

The Genealogy of Maryland Information Technology Company
Founders: Bioinformatics, Medical Informatics, Health Informatics

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The Genealogy of Maryland Information Technology Company Founders: Bioinformatics, Medical Informatics, Health Informatics³

The “family histories” of Maryland technology companies are intertwined stories of entrepreneurs, technologies, and corporate structure. This project has focused on the pathways taken by the people who founded the technology companies operating in Maryland today. But it has been of necessity a study of corporations that have grown and shrunk, restructured or moved away, merged or spunoff, and of successive generations of technology development in core fields like vaccines, genomics, and optics. The results will help the state refine its marketing to both companies and potential entrepreneurs and better understand and capitalize on its research institutions and other technology generators. The Milken Institute’s 2004 survey ranked Maryland 4th overall in its ratings of states best positioned to take advantage of opportunities for growth in the New Economy, based on high scores in educational attainment, R&D, and capital availability.⁴ It is clear from this study that these same strong fundamentals have been providing fertile soil for technology entrepreneurship for 25, 50, and sometimes 100 years.

Six sectors were examined: bioscience and biomedical instruments, information technology equipment and services, private research and development, energy/chemicals/materials, defense and aerospace, and high technology machinery and instruments. Each sector was characterized by different patterns of entrepreneurship.

Why Maryland?

The researchers sought to answer why entrepreneurs started their companies in Maryland by combing databases, websites, news archives, and, when necessary, telephoning companies to determine what brought the founders to the state. The hypotheses they tested were:

- Entrepreneur was born here and either stayed or returned
- Entrepreneur came to Maryland for a job in another firm and left it to start own company
- Entrepreneur stayed in Maryland to start own company when employer left/closed/was acquired/laid off employees
- Entrepreneur came to Maryland for job in a federal laboratory
- Entrepreneur came to Maryland for a job in a university
- Entrepreneur came to Maryland to go to school
- “Serial” entrepreneur cashed out of previous start-up and started new company

³ Conclusions or opinions expressed in this publication are those of the authors and do not reflect the views of staff or others affiliated with the Institute for Policy Studies, The Johns Hopkins University, the Maryland Department of Business and Economic Development, or the Maryland Technology Development Corporation.

⁴ http://www.milkeninstitute.org/pdf/nstech_index04.pdf

Bio-, Medical, and Health Informatics Entrepreneurship in Maryland Executive Summary

The numbers: 142 companies, over 85 percent homegrown, 145 known founders.

FINDINGS

These industries have only existed for about a decade and definitions of these nascent fields are still evolving.

The commercial application of information technology to biomedical research, development of diagnostics and therapeutics, and delivery of health care has a relatively short history. The industries are known variously as genomics, proteomics, bioinformatics, imaging informatics, health informatics, nursing informatics, medical informatics, healthcare automation and others.

The bio/med/health IT industry in Maryland is young.

Of the 108 companies for which a founding year is known, only 12 existed before 1980.

Maryland's research institutions give it key advantages in these new interdisciplinary industries.

Maryland's research institutions (universities and federal laboratories) are advancing knowledge across disciplines, educating a new generation of cross-trained health professionals and researchers, and supporting the development of infrastructure and standards.

Several of the key professional associations in the field are headquartered or have active chapters in Maryland.

The 3,200-member American Medical Informatics Association (AMIA) is based in Bethesda, the American Society of Health System Pharmacists (ASHSP) is also based in Bethesda and the 600-member Maryland Health Information Management Association (MDHIMA) and the 1000-member Maryland Society of Healthcare Information Systems Management (MSHISM) are local chapters of national organizations.

Maryland's government contractors, particularly its systems integrators, are moving aggressively into the bio- and health informatics fields.

Maryland's advanced information technology developers have also found biomedical and healthcare applications for their innovations.

Maryland's 142 bio/med/health IT companies span the full range of activities in these fields.

Biomedical research and drug development companies include those involved in: clinical trials management and support, computational neuroscience, genomics/proteomics/bioinformatics products and services, imaging and molecular imaging, laboratory automation, knowledge management and transfer, modeling, product development, research collaboration/management/support, research tools, and simulation. *Healthcare delivery (clinical informatics) companies* include those involved in: computer-assisted surgery, consumer-directed healthcare, decision-support systems, disease management, electronic (computer-based) patient record, imaging and PACS, nursing informatics, point-of-care computing, provider order entry systems, public health informatics, rehabilitation, and telemedicine. *Healthcare management companies* include those involved in credentialing, education for patients, education and training for staff, emergency department management, healthcare enterprise IT, healthcare enterprise market analysis and marketing IT, healthcare practice management, HIPAA

compliance, laboratory information systems, long-term care IT, managed care IT, medical language processing and transcription, network and security, pharmacy/drug management, and risk analysis and management, including quality control.

Almost all of Maryland's bio/med/health IT companies are homegrown, but the founders come from diverse backgrounds.

Over 85 percent of the companies for which founder data was available were started in Maryland. Sixty percent of the founders had worked in industry, 18 percent in universities, and 16 percent for the federal government.

- **Because so many of the bioscience companies in Maryland are genomics-related, many of the findings of the Maryland Bioscience Founders Report published by TEDCO in 2002 hold true in the bio/med/health IT sector, particularly the unusually high percentage of company founders who came from research institutions.**
- **Of the 68 corporations where Maryland bio/med/health IT entrepreneurs worked previously, 25 were in biomedical or healthcare fields.**
- **Surprisingly few Maryland bio/med/health IT entrepreneurs previously worked in pure information technology companies; many had large company experience.**
- **Very few of Maryland's bio/med/health IT entrepreneurs had previous experience in similar companies or ventures.**

The majority of both bio- and health- IT company founders hold advanced degrees, from colleges and universities in the U.S. and abroad.

While the number of advanced degrees was not surprising among the bioinformatics founders, the prevalence among the health informatics entrepreneurs suggests that these fields require specialized knowledge, either in business or science or both. Approximately one-third of the degrees were from area (including D.C.) universities and colleges.

Several of Maryland's bio/med/health IT companies have diverse international ties.

A health care information security firm is based in London and Glenwood, Maryland. An Annapolis imaging company is commercializing Swiss technology and a Rockville incubator houses a genomics company incubated initially in Israel. Several companies outsource healthcare-related IT services to transcribers, programmers, and IT solutions staff in India, Russia, and Egypt.

Venture capital has flowed unevenly within this diverse group of industries.

Venture capitalists have been responsible for starting a number of Maryland bioinformatics and medical informatics companies, as well as supplying financing to many others. A different group of venture capital firms have funded health informatics companies, which seem less likely to attract venture capital. Corporate venture financing has been made available to several imaging companies.

Like most other industries, the bio/med/health IT world is seeing substantial consolidation, particularly in healthcare-related companies.

Maryland companies have been among both the acquired and the acquiring.

IMPLICATIONS FOR POLICY AND PROGRAMS

Maryland leaders need to:

Provide an open-armed experience for graduate students and post-doctoral and visiting fellows while they are in Maryland, exposing them if possible to some of the state's successful bioscience entrepreneurs.

Work with universities and federal laboratories to identify and encourage interdisciplinary initiatives and research groups that are focused on the intersections of information technology and bioscience and health care. Support university/federal lab/corporate research centers of excellence at the frontiers of grand challenges in these fields, including NSA's informatics initiatives, NSF-supported computer-assisted surgery, molecular imaging, and bioinformatics data mining.

Establish a regular presence at the gatherings of professional associations in these industries, for two purposes. First, to make a concentrated effort to get to know bio/med/health IT company managers and to celebrate their successes. Also, to understand the dynamics and needs of their fields, and to work together on policy initiatives, standards, and other efforts to strengthen these hybrid industries in which Maryland has competitive strengths. Secondly, to foster the start-up of new companies, knitting them into existing networks of support for Maryland entrepreneurs.

