

## **Unintended Consequences and Results**

**University Scholars Day 2011 Keynote Speaker:** V. Lane Rawlins, President

**Affiliation:** University of North Texas

**Bio:**

V. Lane Rawlins became the University of North Texas' 15th president in December, 2010, after first joining the university in May, 2010, on an initial one-year appointment. Before joining UNT as president, he served as Interim Director of the William D. Ruckelshaus Center for Conflict Resolution at Washington State University where he had served as President from 2000-2007. Prior positions include serving as President of the University of Memphis, 1991 to 2000; Vice Chancellor for Academic Affairs, University of Alabama System, 1986 to 1991; Vice Provost, Washington State University, 1982 to 1986; and Chair, Department of Economics at Washington State University, 1977 to 1982.

President Rawlins twice served on the NCAA's Board of Directors and as chair of the Pac-10, Conference USA and Great Mid-West athletic conferences. He has served on the National Conference of Christians and Jews, the Governor's Council on Global Competitiveness, and more than 20 other boards, including Boy Scouts of America, United Way and WKNO National Public Radio.

President Rawlins earned his Ph.D. in economics from the University of California, Berkeley and his B.S. in economics from Brigham Young University. He has focused much of his research on labor economics (especially the effects of education on earnings in people's lives) and public policy.

President Rawlins is a native of southeast Idaho. He and his wife, Mary Jo, have three children, 11 grandchildren, and four great-grandchildren.

**Abstract:**

In his keynote speech to University Scholars Day 2011, Dr. V. Lane Rawlins explored the importance of research to individuals and society and the connections that link scientific discovery, technological change, and economic growth. He posits that research universities, the workplaces for thousands of talented professors and students, have led the way to solve problems by exploring, often with unanticipated consequences and unexpected results that changed the world.

Rawlins asserts that while corporations spend much more on research than universities do, in some ways, it is “the difference between education and training. When we know exactly what we want someone to do or know, we can specifically convey that information or training and then test to measure its effects. But, education is more. It is creating an environment where folks will think outside the box, go beyond their teachers, and use their tools on new problems. As we think about funding research because of the payoff (and the payoffs have been tremendous) we must remember that the most important returns have come because the funding was a mandate to explore, not a contract to find, and the most likely major effect has been a change in our educational mission. That is why, I believe, American higher education remains far ahead of everyone else.”

Dr. Rawlins discusses several examples of “accidental” discoveries that were made when scientists engaged in basic research found something they were not looking for that turned out to be scientifically important. He argued that the process of going from scientific discovery to technological change and marketable products is a part of our national economic model but it is not predictable. Over the course of the 20<sup>th</sup> century, growth in government and corporate funding of research transformed the mission of public and private universities to include research. Dr.

Rawlins concluded however, that the really groundbreaking advances in research still come most often in environments such as those in American universities, where the research outcome is not prescribed, but where scientific exploration flourishes.

## **Introduction**

The best part of my job is being surrounded by well-trained and highly creative people who have no inclination to keep their lamps under a bushel. Some of the most delightful moments in my career have been listening to excited faculty members talking about subjects as diverse as left-handed bush babies, consumer shopping patterns, translating Egyptian hieroglyphics, what happens while you are asleep, the effects of high explosions on materials, how plants fight disease, the global oil crisis, the spread of fungus in barley, soil erosion, world hunger, suicide rates among teenage girls, early learning, global warming, the physiology of owls, and countless other wonderful topics.

I started my university life as a student over 50 years ago. My own academic specialties, economics and economic growth, have made me think about how these research programs affect how we live and work. In fact, I have given a lot of thought to the importance of research to individuals and to society and the connections that link scientific discovery, technological change, and economic growth. I appreciate this opportunity to explore that topic with you today.

## **Unintended Findings from Research**

Let me start by showing you this can of food. Do you know what it is? It is a can of Cougar Gold cheese which has been produced since the 1930's in cans that look just like this. It was developed by Dr. Phillip Golden who had a grant from the U.S. Army in the 1930's to find different ways to preserve food for our troops. His task was to find something edible and nutritious that could survive without refrigeration for an extended period of time. To get a cheese that can survive in a can, it has to be quite dry and sharp. The result, quite unintended, was a sharp white cheddar that has been winning national and international prizes ever since. I don't believe that the Army ever used it, but it has become a favorite of gourmets around the world.

Golden got something he was not looking for, but he was trained as a scientist and took advantage of his unintended findings.

