The American College of Medical Informatics is an honorary society established to recognize those who have made sustained contributions to the field. Its highest award, for lifetime achievement and contributions to the discipline now known more inclusively as biomedical 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. At most once a year, the College gives its highest recognition to an individual whose attainments have, throughout a career, substantially advanced the science and art of biomedical informatics. In 2008, the College was proud to present the Collen Award to Robert A. Greenes, MD, PhD (Figure 1).

‘Bob’ Greenes, who like Dr. Collen himself was one of the pioneers in biomedical informatics, has had multiple achievements as a physician, computer scientist, researcher, educator, and eloquent spokesperson for the field. His career contributions make him most deserving of the recognition embodied in the Collen Award.

A Pioneer in Biomedical Informatics

Bob was born on June 17, 1940 in Cleveland, OH. His parents owned a hardware store in the Polish neighborhood where he and his sister grew up. Upon graduation from Cleveland Heights High School, Bob did undergraduate work at the University of Michigan, where he majored in zoology and took a course in computing (Fig 2). He entered Harvard Medical School in 1962, where he looked for individuals doing work with computers in medicine and quickly sought ways to become engaged in clinical computing research. He later noted:

I’ve had the wonderful luck and opportunity to begin my career in the field of biomedical informatics much at the same time that the field itself was beginning to take shape. In 1964 Octo Barnett came to Massachusetts General Hospital (MGH) to run the hospital portion of a project called 'The Hospital Computer Project. I joined this project as soon as I learned about it.

There was a lot of naïveté and optimism in those days. The idea was to implement a time-shared operating system on a PDP-1 computer, using teletype machines connected by 10-character-per-second modems. It was one of the first time-sharing systems in the country. Neil Pappalardo, Curt Marble, and I began to think about the possibility of developing medical applications using a new operating system and computer language that we would develop on a PDP-7 computer in the laboratory.

This novel computer language evolved during the 1960s into what became known as the Massachusetts General Hospital Utility Multiprogramming System (MUMPS) and it formed the basis for many early applications at MGH. Closely involved with the development of MUMPS was Dr. Octo Barnett, who would later say of Bob Greenes: He was one of a brilliant group of young computer-niks who created a new language and a new vision of the potential role of computer technology in medical care.

With the development of MUMPS, the Hospital Computer Project was awarded a grant from the NIH. Although the novel system was very limited in memory and speed by modern criteria, a series of remarkably successful applications emerged from the MGH group over the next few years.1–4 Some 40 years later, MUMPS (which has since come to be known as “M”) continues to be heavily utilized for both medical and nonmedical applications.

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applied for a postdoctoral grant from the NIH to pursue his PhD in Applied Mathematics (with an emphasis on computer science) at Harvard. To our knowledge, he thus became the first physician in the country to obtain such a doctorate. This type of MD/PhD training later became a critical component of many biomedical informatics programs in the United States. Referring to his PhD training years, Bob has noted:

This was a wonderful opportunity because the program was very flexible. I was able to take courses at both Harvard and MIT, including a course in decision and control taught by Howard Raiffa, one of the fathers and founders of the field of decision science. I decided to do a thesis on structured capture of progress notes by physicians’ data entry in a hypertension clinic at Mass. General Hospital. To do this project, with the help of engineers we developed a touch-screen computer interface to a CRT display terminal. We did this by pasting aluminum strips on the screen at points where selections could be made and connecting those strips with wires to a capacitor circuit (Fig 3).

Also involved in this early research was Edward H. Shortliffe, MD, PhD, President and CEO Designée for the American Medical Informatics Association and recipient of the 2006 Collen award:

I was personally excited to hear that Bob Greenes was selected as this year’s Morris Collen awardee, since Bob has been arguably the single most consistent influence on my professional career since my early days as a Harvard undergraduate when I went over to Octo Barnett’s lab and was paired-up with Bob as his research assistant while he was doing his PhD in the late 1960s.

