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Special Feature

JAMIA

Presentation of the Morris F. Collen Award to Robert S. Ledley, DDS

NAOMI C. BROERING, MLS, MA

Houston Academy of Medicine–Texas Medical Center Library



Robert S. Ledley, DDS

The following description, written by Daniel Masys, provides a historical perspective of the Morris F. Collen Award.

“The American College of Medical Informatics is an honorary society established to recognize those who have made sustained contributions to the field. Since its founding in 1984, 170 fellows have been elected to the College. Its

highest award, for lifetime achievement and contributions to the discipline of medical informatics, is the Morris F. Collen Award. Dr. Collen’s own efforts as a pioneer in the field stand as the embodiment of creativity, intellectual rigor, perseverance, and personal integrity. And so it is that the College gives its highest recognition to those whose attainments have, throughout their careers, substantially advanced the science and art of medical informatics.”¹

This article is based in part on a videotape produced by Ms. Broering for the ACMI presentation of the 1998 Morris Collen Award to Robert S. Ledley, DDS, which was shown November 11, 1998, during the awards presentation at the AMIA 1998 Annual Symposium in Orlando, Florida.

Background

The College is pleased to announce that Robert S. Ledley, DDS, is the 1998 recipient of the Morris F. Collen Award.

Dr. Robert Ledley is a great inventor, scholar, scientist, teacher, and family man. He is witty, clever with words, and has a tremendous sense of humor. Although humble and shy in many ways, he is highly confident of his ability to achieve the impossible. He recognizes that he can invent almost anything.

Today Dr. Robert Ledley is Professor of Radiology, Physiology and Biophysics and the Director of the National Biomedical Research Foundation at Georgetown University Medical Center.

He was born about 60 years ago in Flushing, New York, where he lived his early years and went to school. He earned a doctorate in dental surgery from New York University in 1948, and a master’s degree in mathematical physics from Columbia University the next year. In 1950, two years later, he married Terry Ledley. When they first met, he boldly told Terry he was going to “push forward the frontiers of scientific knowledge.” So, Terry says, “she decided to stick around and watch him do it.” And he did!

The young couple had two sons, Fred and Gary. The family enjoy the outdoors—skiing and hiking. Today, both sons are physicians, graduates of the George-

town University School of Medicine. Fred graduated in 1978 and Gary, a cardiologist, graduated in 1982.²

After serving in the U.S. Army Dental Corps, Dr. Ledley spent the next 20 years in a variety of academic and research positions at the National Bureau of Standards, The Johns Hopkins University, and George Washington University. Today, he is President of the National Biomedical Research Foundation, which he founded in 1960 and where he has supported and created most of his computer systems and inventions. He has received over 60 patents on applications of computers to medical instrumentation.

In the 1960s Dr. Ledley had already begun to demonstrate his unique genius. He moved the National Biomedical Research Foundation to Georgetown University School of Medicine in 1970, where he joined the faculty in the departments of physiology and biophysics and of radiology.

To gain valuable insights of Dr. Ledley's work, a series of interviews were conducted with faculty colleagues at Georgetown University.

Reflections of William R. Ayers, MD, Vice President, Educational Commission, Foreign Medical Graduates; former Senior Associate Dean, Georgetown University School of Medicine:

"There are at least two stories connected with Bob's coming to Georgetown. Both are true. Dean John Rose was really recruiting Bob's wife, Terry. John Rose and she had both attended the High School of Music and Art in the Bronx, and it would be in Georgetown's tradition of liberal arts to have such a person connected with Georgetown. Remember, Georgetown doesn't have an engineering school and at the time didn't have anything going in computers.

"And therein lies the second tale. Georgetown had just received a huge grant to expand the size of the medical school—both enrollment and facilities. To provide an architecturally and symmetrically necessary part of the drawings for the new library building there was an unassigned empty block of space. Someone labeled it "Computers." And this became the home of the National Biomedical Research Foundation.

"Bob is a provocative thinker. Some of those provocative ideas were, of course, contained in his seminal article on the reasoning foundations of medical diagnosis, published in *Science* in 1959 with the late Lee Lusted.³ It is notable that this specific article, the second listed in his curriculum vitae (which is now measured in pounds rather than pages) is certainly the most often cited in the field of medical decision making, according to the automated version of citations.