Include bio/med/health IT strengths in Maryland's marketing and promotion strategies and collateral materials. MDBio's excellent inventory and promotions of the state's bio-tools infrastructure can be usefully incorporated into the state's marketing efforts. Bioinformatics companies generally require less specialized facilities than drug development bioscience companies, and therefore are more footloose. Precious assets that are highly coveted by other states, they deserve a concerted retention effort.

Create opportunities for Maryland buyers and sellers of bio/medical/health IT products and services to interact. Vendors benefit from deeper understanding of purchaser needs and requirements, and purchasers benefit from increased awareness of what is available from local suppliers. Both may find that co-development of new custom-designed products may not only solve an immediate problem, but also open up new markets.

Provide opportunities for enhanced interaction among Maryland providers and users in order to facilitate partnering that better responds to customer needs. Take advantage of NIH, NSF, and other federal funders' support for collaborative tools.

Foster advances in telemedicine that enhance access to state-of-the-art health care throughout Maryland, another benefit of regular interaction among Maryland providers and users of bio/med/health IT products and services.

Find ways to redouble support for the financiers who are matching cutting edge science with seasoned management to launch new bio companies in Maryland.

Understand the financing requirements of all types of companies in this cluster of industries, and make sure that private and public resources are available to support their growth.

Make sure that state education and training systems anticipate and respond to the requirements for a robust pipeline of new skilled bio/med/health IT workers, and continuing education for health care, research, and drug development workers to keep up with new technology developments.

Fully exploit Maryland's international networks to reach bio/med/health IT companies and entrepreneurs around the world.

Bio-, Medical, and Health Informatics Entrepreneurship in Maryland: Findings

These industries have only existed for about a decade.

The commercial application of information technology to biomedical research, development of diagnostics and therapeutics, and delivery of health care has a relatively short history. However, as early as the mid 1800s, when Charles Babbage first built a computing machine, the director of what would become the National Institutes of Health's National Library of Medicine envisioned the use of punch cards for storing census data on each individual to aid in improving health care. Bioengineering publications began to reference "medical data processing" in the 1950s, and in 1950 Robert Ledley launched the use of computers in medical applications in dental projects at the National Bureau of Standards (now the National Institute of Standards and Technology). The development in the mid-1960s of faster and cheaper minicomputers and the MUMPS (Massachusetts General Hospital Utility Multi-Programming System) operating system facilitated expansion of medical use. European universities established departments of "medical informatics" about this time, though the term would not come into use in the United States until later in the 1970s. At Stanford University, work began in 1972 on the Stanford Medical Informatics (SMI) Program to integrate artificial intelligence and medicine, which resulted in MYCIN, a diagnostics expert system for infectious diseases.

In healthcare, European single payer systems along with the U.S. Department of Defense and Veterans Administration were early adopters of MUMPS-based medical information systems. In the United States, where healthcare is highly decentralized and physician resistance strong, the diffusion of information technology has been much slower.

It was not until the 1990s that advances in computing power, personal computers, graphical user interfaces for the Internet, high speed networking, new data mining techniques for exploiting enormous distributed databases of information, hand-held wireless technology, and the emergence of interoperability standards have enabled the integration of medicine and information technology to blossom across all dimensions. Changes in the practice and regulation of medicine have hastened the adoption of information technology -- including a strong shift to outpatient services; the 1996 HIPAA (Health Insurance Portability and Accountability Act) privacy, transaction, and security regulations; and the 1999 Institute of Medicine report-spawned concern about medical errors and patient safety. Where once the IT applications focused on the enterprise of health care (admissions, budgeting, practice management, procurement, reimbursement), they are now becoming deeply embedded in clinical practice, from filmless radiology and disease management to personalized medicine and point-of-care hand-helds that provide decision support systems to caregivers at the bedside. The health care industry is increasingly becoming an information technology industry. The U.S. and Europe, where the legal (patient privacy) and interoperability frameworks are farthest advanced, account for 80 percent of the health informatics market.

In biology, advances in information technology were proceeding at the turn of the 21st century at the same time as the invention of "gene chips" (DNA microarrays that measure the relative levels of gene expression in different cells or tissues, and thus permit the automatic high-throughput screening of genetic information). This coincidence of trends produced the success in 2000 of the effort begun in 1988 to sequence the human genome. The age of bioinformatics was born. By 2006, the bioinformatics

market (hardware—including sample-handling equipment as well as computers, storage and data management systems, knowledge management and collaboration tools) will be \$38 billion, according to International Data Corporation.⁵ In Maryland, dozens of molecular medicine research tools companies have emerged to serve this market.

Digital imaging has not only revolutionized diagnostic and therapeutic radiology, but also is at the heart of telemedicine. It is beginning to inform biological research, drug development, and surgery, when combined with robotic devices. Picture archiving and communication systems (PACS) help health care facilities of all sizes to reduce costs, improve patient outcomes and safety by sharing medical data among practitioners within a facility, and gaining access to experts who can read studies remotely. PACS systems include image-acquisition devices, data archives, diagnostic and review workstations, communications networks, system software, database development and management, and interfaces with other networks. Adoption of DICOM (Digital Imaging and Communications in Medicine) standards and expansion of federal Medicare coverage of telemedicine services have helped speed adoption of these technologies. Image-guided laparoscopy, biopsy, and now robot-assisted surgery have increased the productivity and efficacy of patient care. Molecular imaging, a discipline only a decade old, uses various types of tomography⁶ and magnetic resonance imaging and probes that provide the imaging signal or contrast (similar to stains used in histology) to allow researchers to see molecular and cellular events in living organisms without removing tissue. They can determine the effects (beneficial or detrimental) of drug candidates, the interaction of drugs with intended targets, the delivery of a drug to a target, and what happens to a drug in the body.⁷ The National Cancer Institute-funded American College of Radiology Imaging Network (ACRIN) is seeking through clinical trials to generate shared information that tests the following key hypotheses, in this case applied only to cancer:

- Imaging screening can reduce morbidity and mortality.
- Image-guided intervention can provide local control of cancer and perhaps reduce mortality.
- Molecular imaging of metabolic and physiologic processes can improve diagnosis and treatment.
- Functional imaging can improve upon conventional methods of assessing the effectiveness of treatment.
- Image information, processing, and manipulation technologies can reduce variability and improve care.⁸

Finally, the National Science Foundation, the National Institutes of Health, and other federal agencies have for the past decade supported “network-based virtual laboratories,” seeking to apply information technology to enhance collaboration that improves the speed and output of scientific

⁵ This history is drawn from the work of Herman Tolentino, MD, www.veranda.com.ph/hermant/History.htm; John Martirano (National Center for Supercomputing Applications at University of Illinois at Champagne-Urbana) at <http://niri.ncsa.uiuc.edu/martirano/medex/medIT.html>, the tenth anniversary edition of *Health Data Management* magazine (essay by Greg Gillespie, Managing Editor, “Health Care IT: 1993-2003 and Beyond” at www.healthdatamanagement.com/html/current/CurrentIssueStory.cfm?PostID=14323), and “The Race to Computerize Biology,” *The Economist*, December, 2002, http://www.economist.com/displaystory.cfm?story_id=S%27%29H%3C%2BQ1%23%2B%20P%234%0A.

⁶ Techniques for making x-ray pictures of a targeted plane section of a solid object by blurring the images of the other planes. Computed tomography (CT), sometimes called CAT scan, uses special x-ray equipment to obtain many images from different angles, and then join them together to show a cross-section of body tissues and organs

⁷ Finkelstein, Stan N., A.J. Sinsky, and S.M. Cooper, “Medical Imaging in Drug Discovery – Part II,” *PharmaGenomics*, May 2004, pp. 20-24.

⁸ “Network Chair’s Report” (Bruce J. Hillman, M.D.), *ACRIN*, February 2004, p. 2. Viewed at www.acrin.org.

research. The 2003-2004 focus is on the development of “tools and techniques that creatively manage and analyze large amounts of data that are generated during research and need to be shared among several (or many) groups.”⁹

Definitions of these nascent fields are still evolving.

