scientists, especially in Indiana; to prepare for publications such reports of investigation and discussion as may further the aims and objectives of the Academy as set forth in these articles; and to improve education in the sciences." . . . a strikingly similar charter to that of the newly created Indiana Corporation for Science and Technology.

CST's mission under its charter encompasses the protection of the traditional agricultural and industrial business base of the State, the start-up of technology-intensive businesses in the State, and the attraction of companies outside the State to Indiana through development and diffusion of advanced technology. In support of this mission, the Corporation provides three basic services. The first is technological guidance and counsel, in which information regarding new technology developments is transmitted quickly and effectively to businesses in Indiana. In this area of endeavor, the Corporation spends time protecting businesses and industries from the inappropriate applications of technology, and assists them in locating appropriate technologies and applying them correctly and effectively. A second function is business and financial guidelines and assistance. In this particular area, generic type financial and business advice is provided by the Institute for New Business Ventures, the sister Corporation which we discussed earlier. But, in those cases in which decisions are being made which are

related directly to complex, high-technology elements of the business, that advice and counsel is provided by CST. The third primary CST endeavor is interim funding support to bridge the gap between the ideas of the developer, inventor, or businessman, and their ability to attract funding from traditional funding sources such as banks, investment organizations, venture capitalists, initial public stock offerings, profit flow, etc. In this case, the Corporation for Science and Technology provides up to $10 million a year of funding for worthy applicants, and this funding is an investment in the future of the State of Indiana. The investment selections are based upon a thorough review of both the technological and the business aspects of the proposals. Funding is provided to the recipients on a payback basis, in which the payback is based upon a percentage of gross revenues for the product or process which has been funded wholly or in part by the Corporation for Science and Technology. This allows the funding to be returned to the Corporation for subsequent re-investment.

It is worthy of note that we recently contacted the Principal Investigators of the thirty-five projects that were funded during the first two years of operations of the Corporation. During that period, $21.1 million was invested and the Principal Investigators of those 35 projects made possible by these critical CST investments informed us that over $410 million of non-CST funds were now programmed for investment in these projects during the next three to five years. This indicates well over a 20 to 1 return on investment in these projects and indicates clearly that the "Pump-Priming" or catalytic elements of the CST program are working well.

One thing is very clear, and that is if this nation is to regain it's competitive edge in the world markets, we will need to develop a better educated and more flexible work force. *Change itself is likely to be the only constant factor in the American workplace in the years ahead.* Education and training and rapidly unfolding scientific achievements will be required at an ever increasing pace. Our science must provide the basis for the development of improved technology tools that can be, in turn, used in the development of improved methods for research which will lead to an ever improving understanding of the basic laws of nature. These improved scientific research processes are badly needed to allow our scientists to achieve new scientific levels and our engineers to develop the technologies that will be critically needed for our nation to compete in the world market-place.

Indiana is now in competition with the world for industries and jobs, and there is no form of economic isolationism that is likely to change that very much. But Indiana is very fortunate, as it has an outstanding roster of colleges and universities and an excellent stable of businesses and industries with a natural tendency to work things out together. Today, as never before in the State, we are seeing networking between scientists, engineers, industries, and agricultural operations in which they are using a team effort to achieve goals that they could not begin to achieve by themselves.

Artificial intelligence technology now holds the promise for the reduction of the loss of knowledge that plagues us between generations, as it will soon allow us to "clone" some of the finest minds of each generation and to capture their thought processes and logic processes in specifically selected areas of endeavor. In this manner, the present loss of knowledge experienced by our industries, universities and businesses between generations and after retirement of key scientists, engineers, and managers may soon be significantly reduced. The use of artificial intelligence concepts will allow us to achieve a level of productivity in the development and transfer of new scientific foundational information and reasoning that has never been equalled in the history of the world.

Then, what are the messages to us, as we look at this chain of happenings and developments that are all about us?

First, it is highly probable that the traditional roles of the scientist, the engineer, and technician, and the industries and businesses will survive and be strengthened, but they will be assisted by major productivity and communication advancements.

The interface between these groups will be much tighter and more effective and the interface line will become much less distinct as information transition activities are improved.

Organizations such as the Corporation for Science and Technology will continue to play a major role in this transition period, serving as catalysts among the major players; the universities, industries, daring entrepreneurs, investors, and a more informed and intelligent citizenry.

We are already seeing the benefits of close networking between the scientists and the universities and industry here in Indiana and we believe that the best is yet to come in this area.

We have insufficient time today to discuss CST's targeted technology categories that encompass thirteen technologies that hold high promise for the economic growth of the State; our plans for each of them; and our array of projects today and their promises, exciting as they may be. But I can suggest that if you wish to know more about this subject, you can request a copy of our recently released Annual Report of Operations. I can promise you that if you wish to become personally involved with CST and this exciting and grand experiment in science and technology and economics, you need only to share that desire with us and you will probably find yourself an addition to the roster of over 500 volunteers working with us in planning for tomorrow, today.

Clearly, we are heading into an exciting era for science, technology and the industries of Indiana . . . an era in which those of us in the scientific community will play a vital role. I commend you for your support of science and its further development . . . and I commend you for the achievements of the Indiana Academy of Science during its first 100 years of operation. I sincerely hope that those who will stand here at the celebration of the 200th year of the Academy's operation will recognize our generation as that which put science and technology to work in a most effective manner for the development of additional scientific knowledge for the good of mankind. I, for one, believe that we can achieve that distinction.

I wish you well in your journey into a very high-technology future and, based upon even the most conservative predictions, this should be a most interesting, challenging and rewarding trip for us all.

Thank you very much.