"Not only a prolific writer, Bob has founded and served as editor-in-chief of several journals, some now discontinued, others renamed as the boundaries of science have expanded. At last count, they included *Pattern Recognition, Computers in Biology and Medicine, Computerized Medical Imaging and Graphics, and Computer Languages*.⁴

"After his auspicious beginnings with bits, bytes, ones, zeros, and Hollerith cards, Bob's major interest in medical informatics centered on imaging techniques. He continued work on the application to chromosome analysis and developed the whole-body scanner, the ACTA computerized axial tomography, now shortened to CT."

In 1965 Dr. Ledley wrote a seminal textbook on the use of computers in biology and medicine.⁵ This and his other works sowed the first seeds in the field of medical informatics, in the use of computers to aid physicians in diagnosing and treating patients.

In the 1960s Dr. Ledley's vision of computers led to another great contribution to medical informatics. He began to develop genetic databases. Dr. Milton Corn recalls those early days at Georgetown.⁶

Remembrances of Milton Corn, MD, Associate Director, National Library of Medicine; former Dean, Georgetown University School of Medicine:

"I first met Bob Ledley in the 1970s when I joined the faculty at Georgetown. I became his admirer and have been his admirer ever since. He has a genius for creative opportunism unparalleled among the people I have worked with. He has a sense for spotting opportunity and acting on it. Databases are a good example. Now that we are in the decade of molecular biology, databases are everything. Genbank is an example.

"Another example, though, is Ledley's Protein Information Resource (PIR), one of the premier protein sequence databases in the world—in the public domain, richly annotated, used by almost everybody in molecular biology field. We need to remember that Bob Ledley started on this work in the 1960s when molecular biology was not a growth industry. He and Margaret Dayhoff, a pioneer in the field, compiled an atlas of all known protein sequences. This atlas grew, was maintained by them, ultimately was put into electronic form, and became the Protein Information Resource in the 1980s.⁷ It was supported by the NIH through the National Center for Research Resources, and in 1989 it was transferred to the National Library of Medicine, which has been supporting it ever since. It is still supported by the NLM."⁸



Dr. Ledley in his laboratory at Georgetown University.

The computer is the central thread in Dr. Ledley's work, but most fascinating is the imaginative spin it takes. Once he solves a problem he uses the new knowledge to create something else, something not previously imagined. He says, "you need to look at things from different angles and then you can envision something new."

Comments by Alan E. Zuckerman, MD, Assistant Professor, Georgetown University School of Medicine:

"The first project that Dr. Ledley began when he started the National Biomedical Research Foundation in July 1960 was the computerized analysis of the human chromosome. We believe that this was the first medical imaging application. In those days, and for years afterwards, people would cut up photomicrographs of chromosome spreads and manually paste up the chromosome images in the correct order. Dr. Ledley used a flying spot scanner to digitize the image and developed a syntax-driven pattern recognition algorithm to correct for orientation and identify each chromosome, even when they overlapped. This was the beginning of his work in pattern recognition, and a few years later he founded the *Journal of Pattern Recognition*, which he has continued to edit for 31 years.

"One thing led to another, and the project expanded its scope. Before you could analyze the chromosomes, you had to find them, and this was a very time-consuming task. Dr. Ledley extended the work by using the computer to scan a slide in only three minutes, finding all the metaphase spreads. At a time when most computer interfaces were hardwired or used decks of punched cards, he developed one of the first interactive video displays to allow the technician to select which chromosome spreads to study.

"While others were still getting used to the Apple

Macintosh with its mouse crawling around the desk, Dr. Ledley built a Bat, a three-dimensional mouse, which enabled physicians to make measurements, such as the length of the fetus's femur, and point to objects in three-dimensional space within his stereo images.⁹

"Bob is a most deserving and fitting recipient of the Morris F. Collen Award, and it has special meaning to him because, unlike so many of the other awards he has received, this one comes from his colleagues in the field of medical computing, which he helped create and influence over his long career."

Contributions to Dentistry

The National Institute of Dental Research (NIDR) recognized Dr. Ledley's work to improve dentures. An important video covering Dr. Ledley's work in dentistry and his ongoing research discoveries was developed during the 50th anniversary of the National Institute of Dental Research.