The terminology for these branches of science and industry are still rather muddled, with no widely accepted definitions. In his second book on the subject in 1976, A.I. Mikhailov of the Moscow State University defined informatics as the scientific discipline that “studies the structural and general properties of scientific information and the laws of all processes of scientific communication.” M.F. Collen defines medical informatics as “the application of computer technology to all fields of medicine – medical care, medical teaching, and medical research.”¹⁰ The term genomics, coined in 1986 to describe the science of mapping (on the chromosome), sequencing (the proteins), and analyzing genes, is now understood to have a strong IT component, as does proteomics, the science and process of analyzing and categorizing cell proteins encoded by the genome. Bioinformatics includes “tools and techniques from three separate disciplines -- molecular biology (the source of the data to be analyzed), computer science (supplies the hardware for running, and analysis and networks to communicate the results), and the data analysis algorithms”¹¹. “Discovery informatics,” emerging from new knowledge discovery and data mining approaches, is “the study and practice of effectively employing the full spectrum of computing and analytical sciences and technologies to the singular pursuit of discovering knowledge by identifying and validating patterns in data.”¹² Molecular imaging is sometimes termed “imaging informatics.”¹³

However they are labeled, these fields of study and the industries that have grown out of them are in at best their early childhood, if not infancy. Despite a strong move toward standards in electronic exchange of clinical information and medical vocabulary that are building blocks for achieving President Bush’s national goal of assuring that Americans have electronic health records within 10 years, the challenges of achieving integration while protecting patient privacy are immense. The majority of the 2004 unmet “grand challenges” in medical informatics¹⁴ were related to personal electronic health records and communication of healthcare information. HIMSS¹⁵ surveys of healthcare CEOs and CIOs in 2003 and 2004 show that cost pressures in healthcare are the top business concern, followed closely by Medicare cutbacks, availability and retention of staff, increasing patient safety, and HIPAA compliance. However, proving the quantifiable ROI benefits of new information technologies was listed as the second largest barrier to their implementation. CIOs listed reducing medical errors/patient safety as the top priority in 2004; in 2003 safety ranked second behind meeting HIPAA security requirements. HIMSS and Maryland-based Phoenix Health Systems’ HIPAAAdvisory’s Winter

⁹ PAR-03-134 “Tools for Collaboration that Involve Data Sharing” accessed at <http://grants.nih.gov/grants/guide/pa-files/PAR-03-134.html>.

¹⁰ Herman Tolentino, *op.cit.*

¹¹ Allen B. Richon, “A Short History of Bioinformatics,” *Network Science*, www.netsci.org/Science/Bioinform/feature06.html

¹² JHU SPSBE, Johns Hopkins Business concentration in electronic business, <http://www.business.jhu.edu/mba/index.cfm?action=concentration&majorcode=567&groupid=219&areacode=560>

¹³ Finkelstein et. al., *op.cit.*, p. 24.

¹⁴ Nominated online in response to a 1998 *Informatics Review* article by Dean Sittig, <http://www.informatics-review.com/thoughts/grand.html>

¹⁵ Healthcare Information and Management Systems Society

2004 survey found that 20 percent of providers and 14 percent of payers had not yet met the HIPAA privacy standards required by April 2003; that less than one half were prepared to meet formats and data content standards for electronic claims and related transactions (deadline extended from October 2003 by 90 days); and that over half would not be fully compliant with the HIPAA Security Rule until the April 2005 deadline.¹⁶

The genomics revolution has moved on to the difficult job of making sense of the avalanche of new data -- integrating it, parsing it, mining it for patterns, visualizing and modeling it. The proteomics challenge of understanding the folding of long chains of protein molecules into three-dimensional structures is requiring ever more powerful computers.

The bio/med/health IT industry in Maryland is young.

Of the 108 companies for which a founding year is known, only 12 existed before 1980, and two-thirds have been created since 1990. In the aggregate, these are by far the youngest of the companies examined for this series of technology entrepreneur genealogy studies. Because these companies span statistical industry categories, it is not possible to determine how the pace and volume of company creation in Maryland compares to other technology-intensive states.

**Table BIO/MED/HEALTH IT 1.
Year Maryland Bio/Med/Health IT Companies Were Founded**

| Years | # of companies |
|---------------------|-----------------------|
| Pre-1980 | 12 |
| 1980-1989 | 24 |
| 1990-1999 | 51 |
| 2000-present | 21 |

Maryland's research institutions give it key advantages in these new interdisciplinary industries.

Maryland is at ground zero of this biomedical and health information innovation. Its research institutions are advancing knowledge across disciplines, educating a new generation of cross-trained health professionals and researchers, and supporting the development of infrastructure and standards. They include:

- **Johns Hopkins University**
 - Bloomberg School of Public Health – Department of Biostatistics (master of health sciences degree in bioinformatics)
 - Johns Hopkins Applied Physics Laboratory (collaborated with Johns Hopkins; Oncology Dept. in 1970s to develop its first computerized clinical information system, continuously upgraded since then; telemedicine (including providing day-to-day support for Navy

¹⁶ www.hipaadvisory.com/action/surveynew/winter2004.htm

- **Johns Hopkins University (cont.)**
 - operating forces, and planning for joint medical operations telemedicine; Institute for Advanced Science and Technology in Medicine
 - Johns Hopkins Information Security Institute – offers a master’s degree in security informatics, which includes patient confidentiality, medical records management, public health
 - Johns Hopkins School of Medicine – Division of Health Sciences Informatics (involves all JHU schools and includes medical informatics, genome informatics, information management, consumer health informatics, computer-based documentation systems for point-of-care, informatics and evidence-based medicine, biomedical editing and communication, and electronic publishing); McKusick-Nathans Institute of Genetic Medicine; School of Medical Imaging; Department of Radiology’s Center for Image Guided Interventions; Department of Pathology Division of Informatics; *In Vivo* Cellular Molecular Imaging Center (ICMIC)
 - Johns Hopkins School of Nursing (and Institute for Johns Hopkins Nursing) -- Collaborating Center for Information Systems in Nursing Care (WHO); informatics courses at baccalaureate, graduate and doctoral levels of nursing curriculum
 - Johns Hopkins School of Professional Studies in Business and Education – Visionary lecture series in discovery informatics Fall 2003 and Spring 2004
 - Krieger School of Arts and Sciences -- Part-time Graduate Programs in Arts & Sciences include biostatistics, bioinformatics, computational biology
 - Whiting School of Engineering -- Computer Science Department is involved in health data security through the Information Security Institute, and in computer-assisted surgery in the Center for Computer Integrated Surgical Systems and Technology (an NSF Engineering Research Center)
- **Kennedy Krieger Institute**
 - F.M. Kirby Research Center for Functional Brain Imaging
- **National Institutes of Health**
 - National Cancer Institute’s Center for Bioinformatics
 - Biomedical Information Science and Technology Initiative (BISTI)
 - National Institute of Biomedical Imaging and Bioengineering (newest of NIH’s institutes)
 - Laboratory of Cardiac Energetics (National Heart, Lung & Blood Institute)
 - NIH Clinical Center PET Department
 - National Library of Medicine’s Human Genome resources, Next Generation Internet awards for healthcare testbeds, National Telemedicine Initiative, Communications Engineering Branch, Unified Medical Language System, Digital Library research and initiatives, databases and software tools for analyzing data from molecular sequences to protein structures to complete genomes, MEDLINE/Pub Med access to biomedical journal literature
- **National Institute of Standards and Technology**
 - Hosted “Information Science Standards to Enable Biomedical Research” November, 2003 that included NIH, NSF, DARPA, USDA, university and academic medical center, and industry participants
- **National Security Agency** – Knowledge discovery, networking technology, computer systems security

