

An Evening with Leon Lederman, Nobel Laureate at The Bakken Museum

By Judith Light Feather



Former Fermilab Director Dr. Lederman on the morning of winning the 1988 Nobel Prize for Physics.

Accepting an Invitation to spend the day in Minneapolis, Minnesota on December 8, 2005 was a wise decision. Having just participated in the recent **Beyond Einstein** webcast from CERN, I was very interested in meeting Leon Lederman in person. His participation from the FERMI lab in Illinois was a humorous, educational parody on the David Letterman show titled: **Late Night with Lederman**, which ran for 1 hr. 37 min. Having just viewed the webcast, I knew he would be quite entertaining in person.

If you missed the live broadcast, you can still view it online at:

<http://beyond-einstein.web.cern.ch/beyond-einstein/>

The afternoon talk for students by Earl Bakken, the founder of The Bakken Museum and Leon Lederman was aimed at stimulating the young students in the audience to seek more knowledge in science and math. Since science basically teaches a young mind ‘how the world works’ it should stimulate their natural curiosity to investigate the world around them.

“Inspiring youth to pursue a lifetime in science to help humanity” was the driving passion of Mr. Bakken when he founded The Bakken Museum. As he explained the passion of his early youth to take everything apart in order to discover how it worked, the audience could feel the years roll back and picture Earl as a young child experiencing his first electrical shock as described in the story.

During the question and answer period, a young student posed a question about failure and wanted to know if Earl or Leon ever felt like a failure. In answering the question both Leon and Earl explained that all science is a process of trial and error, observations and experiments, which are the vital components of research and will naturally include failure in the ongoing quest to prove your theory. However, the positive or negative outcome will be your guide to the next level of inquiry. A negative result should never stop you from investigating a new idea that could lead you down an entirely different path that may unfold an outcome that could totally surprise you. He also explained that all scientists have a question in their minds or a theory that they would like to prove when they start a research project. It is during the observation process of the experiment that the wonders of nature often show themselves, more often than not, disputing your proposed theory. This is not considered failure in the research laboratories. Encouraging

all the students in the audience to understand that what might be considered a failure by a non-scientist is really just one necessary step on the path to discovery. The facts recorded during the experiment become the basic guidelines of direction for further inquiry to validate a scientific discovery,

Some of the parents in the audience were inquiring about mentors for their young children to keep their passion and curiosity expanding. The schools are not teaching science to elementary students in grades K-3 and their children were attempting to learn on their own. One child, who came to all the events at the museum had built his own science project at home and presented it to Earl Bakken as a gift at the end of the program. He was only 7 years old. The afternoon session set the tone for the evening lecture that was to be presented by Leon Lederman titled: **The Quiet Crisis**. We had all just experienced it with this audience who totally support their young children that have such inquiring minds and a passion to learn.

The Quiet Crisis in Science Education

The Welcome address was presented by David Rhees, Executive Director of The Bakken, who highlighted the importance of science education. Rhees stated, “We show the human side of science, hands-on experiments and workshops for young inventors.”

A High-Tech Corporation’s Perspective was given by William Linder-Sholer, Executive Director, ADC Foundation who sponsored the event. As a philanthropic foundation, they have investigated the education issues from a National perspective, finding that the aging workforce increases the challenges to the education system with a huge achievement gap. He felt that our country’s lackluster performance has put our country in danger.

Despite the fact that we think our children are above average in Minnesota, the NATE testing show that the state scores are mediocre, with only 40% of students working at proficiency levels. The statewide averages show us a key gap that exists between black students and white students. Only 19% of black seniors in Minnesota complete high school physics compared to 23% at the national average level, proving that we need to ‘up the ante’ in Minnesota and address the underprivileged issues concerning our student population.

Earl Bakken, Founder and Board Chair of The Bakken, Founder and Chairman Emeritus, Medtronic Inc. gave a talk on **A Medical Technology Leader’s Perspective**. Mr. Bakken stated that as a nation we were in a Crisis due to the shortage of engineers and scientists. Medtronic Inc employs 5000 engineers globally and 6 were being inducted the next evening into the **Fellowship of The Bakken Society**. He also stated that he gets tremendous satisfaction with the programs initiated at The Bakken and has had 8 teachers in residence from the Minnesota schools. He plans to continue the programs and workshops for area students to excel in science.

Leon Lederman, winner of the 1988 Nobel Prize in Physics for his work with neutrinos and author of the book titled: **The God Particle** started his presentation mentioning the inspiration for his current work came from Tom Friedman's book titled: **The Flat Earth**.

The 21st Century is different due to the knowledge and information base that has created new opportunities in all dimensions of life. Change will be inevitable as we behave differently due to the fact that technology influences our behavior. Life Long Learning is now essential as humans need to think, learn and collaborate. Cognitive psychologists, neuroscientists and artificial intelligence experts need to collaborate on what they have learned.

The education system has grown beyond the basic foundation of our forefathers design. It may have served its purpose when there were only 13 colonies with small school houses, but the massive engine that now drives the growth is beyond our control. If you want to initiate any changes you must work your way through the current system.