Nursing Informatics Contributions

Not very many people know about Dr. Ledley's contributions to nursing informatics. Most of this work was done at the Georgetown University Medical Center in the 1970s.

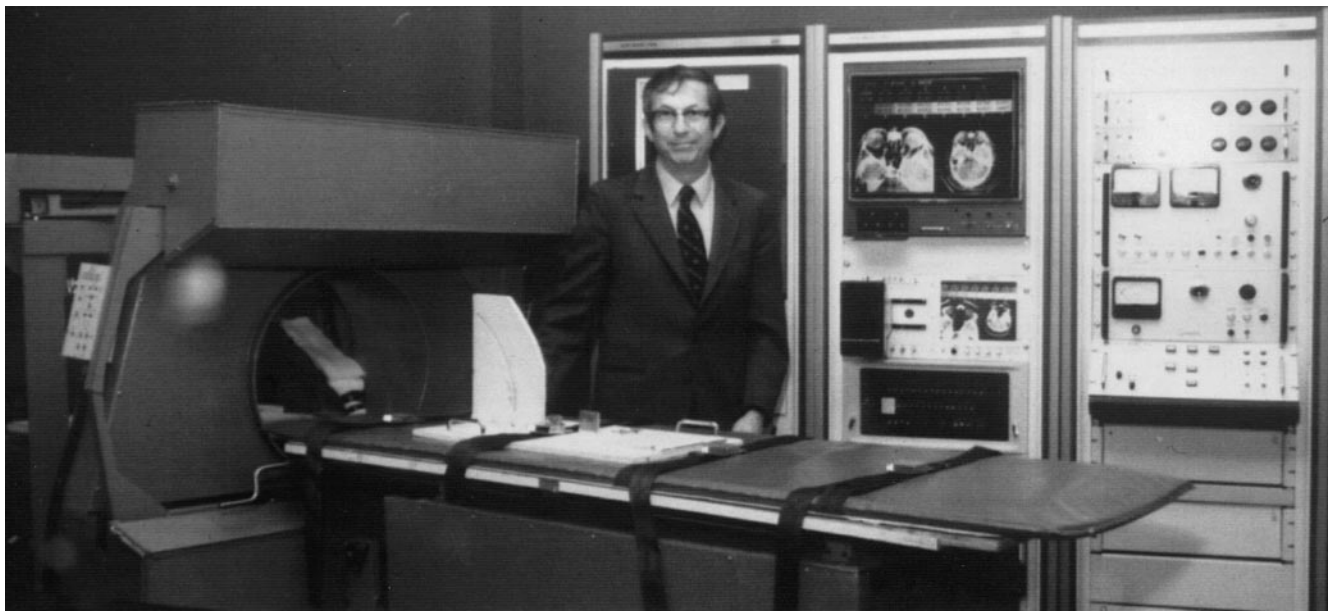
Virginia Saba, RN, EdD, Georgetown University, School of Nursing and Uniformed Services University of Health Sciences:

"Bob Ledley also focused on nursing. His early research helped shape the scope of computer technology in patient care and nursing informatics.

"In the 1970s he conducted studies to demonstrate the use of computer technology in diagnosing and treating patients. His research on cost containment in a concentrated care center is a landmark study that led to the creation of critical care units in hospitals.

"At Georgetown University Hospital, he conducted research on a concentrated care center (CCC) that was being instituted to provide specialized care for serious ill cardiac, surgical, medical, and pediatric patients. He studied their nursing needs, their intensity levels, and other variables that focused on nursing workload measures. He demonstrated that grouping patients by similar intensity levels, or progressive patient care, instead of by disease conditions was the most cost-effective method of determining their nursing requirements.¹⁰

"In another study he focused on the design and development of an automated tool for the screening of



Dr. Ledley with the original ACTA scanner, which is currently housed at the Smithsonian Institute.

clinic patients, which he referred to as a 'steering clinic screening aid.' This effort demonstrated the need for triage of screening of patients, which now is performed by nurses. This tool can also be envisioned as the basis for computer-based patient record.¹¹

"So, Bob, thank you for supporting nursing informatics in your research efforts. You are truly worthy of this prestigious award."