- The Institute for Genomic Research (TIGR) -- not-for-profit research institute with primary research interests in structural, functional and comparative analysis of genomes and gene products from a wide variety of organisms
- Towson University
 - Center for Applied Information Technology (CAIT)
- Uniformed Services University of the Health Sciences
 - Learning Resource Center, Division of Medical Informatics
- University of Maryland
 - Center for Bioinformatics and Computational Biology (includes links to the Human-Computer Interaction Lab's bioinformatics visualization)
 - Clark School of Engineering – Electrical Engineering Department's Medical Informatics and Computational Intelligence Research and Development Laboratory
 - College of Health and Human Performance – Public Health Informatics Research Laboratory
 - Graphics and Visual Informatics Laboratory (GVIL), Department of Computer Science and UMIACS
 - University of Maryland Institute for Advanced Computer Studies (UMIACS)
- University of Maryland, Baltimore
 - School of Medicine – Department of Epidemiology and Preventive Medicine's Division of Biostatistics and Bioinformatics, Program in Human Genetics, Bioinformatics Core and Genomics Core Facility serve all researchers; Department of Diagnostic Radiology and Nuclear Medicine is among the first in the nation to obtain CT (computed tomography) fluoroscopy and portable CT Facility
 - Center for Integrative Medicine's (CFIM) Informatics Program
 - School of Nursing – Nursing Informatics Graduate Program (first in the world to introduce informatics)
- University of Maryland, Baltimore County
 - Laboratory for Healthcare Informatics (computerized patient records, electronic data interchange, collaborative information systems)
- University of Maryland Biotechnology Institute
 - Center for Agricultural Biotechnology (CAB)
 - Center for Advanced Research in Biotechnology (CARB)
 - Center of Marine Biotechnology (COMB)
- University of Maryland University College –Undergraduate and graduate degree programs in health care administration and in business administration include courses on information systems management, health practice management, and management of tele-health
- Veterans Administration – Baltimore VA Medical Center
 - World's first all-digital imaging department (filmless radiology)
 - Innovator in Picture Archiving and Communications System (PACS)
 - 16-detector CT scanner combined with Imaging Services department's supercomputer and a secure, high speed network makes .75 mm scans available as interactive multi-planar and three-dimensional images to radiologists and physicians throughout the medical center

Several of the key professional associations in the field are headquartered or have active chapters in Maryland

- American Medical Informatics Association (AMIA) – Based in Bethesda, AMIA is a 3,200-member nonprofit 501(c)(3) membership organization of individuals, institutions, and corporations dedicated to developing and using information technologies to improve health care. It was formed in 1990 by the merger of three organizations -- the American Association for Medical Systems and Informatics (AAMSI), the American College of Medical Informatics (ACMI), and the Symposium on Computer Applications in Medical Care (SCAMC). The membership includes physicians, nurses, computer and information scientists, biomedical engineers, medical librarians, and academic researchers and educators. AMIA is the official United States representative organization to the International Medical Informatics Association (IMIA). Thirty-year-old IMIA's annual conference Medinfo is held every three years; AMIA was host for 2004 Medinfo meeting in San Francisco in September which featured 800 presenters from 50 countries. Marion Ball (JHU and UMD) and Donald Lindberg (National Library of Medicine) were members of the organizing committee.
- American Society of Health System Pharmacists (ASHSP) – Based in Bethesda, ASHSP is a developer of medical management software and a provider of on-line database services that include drug information for the public and pharmacists.
- Maryland Health Information Management Association (MDHIMA) – MDHIMA is a 600-member component state association of the American Health Information Management Association founded in 1930. Members are specialists in health information management.
- Maryland Society of Healthcare Information Systems Management (MSHISM) – MSHISM is the 1000-member Maryland chapter of the Healthcare Information and Management Systems Society (HIMSS). Members include individuals from healthcare organizations and industry.
- Maryland organizations and companies are active in numerous related associations: American Nursing Informatics Association (ANIA), CA; American Telemedicine Association (ATA), Washington DC; Association for Electronic Health Care Transactions, Washington DC; Association of Telehealth Service Providers (ASTP), Portland OR; Internet Healthcare Coalition; National Association of Health Data Organizations (NAHDO); Society for Computing and Technology in Anaesthesia (SCATA), UK.

Maryland's government contractors, particularly its systems integrators, are moving aggressively into the bio- and health informatics fields.

A recent article in the New York Times¹⁷ noted that latecomer IBM's life sciences division was now producing \$1 billion in business for Big Blue. Maryland's largest defense and civilian government contractors are finding similar opportunities. OAO Technology Solutions, a 2500-employee IT services company headquartered in Greenbelt that spun off in 1996 from parent company OAO Corporation (part of Lockheed Martin as of December, 2001), went public in 1997 and became privately held in 2004. Its healthcare division, OAO HealthCare Solutions, is based in Woodland Hills, CA and serves 100 clients

¹⁷ Southwick, Karen, "IBM Looms Large in Life Sciences Quest," June 1, 2004.

worldwide. In May of 2002, Lockheed Martin won a \$401 million contract to consolidate IT infrastructure and provide other services to the Centers for Medicare and Medicaid Services for 7-1/2 years. About its Canadian work, the Lockheed Martin website¹⁸ says:

Lockheed Martin Canada is leveraging its experience as a premier systems integrator to manage and deliver large-scale electronic health record solutions for the Canadian healthcare sector. Our heritage in the aerospace and military markets contributes to our ability to integrate a number of complex and disparate health information systems and deploy them as a single seamless solution within a highly secure environment.

Other smaller systems integration firms include healthcare as a line of business along with other IT services customers. In 2004, CompuDyne, a high technology public security company, acquired Yakima, Washington-based 90 Degrees, which sells information management systems for fire and emergency medical first responders. Dakota Imaging's software and turnkey systems for automated data capture, paper, EDI and Web transaction processing, document imaging and document management have found customers in healthcare insurance, fulfillment, and government markets. It was acquired in April, 2004 for \$40 million plus up to \$25 million in milestone payments by WebMD, a provider of complete claims communication services to the healthcare industry. Ingenium's e-business solutions and secure communications networks efforts include an intranet for Walter Reed Hospital. Microlog, a Germantown-based provider of customer service communications infrastructure and applications, serves homeland security, state/local government, healthcare, and retail pharmacy markets.

Optimus Corporation provides IT software and services for public safety, health, and national defense. PSI (Planned Systems International in Columbia) has offices in Falls Church and Patuxent River to provide information and communications systems to military customers, and has also won a number of military healthcare contracts. The most recent award, from DoD Military Health Systems Resources Information Technology Program Office, is a web-based defense medical human resource system and training for 170,000 users worldwide. PSI's partners on the contract include CSC and Northrop Grumman. RiskWatch Inc.'s Security Risk Management (SRM) software solutions are used by government and industry, including solutions for physical/corporate and information systems security, compliance solutions such as HIPAA and ISO 17799, and GLBA (1999 Gramm-Leach-Bliley Act governing financial privacy), homeland security, maritime security, force protection, and certification and accreditation software. Usi, a pioneer in application hosting, managing and support services, has developed a web-based eMedicaid system for State of Maryland, enrolling and managing caregiver participation. Healthcare is one of the areas of focus of Woodbourne Solutions, a web and wireless solutions company based in Germantown. Xtria Healthcare's (Frederick) parent company, Xanser (Richardson, TX) formed Xtria in early 2001 to integrate its four information technology businesses.

Maryland's advanced information technology developers have also found biomedical and healthcare applications for their innovations.

Ceresoft's (formerly Nonlinear Technologies Inc.) optical character recognition software, developed with support from DARPA and tested at NIST, has found application in medical claim forms processing. Civilized Software developed MLAB, an advanced mathematical and statistical modeling system with many applications, including neurophysiological modeling. In February 2001, Lockheed Martin licensed its fiber optic technology to Fiber Rx (Orlando FL) for use in hospitals and medical

¹⁸ <http://www.lockheedmartin.com/wms/findPage.do?dsp=fec&ci=14943&rsbci=13159&fti=0&ti=0&sc=400>

facilities. TTSS Interactive Products, Inc., which develops interactive public information kiosks and services, has a number of large hospital customers.