Let me turn to a more substantive example, from the laboratory of the nation's leading plant scientists. Over the past decade or so, Dr. Kim Kidwell, with the help of an able team of faculty, staff, and student collaborators, has developed several new varieties of wheat that are now in production across the nation and have resulted in millions of dollars in increased yields. In her wheat-breeding lab she is concerned with quality, yield per acre, and the ability of these crops to withstand disease. Her work is so highly regarded that when she announces a new variety there can be hundreds of thousands of acres planted within a few months.

Recently, while Dr. Kidwell has engaged in considering how to develop wheat with greater resistance to the herbicides used against the expanding variety of noxious weeds, she made an important discovery that has little to do with the production of wheat. I am not really competent or authorized to discuss the findings but I can tell you that it relates to the resistance of plants to herbicides and has the potential to greatly increase the production of soybeans and related crops around the world. As an economist, I am always impressed with "the market test," and the patents and licenses emerging from this finding are already earning considerable sums of money for Dr. Kidwell, her colleagues, her department, and the university. Remember, she started out to develop a better variety of wheat but her research took her someplace else.

Let me take you through one more example. Dr. Michael Skinner is a renowned researcher in molecular sciences whose research in his center for reproductive science has long been recognized as among the most important in his field. I have known Dr. Skinner since the 1980's and when some of his research was featured as the lead article in *Science*, I asked him to

tell me about it. Let me try to retell a little bit of his most recent discovery story as Dr. Skinner related it to me.

He and some of his colleagues, including graduate students and post-doctoral fellows, were looking at female rats that were exposed to an external agent (let's call it a pollutant) during that critical time in pregnancy when gender is being determined. They observed that almost all of the male offspring of those rats developed the same disease. But, as Mike says, that was an important finding but nothing outside the realm of normal scientific observation. Fortunately, one of those people in his lab made a mistake and bred one of the diseased male rats to a perfectly healthy female. To their collective surprise, the male offspring of this coupling had the same rate of disease as the original male offspring of the exposed female. That is, the disease, caused by an external pollutant exposed to a female had now become hereditary in the male offspring (at least to the fourth generation.) This did not happen as an alteration of the DNA sequence, which remained normal, but was in what Mike calls the "epigenetic" relationship. Remember, this "experiment" too was a mistake.

I could give many more examples of current research findings but let me turn the clock back a few decades to the work of Orval Vogel. While working on the improvement of some standard wheat varieties, Dr. Vogel, considered the father of the Green Revolution, discovered the gene and process that led to the modification of nearly all grain varieties now grown in the world. He was looking for larger heads and found a key to "dwarf" grain varieties. Again, Dr. Vogel found something he was not looking for.

### **Economic Growth, Technological Change, and Basic Research**

As you can see from these examples, the findings from the research laboratories of our universities are developing new products, changing the way we think about all matter of things,

and helping us stay competitive. But the outcomes are not always predictable or programmable. Nevertheless, as we look more intensely at how our region and nation are expected to compete in the future, the pressure to do important research and the opportunities deriving from it seem to both be increasing. Economic growth, technological change, and basic research are clearly linked and we are increasingly trying to program those outputs to keep pace or stay ahead of the rest of the world.

A look at economic history, at least back through the industrial revolution, helps us understand these connections. Not long ago, I read the history of the simple clock. It was hundreds of years in development in China and was mostly a toy or simply a curiosity. But, at the time of the industrial revolution in Europe, as labor markets were developing, it became a tool for measuring productivity, the workday, and all of the research where time is an important variable. In other words, the science led to a productive technology, one for which the market implications were evident and important. But it was a very slow process. Certainly the clock was not invented in response to market needs. Rather it was one of those devices that affected how we think about everything else. The process of going from scientific discovery to technological change and marketable products is now part of our economic model, but it is still not predictable. Still, we work hard to search for the results we want.

Now let me shift gears to a broader topic. Much of the government and corporate funding of research in the past sixty to seventy years reflect a belief in those connections and has been much directed. Immediately after WWII, America and the western world experienced a tremendous technological revolution that was spawned in large part by the support of research to win the war. This included all of the nuclear research and a host of other revolutionary findings from areas as diverse as medicine, food storage, and all forms of transportation. Federal research



labs were created in this environment with a “big science” and “national security” agenda. And the private sector got into the act as well with such ventures as “Bell Labs” where many of the best and brightest of the sixties and seventies ended up.