Discussion: The ACTA Scanner

There is no doubt that Dr. Ledley's most prominent contributions have been in computerized tomographic scanning technology. In the early 1970s, he invented the automatic computed transverse axial (ACTA) scanner, which was the first CT scanner capable of making cross-sectional images of any part of the human body.¹² When he described to his colleagues what he wanted to create, no one could envision that it would work. Well, his motto is "if you don't know, then make it up." So, he made a model of balsa wood and showed it to his coworkers, and they reacted immediately by saying "Oh, okay, let's build it." This device revolutionized the fields of radiology and medical imaging. It set the standard for all subsequent CT scanners. The algorithms that Bob devised were later adapted for use in magnetic resonance imaging and positron emission tomography.

The prototype of Dr. Ledley's ACTA scanner is in the Smithsonian Institution. Because of this outstanding

discovery he was inducted into the National Inventor's Hall of Fame in 1990.¹³

During 1979–80, Dr. Ledley developed the computerized electroneuro-ophthalmograph (CENOG), an integrated system for the analysis of ocular motility, which helped in diagnosis of seizure patients. This great discovery was broadly covered by the national media from Washington, D.C.¹⁴

The National Medal of Technology

Dr. Ledley's lifetime achievements and significant contributions to the nation were recognized in a White House ceremony on American Leadership in Science and Technology, where he was awarded the 1997 National Medal of Technology by the President of the United States, Bill Clinton. In the ceremony, which was attended by numerous dignitaries, Dr. Ledley of the National Biomedical Research Foundation, Georgetown University Medical Center, received the award under the category of general product and processing of innovation. The award citation states:

For pioneering contributions to biomedical computing and engineering, including inventing the whole body CT scanner, which revolutionized the practice of radiology, and for his role in automating chromosome analysis for prenatal diagnosis of birth defects.¹⁵

In a delightful *Scientific American* interview with Dr. Ledley by the actor Alan Alda, it is evident that this

humorous, modest, and charming man could fascinate even a movie star, with his many inventions and outstanding achievements. Alan Alda spoke about the early development of automated chromosome analysis and how Dr. Ledley became a leader in the automation of prenatal screening of birth defects. This work was significant because it made it possible to scan chromosomes for anomalies that cause Down syndrome and other birth disorders.

They also discussed Dr. Ledley's vision of computers, which led to the creation of the Protein Sequence Database, PIR, and the early development of a genetics database, which is now Genbank, the premier, universally used genetics database.

Dr. Ledley's major interest in medical informatics centered on imaging techniques. He told Alan Alda how he was able to solve imaging problems through an algorithm that he laughingly called the "convolution revolution." It resulted in development of the whole-body ACTA scanner.

When asked by Alan Alda what the central theme of his work was, Dr. Ledley replied, "It is computer applications in medicine, mathematical algorithms, and putting them together."¹⁶

Conclusion

Dr. Ledley is not finished working yet. He currently has a grant from the NIH on three-dimensional stereo aids to stereotactic brain cancer surgery. He is fascinated by stereoscopic display of three-dimensional images, something the world has been slow to follow, but who knows where it will lead? A sign in his office reads, "Be Reasonable, Do It My Way." As Alan Zuckerman from Georgetown says, "The success of Ledley's approach is based on careful attention to critical details."

The great Albert Einstein (1879–1955) is a hero of Dr. Ledley's. He wrote, "The whole of science is nothing more than a refinement of everyday thinking."¹⁷ Obviously, this pursuit is the code by which Dr. Ledley thinks, invents, and creates.

For all his contributions to science and medicine, the American Medical Informatics Association and the members of the American College of Medical Informatics congratulate Dr. Ledley on his scientific achievements. For his contributions to the field of medical informatics, to the advancement of medical diagnosis, and to humanity, the College is proud to

present the 1998 Morris F. Collen Award for lifetime achievement to Dr. Robert S. Ledley.

The author thanks Daniel R. Masys, MD, William R. Ayers, MD, Milton Corn, MD, Alan E. Zuckerman, MD, and Virginia Saba, RN, EdD, for their contributions to the video presentation and to this paper.

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