Maryland's 142 Bio/Med/Health IT companies span the full range of activities in these fields.

- Biomedical research and drug development
 - Clinical trials management and support
 - InforMedix* (patient medication monitoring)
 - Matthews Media Group*
 - Optimus* (handheld data collection)
 - Pharmakinetix* (now Bioanalytical Systems Inc. Clinical Research Unit)
 - Social and Scientific Systems Inc.*
 - TherImmune Research Corporation* (division of Gene Logic)
 - Westat
 - Computational neuroscience
 - Civilized Software*
 - Genomics/proteomics/bioinformatics products and services
 - 20/20 Gene Systems*
 - AlphaGenics*
 - Artesian Therapeutics*
 - Avalon Pharmaceuticals*
 - Capital Genomix*
 - Celera*
 - Compugen
 - Correlogic Systems*
 - DataNaut
 - ExonHit Therapeutics
 - Gene Logic*
 - GenVec*
 - Human Genome Sciences*
 - InforMax*
 - Large Scale Biology – Proteomics Div.(subs. of Large Scale Biology Corp – CA)
 - Meso Scale Discovery*
 - OriGene Technologies*
 - Protein One*
 - MetriGenix*
 - Psychiatric Genomics*
 - ReceptorBase*
 - SuperArray Bioscience Corporation*
 - Imaging and molecular imaging
 - Atto Bioscience* (now part of BD)
 - Deus Technologies*
 - Genex Technologies*
 - Loats Associates (LAI)*
 - Microcosm* (micro-imaging instrumentation and software)
 - Mirari Biosciences*

- Imaging and molecular imaging (cont.)
 - Sensors for Medicine and Science*
- Laboratory automation
 - Celadon Laboratories*
- Knowledge management and transfer
 - Ariadne Genomics*
 - Novascreen Biosciences Corp.*
- Modeling
 - Civilized Software*
 - VeraChem*
- Product development in pharmaceutical and biotechnology industries
 - GloboMax* (now a division of ICON)
- Research collaboration, management and support (including communications)
 - Apex Digital Systems*
 - BME Systems*
 - Data Unlimited International*
 - DNA Technologies*
 - The EMMES Corporation*
 - GenoQuest.*
 - InforMax*
 - Lofstrand Labs*
 - NovaScreen Biosciences* (formerly Adheron, Oceanix)
 - Veritas*
 - Virotech International
- Research tools
 - Applied Cell Sciences*
 - Atto Bioscience* (now part of BD)
 - Marligen Biosciences*
 - Phoenix S&T
 - Protiveris
 - QIAGEN
 - Quanta Biosciences
 - Spectra Stable Isotopes* (was Martek Stable Isotope Group)
 - TransMedix Corporation*
 - Trevigen
 - TrimGen (subsidiary of Nihon Trim Co.)
- Simulation
 - Juxtopia*
- Health care delivery (clinical informatics)
 - Computer-assisted surgery
 - ImageGuide*
 - Immersion Medical*
 - Consumer-directed healthcare (including patient-caregiver communication)
 - Medifocus.com* (health information library)

- Decision-support systems (including clinical data repositories, outcomes assessment)
 - Austin Systems*
 - Axiom*
 - AXS Technologies
 - Eclipsis Corp. (HQ in Florida)
 - Drug Information Technologies (Scholz Healthcare – GERMANY)
 - HCIA* (now Solucient)
 - Medisolv*
 - VIPS*
- Disease management
 - Adventa Health Education* (now part of HealthOnline)
 - APS Healthcare* (formerly American Psych Systems)
 - Axiom Systems*
 - BRIDGE Information Technologies*
 - FutureHealth*
 - HCIA* (Solucient)
 - InforMedix*
 - OAO* HealthCare Solutions
 - Sensors for Medicine and Science*
 - VIPS*
- Electronic (computer-based) patient (health) record
 - ArticSoft
 - ElderHealth* (for seniors on fixed incomes in Baltimore City)
 - MDanywhere Technologies*
 - SoftMed Systems*
- Imaging and PACS (picture archiving communications system)
 - Alan Penn & Associates*
 - DeJarnette*
 - Diagnosoft
 - HipGraphics*
 - Microcosm*
 - Naviscan PEM* (formerly PEM Technologies)
- Nursing informatics
 - VasTech* (Nightingale Nursing Information System)
- Point-of-care (point-of-service computing -- PDAs, other wireless, etc.)
 - DeJarnette*
 - InstantDX*
 - MDanywhere Technologies*
 - Point of Care Technologies*
- Provider order entry systems (CPOE)
 - InstantDX*
 - RxNT*
- Public health informatics
 - Danya International*
 - Discoveryhealth.com*
 - ElderHealth*

- Public health informatics (cont.)
 - FutureHealth*
 - Macro International* (now ORC Macro)
- Rehabilitation
 - BTE Technologies*
- Telemedicine for home care monitoring, intensive care, medical consultation, and patient compliance
 - DeJarnette*
 - Digital Angel (formerly Medical Advisory Systems* -- telemedicine to ships and other remote locations, travelers)
 - InforMedix* (patient medication monitoring)
 - Meridian Medical Technologies (now subs. of King Pharmaceuticals TN – personal heart monitors)
 - VasTech* (home health)
 - Visicu* (intensive care)
- Health care management
 - Credentialing
 - VasTech*
 - Education for patients
 - TTSS Interactive Products* (software and services for hospital kiosks)
 - VIPS*
 - Education and training for staff
 - Immersion Medical*
 - Macro International* (now ORC Macro)
 - VasTech*
 - VIPS*
 - Emergency department management
 - Codonix*
 - Healthcare enterprise IT (admissions/discharge/transfer, billing/claims/payment processing, customer relationship management (CRM), e-commerce, electronic data interchange (EDI), human resource management, IT networks and systems integration, medical records and document management, supply chain management)
 - ABIS Inc.*
 - ADP Integrated Medical Solutions
 - Allied Technology Group
 - Amisys Synertech (networking/LAN/WAN), originally Jurgovan & Blair*
 - ArticSoft
 - Axiom Systems*
 - Baldwin Solutions*
 - CereSoft* (optical character recognition software for claims form processing)
 - CyberSystem Technologies* (supply chain automation)
 - Dakota Imaging* (document imaging and management for automated health claims processing) now part of WebMD, New Jersey
 - Daou Systems (MD office specializes in government healthcare)

- Healthcare enterprise IT (cont.)
 - DeJarnette* (document imaging/optical disk storage, EDI, integration/interface engines)
 - Dr. First*
 - eServices Group*
 - HCIA* (Solucient)
 - Health Administration Systems (OCR, database development, survey automation, billing and patient records)
 - HealthASPex* (ASP for third party administrators)
 - HealthBizNow*
 - Institute for Radiological Sciences*
 - Keane
 - Lockheed Martin*
 - OAO* (healthcare division is in CA)
 - OPNET* (parent is Hanger – network linking managed care organizations to orthotics and prosthetics services)
 - PeopleSoft*
 - Quality Data Processing*
 - Rewards Plus*
 - SASHA Care International*
 - SoftMed Systems*
 - Tela Sourcing (claims processing outsourcing to India)
 - TriZetto Group*
 - Usi* (web-based eMedicaid system)
 - VasTech*
 - VetCentric* (veterinary industry)
 - VIPS*
 - Xtria Healthcare (parent in Texas)
- Healthcare enterprise market analysis and marketing IT
 - eHealthFIRST* (comparative market analysis for healthcare providers, acquired by HHS Inc., CT)
 - Estco Medical* (software for on-line marketing)
 - HCIA*
 - IMV Limited
 - Macro International* (now ORC Macro)
- Healthcare practice management
 - Axiom*
 - CodoniX*
 - DrFirst*
 - InfoSoft*
 - Knowledge Link*
 - MDanywhere Technologies*
 - Netinterests*
 - Ortho Spot* (orthopedic practices)
 - Physicians Practice* (business website for physicians)