A truly major change in the education landscape accompanied these developments with the emergence of “research universities.” The great universities in America, like Harvard, Michigan, and Berkeley, were home to the greatest minds and many of the best research labs even in the first half of the 20<sup>th</sup> century. But during the post-WWII era many state and private universities that had been home to scholars and students began to emphasize “research” and to prepare research proposals for external funding. This was a clear strategy pushed by federal funding through NSF, NIH, and most of the federal agencies and is the way your research universities now do business. Think of their impact! It can be argued that they have changed the world and the way the world thinks about research and higher education.

Three major initiatives of the past fifty or sixty years have accelerated the process. The first was the period immediately after WWII which, as I previously noted, linked research and national security and focused on an elite core of intellectuals and projects. The second was the major expansion of research emphasis and funding that occurred right after the launch of Sputnik. As a nation this was a signal that the USSR had surpassed us in some areas. The response to this shocking news was to launch and fund programs that would encourage science and research, including heavy support for graduate education. A lot of this effort was connected to expanding databases and managing masses of information. Perhaps the intent was not an information technology revolution that would change everything we do, but the revolution followed the funding and the research. The early advances in both hardware and software were

initiated out of this research. The unintended consequence was a transformation of modern life, still unintended, called the information revolution.

More recent progress came with the expanding of research funding by the federal government in connection with efforts to get at the root causes of disease and develop new treatments. This effort dominated the expanding NIH budget and played a major part in the growth of agency-funded research. And, on the economic development agenda, the biotech industry became an important part of our business agenda that we are only beginning to realize.

### **Creation of Research Universities**

I know I have oversimplified the connections, but I would argue that I have not exaggerated. It is simply obvious that our prosperity and technological leadership are outcomes of research investments that were based largely on quite different objectives. I think it is also abundantly clear that the success of the United States in the latter half of the 20<sup>th</sup> century was also closely related to the manner in which these investments created a new kind of university, not because anyone was trying to create a new university but because research became a prime objective of these institutions. The research production kept us ahead in many key areas and from that transformation emerged a core faculty and an educational process that challenged students to get out of the past and present and focus on shaping the future. America was promoting the development of new ideas in an economic environment that was increasingly opportunistic and market driven.

Let's consider some sweeping and revolutionary changes. For example, universities were among the first institutions to see the great potential of computers. The research involved faculty and their students and those very students, educated to think beyond the present and driven to put the results on the market, created the information revolution and turned it into a previously

inconceivable power to manage and use information for business, science, education, entertainment, as well as nearly every form of vice and perversity. In other fields, they mapped the human genome and began to probe the sources of life. They made the calculation and the material necessary to explore space. The list of new areas of inquiry and great leaps of technology boggle the mind. If the first half of the twentieth century provided the basic theory, the second half put it to work.

### **Conclusion**

Now let me return to the examples with which I started this discussion. The common theme among these examples of important scientific discovery as a result of research is that the investigators were not looking for what they found. I believe that this is an incredibly important point. If we fund research on the basis that it must lead to new products and economic growth, we may restrict the area of inquiry in a way that prevents the most important findings. Even on a macro scale, the research aimed at national defense or a cure for cancer has enormously changed all kinds of things, but it is not clear that our nation is more secure and cancer has not been cured. It is the unintended consequences that always make the most difference.

In today's research environment, corporations spend much more on research than universities, and with good results. But the really breathtaking advances still most often occur in environments where the outcome is not prescribed and you find what is there even if it is not what you were looking for. When the outcome is prescribed and the funding is dependent on the technology transfer, the windows of discovery become clouded.

Research universities as we know them now are also unintended consequences of the decision to fund major research projects through universities. Universities are filled with folks

who are thinking about change and solving problems, rather than focusing, as universities traditionally did, on preservation of culture, language, and traditions.

It is, in some sense, the difference between education and training. When we know exactly what we want someone to do or know, we can specifically convey that information or training and then test to measure its effects. But, education is more. It is creating an environment where folks will think outside the box, go beyond their teachers, and use their tools on new problems. As we think about funding research because of the payoff (and the payoffs have been tremendous) we must remember that the most important returns have come because the funding was a mandate to explore, not a contract to find, and the most likely major effect has been a change in our educational mission. That is why, I believe, American higher education remains far ahead of everyone else.

Congratulations on your accomplishments and I look forward to watching you change the future!