The field that we now call biomedical informatics was unrecognized as a discipline at that time, and others have pointed out that Bob Greenes was a visionary in his appreciation of what was coming and the kind of professional commitments that were needed. For example, Milton Corn, MD, Director of Extramural Programs at the National Library of Medicine, has noted:

I think there was some appreciation, some ability to see the future, in Bob, that made him realize long before almost anybody else that the role of the computer in improving health care was going to be enormous ... and he took a chance.

After completing his PhD, Bob briefly worked in the commercial world, serving as President of a young company, Automated Health Systems, Inc, that sold MUMPS-based clinical information systems into the hospital marketplace. Recognizing that he preferred the academic research envi-
results of his decision analysis research in Medical Decision Making, then in its third year of existence,\textsuperscript{8} as well as several other journals.\textsuperscript{9,}\textsuperscript{10,}\textsuperscript{11} He collaborated with his former mentor, Octo Barnett, and Rita Zielstorff in the first IAIMS grant to Harvard Medical School.\textsuperscript{12}

At the DSG, Bob led several federally funded projects related to medical knowledge management and decision support. A key contribution of the DSG was its role in the development of the Unified Medical Language System (UMLS). Dr. Betsey Humphreys, Deputy Director of the National Library of Medicine, has noted:

> In my mind, Bob Greenes will always be associated with the early years of the UMLS project. He was at that time utterly consistent, and throughout the rest of his career as well, in saying that what we really needed were some good tools that would make the UMLS resources more useful and usable to people. So Bob was really ahead of the curve and brave to be working solely or heavily on the tool side when there was absolutely nothing like platform independence (in fact, in a period in which platform independence was a pipe-dream).

The UMLS effort was precedent setting, not only for the results but for the way in which the coordinated project, with contracts from the NLM to several leading informatics research sites, brought people together across institutional boundaries and showed how collaboration could work at a distance and with crucial involvement by trainees as well as faculty members. Bob Greenes would later note:

> I’ve come to believe that informatics is a terrific vehicle for social engineering. If one has a good idea and can bring people together to test it, to explore it, to expand on it, and to use it, we’ve actually created something that was not there before.

Bob supervised research on information retrieval by one of his first trainees, Dr. William Hersh.\textsuperscript{13} He also addressed practical problems at the Department of Radiology by developing practical computer-based solutions. For example, derivatives of pioneer work on a structured reporting system for ultrasound studies, developed by Dr. Doug Bell under Bob’s supervision, are still in use at BWH.\textsuperscript{14,}\textsuperscript{15} Another early trainee, Dr. Rick Shiffman, worked on the representation of clinical practice guidelines as decision tables.\textsuperscript{16} Bob allowed his trainees to explore their own ideas, but also brought them back firmly to well-grounded problems that could be tackled effectively and in the time available to them. As Dr. Shiffman (now an associate professor at Yale University) recalls:

> Among the first projects I proposed to Bob was creating an expert system to help with the diagnosis of dysmorphic children. At the time Bob himself was thinking about knowledge representation using algorithms. And he counter-offered a suggestion that I pursue a problem he was wrestling with. Now one of Bob’s most enviable qualities is his ability to focus on a problem until it gets solved. Each month I’d offer a fresh expert systems proposal at our meetings and each month he’d patiently re-describe for me the issue with the CAT scan, and how he thought it’d make a good fellow project.

Dr. Bill Hersh, Professor and Chair of the Department of Medical Informatics and Clinical Epidemiology at the Oregon Health and Sciences University, also has fond memories of Bob’s mentoring skills:
An important aspect of Bob’s mentorship is that he taught me how to be a mentor... he showed me that it’s not just a matter of teaching someone or critiquing their work, but really keeping an eye out for their career and the directions that they’re headed.

Another former trainee, Dr. Luke Sato (Chief Information Officer for the Harvard Risk Management Foundation), notes:

I was just really struck with the sophistication, the innovation, and the out of the box thinking that was taking place in his laboratory. He really forced us to think non-traditionally and challenged us on our assumptions and forced us to think beyond what was really capable at the time.