- HIPAA compliance – privacy, transactions, safety
 - ArticSoft
 - Axiom Systems*
 - Certimys Solutions* (formed by HIPAAdocs)
 - DrFirst*
 - HIPAAdocs*
 - Knowledge Link*
 - Phoenix Health Systems* (publisher of on-line HIPAAnews)
 - VIPS*
- Laboratory information systems
 - Trionics*
- Long-term care IT
 - HealthObjects* (post-acute, home infusion, pharmacy)
- Managed care IT
 - APS Healthcare* (behavioral healthcare)
 - HCIA* (Solucient)
- Medical language processing and transcription
 - CBay Systems (outsourcing to India)
 - LifeART
- Network and security
 - ArticSoft
 - Axiom*
 - DrFirst*
 - Ingenium*
 - PSI (Planned Systems International)*
 - Woodbourne Solutions* (web and wireless solutions)
- Pharmacy/drug management
 - Axiom*
 - HealthExtras* (pharmacy benefit management)
 - Microlog
- Risk analysis and management, including quality control
 - DeJarnette*
 - RiskWatch*
 - VIPS*

Almost all of Maryland's companies are home-grown.*

The companies marked with an asterisk in the lists above, over 85 percent of all the companies analyzed, were founded in Maryland. The state's biomedical research and healthcare institutions and industries have proven to be fertile initial markets for new information technology applications that are now being used by customers across the country. Healthcare accounts for a 25 percent larger share of employment in Maryland than in the U.S. as a whole, and the state is the home of the largest biomedical research institution in the world, the National Institutes of Health, as well as its largest grantee, Johns Hopkins University. The state's biomedical research enterprise also encompasses public institutions such as the University of Maryland Baltimore and other federal laboratories, including the Walter Reed Army Institute of Research, the U.S. Army Medical Command, the Naval Medical Research Institute,

and the Uniformed Services University of Health Sciences, as well as private institutions such as the Howard Hughes Medical Institute, Jackson Foundation (military medicine), and the Carnegie Institution of Washington's Department of Embryology.

The founders of Maryland's 142 bio/med/health IT companies come from diverse backgrounds.¹⁹

Information was collected on 145 founders. Because these industries represent the intersection of sectors, the individuals who have founded them may have previously worked in research (university or federal), pharmaceutical, health care, information technology, consulting, or unrelated corporate organizations. Sixty percent of the founders' previous experience was in industry, eighteen percent in universities, and 16 percent in the federal government. Some founders previously worked in both research institutions and industry.

The youth of the industries is highlighted by the relatively small number of entrepreneurs who have had previous experience in the same type of cross-fertilized firm they founded. Far more of the founders came to the bio/info intersection from the biomedical/healthcare realm than from the pure information technology field. This finding should be viewed somewhat guardedly, since bio-related founders are more likely to publicize their academic/research credentials than are IT professionals.

Table BIO/MED/HEALTH IT 2. Founders' previous employment

(Totals will not add: many founders have had multiple previous employers; firms may have multiple founders)

| | |
|---|----|
| Corporate: biotech or pharmaceutical | 15 |
| Corporate: consulting/research | 12 |
| Corporate: general | 23 |
| Corporate: healthcare provider or payer | 20 |
| Corporate: bio/med/health informatics | 19 |
| Corporate: information technology | 10 |
| Federal government | 26 |
| Foreign government | 3 |
| Healthcare professional | 3 |
| Non-profit institution or organization | 3 |
| University | 29 |

Because so many of the bioscience companies in Maryland are genomics-related, many of the findings of the Maryland Bioscience Founders Report published by TEDCO in 2002 hold true in the bio/med/health IT sector, particularly the significant (compared to all IT companies) percentage of company founders who came from research institutions.

More than a third of the founders' previous employers were universities or federal laboratories in the U.S. or abroad. The healthcare professionals who launched companies had previously worked at academic health centers, and several of the company founders have continuing university connections.

¹⁹ Founder information was not available for all companies.

**Table BIO/MED/HEALTH IT 3. Maryland Bio/Med/Health IT Companies
Founded by Former Research Institution Employees**

| Company Name | Founder(s) | University | Federal government | Current |
|-------------------------------------|----------------------|---|--|--|
| Alan Penn & Associates (APA Inc.) | Alan I. Penn | | | U Penn adj, Med. Center |
| AlphaGenics | Frederic Abramson | American U, Georgetown U, UKY College of Medicine | | JHU adj Montg Co campus |
| Applied Cell Sciences | Jesse Baumgold | | NIH | |
| APS Healthcare, Inc. | Kenneth A. Kessler | | | Harvard Lecturer Dept Psychiatry |
| Atto Bioscience | Gary Brooker | Georgetown U | | JHU Dir , Integrated Imaging Center, Dept of Biology, Montg Co. Campus |
| Austin Systems, Inc. | Rayol John Augustus | | Ministry of Defense, India | |
| Austin Systems, Inc. | Kamal Kishore Rajput | | Ministry of Defense, India | |
| BTE Technologies | Raymond Curtis | JHU | | |
| Celadon Laboratories | Raymond Peterson | | NIH – NCI | |
| Celera | Craig Venter | | NIH | |
| CereSoft | ? | U MD | | |
| Certimys Solutions (also HIPAAdocs) | Lewis Lorton DDS | | Army | |
| Civilized Software, Inc. | Gary Knott | U MD Computer Science | USPHS, NIH | |
| Correlogic | Peter Levine | | General Counsel US Senate Subc on Intergovt'l Rel; govt trial atty for DOJ, DHEW, office of U.S. Atty, Wash DC | |
| Correlogic | Ben Hitt | Stanford U Med Sch; U Cincinnati Med Sch | VA Med Cntr Palo Alto | |
| Dakota Imaging | Sandeep Goel | U of Arizona | | |
| Deus Technologies | Michael Yeh | | NASA | |
| Diagnosoft | Jerry L. Prince | MIT Lincoln Laboratories | | JHU EE&CE, IT in radiol, BME, math'l sci |
| Diagnosoft | Nael F. Osman | | | JHU SOM |

| Company Name | Founder(s) | University | Federal government | Current |
|--|------------------------------------|--|--|----------------|
| DrFirst.com | James Chen | | Intelsat | |
| GenVec | Ronald Crystal | | NIH | |
| GloboMax (div. of ICON) | David Young | U MD Baltimore; U of Texas | | |
| HipGraphics | Elliott K. Fishman | | | JHU SOM |
| Human Genome Sciences | Alan G. Walton | Harvard Medical School; Indiana U; and Case Western U | | |
| InforMax | Alex Titomirov | | NIH, Institute of Molecular Biology, Moscow | |
| Institute for Radiological Image Sciences | David J. Goodenough | U Chicago; George Washington U | | |
| Intronn | Lloyd Mitchell | GWU Medical Center; U of S. Florida; | NIH (fellowship) | |
| Intronn | Mariano Garcia-Blanco | Duke U | | |
| Large Scale Biology Corporation, Proteomics Division | N. Leigh Anderson | | Argonne Nat'l Labs | |
| Large Scale Biology Corporation, Proteomics Division | Norman G. Anderson | | Argonne Nat'l Labs Oak Ridge Nat'l Lab | |
| Lofstrand Labs | Richard G. Smith | | NIH – NCI | |
| MDanywhere Technologies, Inc. | Rudy Rai | Johns Hopkins University Hospital | | |
| Medifocus.com | Elliot Jacob | | Walter Reed Army Institute of Research | |
| Naviscan PET Systems, Inc. | Irving N. Weinberg | | NIH | |
| OAO Corporation | Cecile D. Barker | | NASA | |
| Optimus Corporation | Eric A. Adolphe | | FAA | |
| Phoenix Health Systems | Ronald L. Gue | Southern Methodist U | | |
| ProteinOne | Hui Ge | | NIH | |
| Protiveris | John Peeters | | DOE | |
| Receptor Base | Lee Kolakowski | U Texas Health Science Cntr San Antonio; Harvard Med Sch & Children's Hosp | | |
| RiskWatch, Inc | Caroline Hamilton | | NIST | |
| SASHA Care International | Sasha J. Koch | U MD Baltimore | | |
| Solucient (formerly HCIA) | Carl J. Schramm | JH Sch of Public Health | U.S. Senate Committee on Labor and Human Resources | |
| VeraChem | Michael K. Gilson | UMBI CARB | | |
| Vera Chem | Hillary S.R. Gilson | | NIST CARB | |
| Veritas | Randall Kincaid | | NIH | |
| VIPS Healthcare Information Solutions | Wilson T. "Tom" Gildee | | Centers for Medicare & Medicaid Services | |
| Visicu | Brian Rosenfeld Michael Breslow | Johns Hopkins Hospital Johns Hopkins Hospital | | |

Of the 68 corporations where Maryland bio/med/health IT entrepreneurs worked previously, 25 were in biomedical or healthcare fields.