System Hierarchy

Teachers

Unions

Supervisors

Principles

School Boards

Parents

Training Colleges

Textbook publishers

Legislators

...and finally - the Students.

Everyone is an **EXPERT!** So you might ask...

Why must scientists be involved in education and what can scientific spirit contribute?

Following the Questions below you will find the answer to be...they instill the qualities that make science:

What is Scientific Thinking?

Blend of curiosity and ego

Humility in relationship to the heritage

Skepticism about universal validity of what we learned

A liberating sense of freedom to question authority

An open mindedness regarding new ideas

A confidence in rationalization

Faith in the beauty of science

Science is a way of thinking and we need to make sure every student graduating from high school has it. It is time to wage a war on ignorance. We cannot maintain a 21st Century economy with a 19th Century curriculum. The National Academies report: **Rising Above the Storm** states that we need to train 10,000 teachers every year at a cost of \$20,000 per teacher. We have 16,000 school districts in the United States and have no coherent strategy. No one is in charge...and everyone is the expert...and we continue to fail in both National and International testing scores since they were initiated in 1996.

Therefore over the past 10 years I have developed a program titled: **America's Renaissance in Science - Physics First**, which proposes a core curriculum for a coherent three-year science sequence, titled simply: Science I, Science II, Science III.

I have found in my research and teaching that we teach backwards. Mathematics is the base foundation of all science and we do not introduce algebra into our current curriculum until 9th grade. We also introduce Biology in 9th grade, chemistry in 10th grade and physics is introduced last in 12th grade. This decision was made in 1893, so we have been teaching backwards for over a hundred years.

There is a hierarchy in science that depends on mathematics as the base for all other subjects. Algebra I should be introduced in 7th grade, along with conceptual physics, which avoids the use of extensive math, but emphasizes a grasp of concepts.

Example: $X=VT$ (Velocity/Time)

Concepts of momentum, force, acceleration, temperature, etc. Conservation laws are the natural base of Physics First which can be told with storytelling.

Physics First teaches the key to modern science is the atom, "everything is made of atoms." We need to be teaching the structure of atoms in 7th grade, vertical to the concepts of the Introduction to Algebra. This makes room for advanced courses in physics at the high school level. Chemistry is next in 8th grade as the teachings in chemistry depend on quantum theory at the atomic level, which are covered in physics. Biology is third in the pyramid as cells are made from molecules, which are composed of atoms.

After the introductory courses in middle school, the same hierarchy can be followed for a deeper comprehension of the basic sciences in high school, and the inclusion of higher levels of mathematics, such as geometry, trigonometry, calculus I and II. By teaching the basic Introduction to Algebra, Algebra I and Algebra II in middle school, our students can be competitive globally and prepared for their college courses. Our high school students currently need one math course and one science course per year in high school to graduate. Globally the requirements are three sciences and three math courses per year to graduate high school. Even if we start to make these changes now, it will be a couple of decades before our graduates are able to compete and excel in science and math.

We now have 1000 high schools out of over 24,000 nationwide teaching Physics First. Many of them are in San Diego, CA. It Works!

In our current system biology is just rote memorization to pass the course. It does not make any sense to the students as they have no foundation in physics to base it on.

How do we implement this new structure? We need to require teachers to spend 20% of their time in professional development with each other. They need to relate to each other with storytelling sessions to share the knowledge of their subjects for integration between them, which will then spill over in the classrooms. Show teachers and students that science is life, that science involves everything in their world, from the smallest energy particle to the largest object in space.

Sciences need to be taught as a humanistic activity.

How does it work? How messy is the process of discovery? We need to teach by learning new ways of communicating and integrating our subjects with a coherence that makes sense in the 21st Century! Team teaching and learning through collaborative efforts that encourage students to apply the concepts they are learning about their world to actual situations in their lives. The world is not flat and the crisis is real!

Visit the website for The Bakken Museum at: www.TheBakken.org

If you missed the live broadcast from CERN on Dec. 1, 2005, you can still view the presentations online at:
<http://beyond-einstein.web.cern.ch/beyond-einstein/>

About Leon Lederman:

Leon M. Lederman, internationally renowned high-energy physicist who won the Nobel Prize in physics in 1988. His publications exceed 300 research papers and several popular books. His work in particle physics has contributed significantly to what is known as the “Standard Model”. Dr. Lederman was the Director of Fermi National Accelerator Laboratory from 1979 to 1989. He is a member of the National Academy of Sciences and has served as President and Chairman of the American Association for the Advancement of Science, the largest scientific organization in the U.S.

“Saturday Morning Physics” (a short-course for high school students) was initiated by Lederman in 1980. He has been an outspoken advocate for new approaches to secondary science that emphasize a coherent three-year science curriculum beginning with physics. There are a growing number of schools introducing the new curricula inspired by his advocacy.

Leon Lederman feels very strongly that the academic and corporate worlds need to respond to the growing concern that the United States is now trailing other nations in producing scientists, engineers and mathematicians.