These themes are often recapitulated by other trainees, such as Dr. Steven Labkoff, now a Senior Director with Pfizer’s Global Business Unit:

One of the most compelling things about working in the DSG was best summed up in a poem by Edgar A Guest. The poem was, “It Couldn’t Be Done”. The poem outlines stepping up to huge challenges. It summed up Bob’s philosophy about our projects. He seldom if ever said “it can’t be done”, or “you can’t do that” in general. In point of fact, the lab was a place which encouraged me to push the envelope, test the limits, and where possible, break through. It was this kind of creative freedom that helped me to try ground breaking things. It is a philosophy I’ve kept with me throughout my career in the business world.

Bob led a group of talented physician trainees and computer scientists in the exploration of several new technologies that later became mainstream in informatics, such as a web-based prototype for scientific journal publishing in the mid 90s (a prototype for the New England Journal of Medicine’s online publication was developed at the DSG), and a web system for Partners Healthcare System (a merger of BWH and Massachusetts General Hospital, two of the academic medical centers affiliated with Harvard Medical School).

Other contributions from this period include participation in the InterMed Collaboratory, a consortium of leading medical informatics centers from 1995 to the early 2000s involving medical informatics researchers from Columbia, Stanford, McGill, and Harvard Universities. As part of InterMed, the GuideLine Interchange format (GLIF), a model for representing and sharing guidelines in a computer-interpretable format, was created. Under Bob’s leadership, this line of research, as well as many others, was continued at the DSG (Fig 5). GELLO, an expression language for GLIF, later became an HL-7 standard.

In 2005, at the celebration of the 25th anniversary of the DSG, Bob became the first incumbent of the Distinguished Chair in Biomedical Informatics at BWH and also received a leadership award from AMIA. Over 200 colleagues, family, and friends from around the world came to the Harvard Faculty Club to celebrate this memorable event.

The Boston-Area Informatics Research Training (BIRT) Program

Bob founded and was the director of the BIRT program for 15 years. The BIRT program is the largest NLM-funded program in biomedical informatics, with 24 pre- and post-doctoral trainees who perform research in ten different biomedical informatics laboratories in the Boston area. This consortium of laboratories includes Harvard, MIT, Tufts, and Boston University. Bob worked with Professor Peter Szolovits from MIT in the creation of a master’s program in Medical Informatics at the Division of Health Sciences and Technology of Harvard-MIT. The master’s program was launched in 1996 and has graduated over 30 professionals, who now hold several prominent positions in the healthcare industry and academia, nationally and abroad. Doctoral degrees are granted through the Department of Electrical Engineering and Computer Science at MIT or the Department of Health Decision Science at Harvard.

Given his dual role as training program director and director of one of the ten laboratories that compose the program, Bob had the opportunity to interact with several trainees, faculty, and staff from competing institutions. His success in this challenging role attested to Bob’s leadership skills and continued commitment to education in biomedical informatics. The excellence of his educational role has been recognized not only by his trainees and local colleagues, but also by external observers such as Dr. Donald A.B. Lindberg, Director of the National Library of Medicine.
I think Bob more tends to investigate questions than to pound-out and insist on answers to a problem. I think he sees a problem as an opportunity for search and inquiry: that’s what makes a good teacher to begin with. I can remember years ago, he was very interested, again with foresight, in the Apple machine. They had some programs that allowed you to make associations and sort of build almost toy databases and he got a lot out of those—and he used that, again in this teaching mode, so that a person could go ahead and develop a conceptually interesting problem without being bogged down by the weeks and weeks of program writing. I think he has been an excellent mentor—no doubt to many people.