The majority of the companies for which the entrepreneurs worked were healthcare providers or payers. As would be expected, the bioinformatics company founders were more likely to have emerged from biomedical backgrounds, while health informatics company founders more typically had healthcare provider or payer experience.

**Table BIO/MED/HEALTH IT 4. Maryland Bio/Med/Health IT Companies
Founded by Former Health and BioMedical Company Employees**

| Company Name | Founder(s) | Healthcare company | Biotech/pharma company |
|------------------------|---|--|--|
| 20/20 GeneSystems | Jonathan Cohen | | Oncor |
| AlphaGenics | Frederic Abramson | GE | |
| Applied Cell Sciences | Jesse Baumgold | | Receptor Biology (founder) |
| APS Healthcare, Inc. | Kenneth A. Kessler | American Psych Mgmt * (now Value Behavioral Health); Metropolitan Psychiatric Group | |
| Ariadne Genomics | Ilya Mazo | | Clontech |
| Artesian Therapeutics | Aaron Schacht Michael J. Brennan (Oxford Biosciences) | | Eli Lilly Boehringer Mannheim; Johnson & Johnson; Gene Logic |
| Avalon Pharmaceuticals | Kenneth C. Carter | | Human Genome Sciences |
| BTE Technologies | Raymond Curtis | Union Memorial Hospital (Curtis Hand Center) | |
| BRIDGE Technologies | James E. Robinson | | Boehringer Mannheim Corp. Therapeutics Division |
| Capital Genomix | William Hearl | | Kirkegaard & Perry Labs; Life Technologies; Pharmacia Diagnostics (Columbia MD) |
| Diagnosoft | Jerry L. Prince | Brigham & Women's Hospital | |
| ElderHealth Inc. | David Carliner | Genesis Health Ventures | |
| Gene Logic | Michael J. Brennan | | Boehringer Mannheim, Johnson & Johnson, Molemed International |
| Gene Logic | Mark Gessler | | Gene Medicine |
| HealthASPex | Dan Riston | Diversified Group Administrators | |
| HealthExtras, Inc. | David Blair | United Payors & United Providers | |
| HealthObjects | Michael Bronfein | Neighbor Care* | |
| Human Genome Sciences | Alan G. Walton | | University Genetics |
| ImageGuide | Maurice Ferre | GE Medical Systems, Visualization Technology (founder) | |
| ImageGuide | John Kroon | GE Medical Systems | |

| Company Name | Founder(s) | Healthcare company | Biotech/pharma company |
|----------------------------|----------------------|--|--|
| InforMedix | Bruce A. Kehr | Contemporary Psychiatric Services* | |
| Lofstrand Labs | Richard G. Smith | | HEM Research |
| Marligen Biosciences | Sherry Chalberg | | Life Technologies; Digene |
| Matthews Media Group | Molly Matthews | Children's Hospital D.C. | |
| Medisolv Inc. | Zahid Butt | St. Agnes Healthcare | |
| MetriGenix | Andrew O'Beirne | | Gene Logic |
| Naviscan PET Systems, Inc. | Irving N. Weinberg | | PEM Technologies |
| OriGene Technologies | Wei-Wu He | | Human Genome Sciences |
| ProteinOne | Peter Shin | Capitol Hill Nursing Cntr and Medlink Hospital (Wash DC) | |
| Psychiatric Genomics | Michael Palfreyman | | Merrell Dow Research Institute; Beecham Pharmaceuticals (UK) |
| Rewards Plus | Kenneth P. Barksdale | Maryland Casualty (Zurich American) | |
| Solucient (formerly HCIA) | Carl J. Schramm | Fortis Inc; Fortis Healthcare; Health Insurance Association of America | |
| TriZetto Group (The) | Jeff Margolis | FHP International Corp | |

*founder

Surprisingly few Maryland bio/med/health IT entrepreneurs previously worked in pure information technology companies; many had large company experience.

The path to creation of a cross-over health/info or biomedical/info firm does not appear to originate often in the pure IT sector. Most of the corporate entrepreneurs who have not emerged from the health and life sciences industries (Table 3) have had IT experience with healthcare customers of large consulting or systems integration firms (of which there are many in Maryland), or have been engaged in cutting edge research in platform technologies with multiple applications (including healthcare or bioscience).

Table BIO/MED/HEALTH IT 5. Maryland Bio/Med/Health IT Companies Founded by Former Non-Health Corporate Employees

| Company Name | Founder(s) | Information technology | Consulting/research | General |
|-----------------------|-----------------|------------------------|---|--|
| Ariadne Genomics | Ilya Mazo | Informax | | |
| AXS Technologies Inc. | Alain Farine | | AF-CSE Computer Science Engineering, Lausanne | |
| Compugen | Eli Mintz | Orckit | | |
| Correlogic | Peter J. Levine | | | TransNational, intl trade & investment consulting co; private IP and SW-related law practice |
| Deus Technologies | Michael Yeh | | Caelum Research Corporation* | |

| Company Name | Founder(s) | Information technology | Consulting/research | General |
|---|----------------------|---|--|--|
| Diagnosoft | Jerry L. Prince | | The Analytic Sciences Corp. | |
| DrFirst.com | James Chen | V-One Corporation* | | |
| eHealthFIRST | Stephen Coy | | Ernst & Young; Booz, Allen & Hamilton | |
| eServices Group | David Walsh | | | Cirrus Technology |
| Gene Logic | Michael J. Brennan | | Chronotech* (shift work scheduling) | |
| HealthObjects | Michael Bronfein | | | Signet Bank; retail food industry |
| ImageGuide | Maurice Ferre | Thinking Machines | | |
| Ingenium Corporation | Andre L. Lynch | Network Solutions | | |
| LAI (Loats Associates) | Harry Loats | | | Ecosystems Intl |
| NovaScreen Biosciences Corporation | John Sabin | | | Hudson Hotels Corp; Vistana Inc.; Manor Care; Marriott Corp |
| OAO Corporation | Cecile D. Barker | | | Grumman |
| Optimus Corporation | Eric A. Adolphe | | | SENTEL Corporation; NAVCOM System |
| Ortho Spot | William J. Schaefer | | | Lockheed Martin |
| Ortho Spot | Shari Cohen | | | Lockheed Martin |
| Phoenix S&T | | | DuPont Central R&D Dept microfluidics; Bell Labs AT&T (post-doc) | |
| PSI, Inc. (Planned Systems International) | Nasser Bassir | software engineer and IT consultant | | |
| PSI, Inc. (Planned Systems International) | Terry Lin | software engineer | | |
| Spectra Stable Isotopes | Richard Radmer | | | Martin Marietta |
| Tela Sourcing | Brij Sharma | Evincere Software* | | Pace Global Energy Services; Constellation Energy Group; Reliance Industries |
| Usi | Christopher McCleary | DIGEX; American Mobile Satellite Corporation; Radiation Systems | | |
| Usi | Stephen McManus | Data General (telecom unit); Silicon Graphics | | |
| VasTech (Visual Advance Systems Technology) | Josh Vance | | | defense contractor |

*founder

Very few of Maryland's bio/med/health IT entrepreneurs had previous experience in similar companies or ventures.