Leon M. Lederman – Autobiography

New York City in the period of 1922 to 1979 provided the streets, schools, entertainment, culture and ethnic diversity for many future scientists. I was born in New York on July 15, 1922 of immigrant parents. My father, Morris, operated a hand laundry and venerated learning. Brother Paul, six years older, was a tinkerer of unusual skill. I started my schooling in 1927 at PS 92 on Broadway and 95th Street and received my Ph.D. in 1951 about one mile north, at Columbia University. In between there were neighborhood junior and senior high schools and the City College of New York. There I majored in chemistry but fell under the influence of such future physicists as Isaac Halpern and my high school friend, Martin J. Klein. I graduated in 1943 and proceeded promptly to spend three years in the U.S. Army where I rose to the rank of 2nd Lieutenant in the Signal Corps. In September of 1946 I entered the Graduate School of Physics at Columbia, chaired by I.I. Rabi.

The Columbia Physics Department was constructing a 385 MeV Synchrocyclotron at their NEVIS Laboratory, located in Irvington-on-the-Hudson, New York. Construction was aided by the Office of Naval Research and "NEVIS" eventually proved to be an extremely productive laboratory, as judged by physics results and students produced.

I joined that project in 1948 and worked with Professor Eugene T. Booth, the director of the-cyclotron project. My thesis assignment was to build a Wilson Cloud Chamber. Rabi invited many experts to Columbia to assist the novice staff in what was, for Columbia, a totally new field. Gilberto Bernardini came from Rome and John Tinlot came from Rossi's group at MIT. Somewhat later, Jack Steinberger was recruited from Berkeley. After receiving my Ph.D. in 1951 I was invited to stay on, which I did, for the next 28 years. Much of my early work on 1 ions was carried out with Tinlot and Bernardini.

In 1958, I was promoted to Professor and took my first sabbatical at CERN where I organized a group to do the "g-2" experiment. This CERN program would continue for about 19 years and involve many CERN physicists (Picasso, Farley, Charpak, Sens, Zichichi, etc.). It was also the initiation of several collaborations in CERN research which continued through the mid-70s.

I became Director of the Nevis Labs in 1961 and held this position until 1978. I have been a guest scientist at many labs but did the bulk of my research at Nevis, Brookhaven, CERN and Fermilab. During my academic career at Columbia (1951 - 1979) I have had 50 Ph.D. students, 14 are professors of physics, one is a university president and the rest with few exceptions, are physicists at national labs, in government or in industry. None, to my knowledge, is in jail. In 1979, I became Director of the Fermi National Accelerator Laboratory where I supervised the construction and utilization of the first superconducting synchrotron, now the highest energy accelerator in the world.

I have three children with my first wife, Florence Gordon. Daughter Rena is an anthropologist, son Jesse is an investment banker and daughter Rachel a lawyer. I now live with my second wife Ellen at the Fermilab Laboratory in Batavia, Illinois, where we keep horses for riding and chickens for eggs. I have been increasingly involved in

development via scientific collaboration with Latin America, with science education for gifted children and with public understanding of science. I helped to found and am on the Board of Trustees of the Illinois Mathematics and Science Academy, a three year residence public school for gifted children in the State of Illinois.

Honors

Leon Lederman is the recipient of fellowships from the Ford, Guggenheim, Ernest Kepton Adams and National Science Foundations. He is a founding member of the High Energy Physics Advisory Panel (to AEC, DOE) and the International Committee on Future Accelerators. He has received the National Medal of Science (1965) and the Wolf Prize for Physics (1982) among many other awards.

Honorary D.Sc.'s have been awarded to Leon M. Lederman by City College of New York, University of Chicago, Illinois Institute of Technology, Northern Illinois University, Lake Forest College and Carnegie Mellon University.

From Nobel Lectures, Physics 1981-1990, Editor-in-Charge Tore Frängsmyr, Editor Gösta Ekspång, World Scientific Publishing Co., Singapore, 1993

This autobiography/biography was written at the time of the award and later published in the book series Les Prix Nobel/Nobel Lectures. The information is sometimes updated with an addendum submitted by the Laureate. To cite this document, always state the source as shown above.

Addendum 1991

I retired from Fermilab in 1989 to join the faculty of the University of Chicago as Professor of Physics. In 1989 I was appointed Science Adviser to the Governor of Illinois. I helped to organize a Teachers' Academy for Mathematics and Science, designed to retrain 20,000 teachers in the Chicago Public Schools in the art of teaching science and mathematics. In 1991 I became President of the American Association for the Advancement of Science.

Honors

D.Sc.'s have been awarded among others by the universities at Pisa, Italy and Guanajuato, Mexico. Elected to the National Academies of Science in Finland and in Argentina. Serves on thirteen (non-paying) Boards of Directors of museums, schools, science organizations and government agencies.

2005 Year of Physics honors Albert Einstein with this message to students on the Nobel Prize organization website :

"Do not worry about your difficulties in mathematics. I can assure you that mine are still greater." - Albert Einstein

Explore the educational pages for students: <http://nobelprize.org/physics/educational/>