National and International Service to the Field of Biomedical Informatics

Bob served in many capacities on national and international academic and industrial committees. Nationally, he served on the Biomedical Library Review Committee of the National Library of Medicine (for which he served as Chairman in 1986–87) as well as numerous review committees in other institutes at NIH. A fellow of the American College of Medical Informatics since 1984 (the year in which the organization was founded), he rose to positions of leadership in a number of professional organizations, including the American Medical Informatics Association, the Radiological Society of North America, and the American College of Radiology. He was elected President of the American College of Medical Informatics in 1996 and served for many years on the Radiology Information Systems Consortium. He is also a frequent speaker at national and international meetings, where he not only presents his own research but also often is asked to give analytic presentations that reflect his broad knowledge of the field and his ability to synthesize the complex topics that range from computer software and hardware to both the clinical and basic medical sciences. In 1999, he was elected to membership in the Institute of Medicine of the National Academy of Sciences. Bob Greenes has authored over 200 articles books in the fields of medical informatics and is an associate editor of the Journal of Biomedical Informatics. He is the editor of a textbook entitled Clinical Decision Support: the Road Ahead, published by Academic Press, Burlington, MA, 2007 (Fig 7). Bob also contributed two co-authored chapters to the now classic textbook Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Shortliffe and Cimino, eds, Springer, 2006).

The Department of Biomedical Informatics at Arizona State University

After careers that kept Bob and his wife Carole in Boston for most of their adult lives, both of their professional circles were startled when, in 2007, they announced their decision to leave their familiar surroundings and accept positions at Arizona State University (ASU) in Phoenix and Tempe. Bob was attracted by the opportunity to serve as founding chair of a new Department of Biomedical Informatics, created at ASU as part of their contribution to a new medical school campus in Phoenix, jointly created with the University of Arizona. The University of Arizona College of Medicine—Phoenix, in partnership with Arizona State University brought a new medical school to Phoenix, the fifth largest city in the United States and the only major United States city without a medical school. The University of Arizona’s College of Medicine was founded in Tucson in 1967 and has been the only allopathic School of Medicine in the entire state. It was established with strong support by state and city government and with an early commitment to incorporating biomedical informatics into the medical curriculum as part of a collaboration between the two major state universities.

Since assuming his new role in Sept 2007, Bob has been building an exciting new department with excellent, well-known faculty members and advanced facilities. He and his colleagues have described the new program in a recent article and he has expressed his enthusiasm for what is possible in the Arizona program:

The move has turned out to be a very enlightening and exciting experience . . . with the openness of collaboration and the willingness to build bigger and better things to improve health and healthcare.

One of his senior faculty members, Professor Vimla Patel, preceded him in Arizona and helped to get the program established before Bob was recruited:

When I moved to Arizona and agreed to be the interim-chair of the newly formed department of biomedical informatics, one of my major goals was to find a permanent chair. One of the first names that came to my mind was Bob Greenes—given his background in informatics education and his profile as a cutting-edge researcher in his field.
The ASU’s leadership has been remarkably visionary in identifying the need for an academic program in biomedical informatics and working to commit the necessary resources. The ASU President Michael Crow, PhD, has been especially enthused that the university has attracted Bob Greenes to this leadership role:

He came to ASU from Harvard and has done a tremendous job here building our department of biomedical informatics. But far more than that, I think of this as an example of the kind of impact he had throughout his entire life: he comes in and starts taking-on big questions and big issues.

Similarly Dr. Sethuraman Panchanathan, Professor of Computer Science and Director of ASU’s School of Computing and Informatics (which is the home to the new Department of Biomedical Informatics), has remarked:

Clearly the pace at which Bob has progressed biomedical informatics and made it an integral part of many clinical translational research and academic opportunities in Arizona is reflective of the kind of person Bob is, in terms of being able to advance things rapidly, as well as with very high quality.

Final Remarks

Bob Greenes’ accomplishments amply reflect his novel background and abilities, his willingness to be a risk-taker, and his tendency to be among the first in our field to identify the important “next problem” to which he wishes to devote his time and energy. His special contributions to medical decision making and its computational components have been particularly noteworthy, as emphasized by Octo Barnett:

Much of the work of we dwarfs in clinical decision making have benefited by standing on Bob’s shoulders.

It is accordingly fitting and timely for his remarkable career and contributions to biomedical informatics to have been recognized with the Morris F. Collen Award for 2008.

References