Because these industries are young, it is less likely that entrepreneurs will have had previous experience in similar companies. GE's long history in medical equipment and medical systems has made it fertile ground for spawning entrepreneurs, and the more recent success in genomics at Human Genome Sciences has given rise to additional entrepreneurs. Several serial entrepreneurs have founded multiple firms.

**Table BIO/MED/HEALTH IT 6. Maryland Bio/Med/Health IT Companies
Founded by Entrepreneurs With Bio/Med/Health IT Experience**

| Company Name | Founder(s) | Previous bio/med/health IT company |
|------------------------|-----------------------------|---|
| AlphaGenics | Frederic Abramson | GE |
| Applied Cell Sciences | Jesse Baumgold | Receptor Biology* |
| Ariadne Genomics | Ilya Mazo | Informax |
| Artesian Therapeutics | Michael J. Brennan | Gene Logic* (co-founder) |
| Avalon Pharmaceuticals | Kenneth C. Carter | Human Genome Sciences |
| Celera | J. Craig Venter | The Institute for Genomic Research |
| Estco Medical | John Estafanous | APACHE Medical Systems; IT consultant to Cleveland Clinic Foundation and Aspect Medical Systems |
| HealthBizNow | Craig Overpeck | GoSoft Mobile Technologies |
| ImageGuide | Maurice Ferre John Kroon | Visualization Technology, Inc*; GE GE |
| MetriGenix | Andrew O'Beirne | Gene Logic |
| OriGene | Wei-Wu He | Human Genome Sciences |
| Phoenix Health Systems | Ronald L. Gue | Medicus Corporation*; healthcare IT consulting with Arthur Young; Sheldon Dorenfest; Block McGibony, Bellmore |

*founder

The majority of both bio- and health- IT company founders hold advanced degrees, from colleges and universities in the U.S. and abroad.

Information on the educational background of all founders was not available, and those with advanced degrees may be more likely to trumpet the fact. However, while the number of advanced degrees was not surprising among the bioinformatics founders, the prevalence also among the health informatics entrepreneurs suggests that these fields require specialized knowledge, either in business or science or both. Overall, the percentage of advanced degrees was higher than in other information technology industries examined in these genealogy studies. Approximately one-third of the degrees were from area (including D.C.) universities and colleges.

Table BIO/MED/HEALTH IT 7.
University Degrees of Maryland Bio/Med/Health IT Company Founders

| Universities | Company Name (when founded) | Under Grad | Mas- ters | Prof'l | PhD | MD |
|---|--|------------------------|--------------|---------------|-----------------|----|
| Abilene Christian | Avalon Pharmaceuticals | X | | | | |
| American U | 20/20 GeneSystems Civilized Software Estco Medical Ingenium | X X X | | JD | | |
| Baylor Coll of Medicine | OriGene | | | | X | |
| Boston U | ImageGuide | | | | | X |
| Brandeis U | Lofstrand Labs | | | | X | |
| Brigham Young U | NovaScreen Biosciences Corp | | X | MBA & JD | | |
| Cairo U | Diagnosoft | X | X | | | |
| California Institute of Technology | Civilized Software | | X | | | |
| Cambridge U (UK) | Large Scale Biology Corp – Proteomics | | | | X | |
| Catholic U | Optimus Corp | | | JD | | |
| City U of New York | OAo Corp. Optimus Corp (City College of NY) | X X | | | | |
| Columbia U | VeraChem | | | | XX | X |
| Duke U | Large Scale Biology Corp – Proteomics | X | X | | X | |
| ENSAE (Ecole Nationale Supérieure de l' Aéronautique et de l' Espace, Toulouse, FR) | Austin Systems | X* | | | | |
| Fairleigh Dickinson U | Correlogic | X | | | | |
| Florida Atlantic U | LAI (Loats Associates) | X | | | | |
| Georgetown U | Estco Medical InforMedix Intronn Solucient (HCIA) | | X | JD LLB | | X |
| George Washington U | DrFirst.com Immersion Medical Juxtopia | | X | | X** | X |
| Georgia Institute of Technology | DrFirst.com | X | | | | |
| Gordon College | Digital Angel (fka Medical Advisory Systems) | | | | | |
| Haverford College | Apex Digital Systems | X | | | | |
| Harvard U | Intronn ReceptorBase Visicu | X X | | | Xpost doc | |
| Howard U | Juxtopia | | X | | | |
| Indian Institute (Madras) | Austin Systems | X | X | | | |
| Johns Hopkins U | 20/20 GeneSystems Diagnosoft LAI (Loats Associates) Marligen Biosciences Phoenix Health Systems VIPS Healthcare Information Solutions | X X | X XX | | X X X | |

| Universities | Company Name (when founded) | Under Grad | Masters | Prof'l | PhD | MD |
|---|---|------------|---------|--------------|-----------------|--------|
| LeMoyne College | Solucient (HCIA) | X | | | | |
| Lenoir Rhyne College | BRIDGE Information Technologies | | | | | |
| Loyola College (MD) | OAQ Corp | X | | | | |
| Madras Institute of Technology (MIT Madras) | Austin Systems | XX | | | | |
| Massachusetts Institute of Technology (MIT) | Alpha Genics Diagnosoft ReceptorBase | | | Sloan Fellow | X Xpost doc | |
| Michigan State U | Danya International | X | | | | |
| New England School of Law | Correlogic | | | JD | | |
| Nanjing U | OriGene | X | | | | |
| Northeastern U | Usi | X | | | | |
| Nottingham U (UK) | Human Genome Sciences | | | | X | |
| Oberlin College | Juxtopia | X | | | | |
| Pacific Western Univ (distance education) | Austin Systems | | | | X | |
| Pennsylvania State U | Celadon Laboratories | | | | X | |
| Rensselaer Polytechnic Institute | Woodbourne Solutions | X | | | | |
| Russian Academy of Sciences | InforMax | | | | X | |
| St. Peter's College | Lofstrand Labs | X | | | | |
| Stanford U | Civilized Software Danya International Correlogic | | X | | X X post doc | |
| Temple U | Visicu | | | | | X |
| Tennessee State U | Capital Genomix | X | | | | |
| Tufts U | Visicu | | | | | X |
| U of Baltimore | FutureHealth Corporation HealthObjects SASHA Care International | X X | | MBA MBA | | |
| U of California, Riverside | RiskWatch | X | | | | |
| U of California, San Diego | Celera VeraChem | X | | | X X | |
| U of Cambridge (UK) | Protiveris | | | | X | |
| U of Chicago | Spectra Stable Isotopes | | | | X | |
| U of Connecticut | Diagnosoft | X | | | | |
| U of Illinois | Artesian Therapeutics TriZetto Group | X X | | | | |
| U of Illinois, Chicago | Ariadne Genomics MetriGenix | X | | | X | |
| U of Kentucky | Usi | X | | | | |
| U of Maryland | Alan Penn & Associates PSI (Planned Systems International) Rewards Plus | XX X | | | X | |
| U of Maryland Baltimore | HipGraphics Intronn SASHA Care International | | | | | X X |
| | | X BSN | | | | |

Several of Maryland's bio/med/health IT companies have diverse international ties.

ArcticSoft's FileAssurity software enables health care organizations to encrypt and digitally sign files, folders, documents, and emails, and to remove unwanted files from a disk without risk of recovery. The company is based in London and Glenwood, Maryland, the home of Steve Walker & Associates, which specializes in investments in early stage information security companies. The company has received venture capital from Southeast Growth Fund in England.

AXS Technologies's EyeSpy images overcome bandwidth restrictions to provide high speed, high quality detailed images on standard computers, enabling physicians to collaborate online in making a diagnosis. The Annapolis-headquartered company was founded by the Swiss technology developer, Alain Farine, who has now started a Swiss AXS spin-off, Instant IT SA, which provides enterprise level server solutions that work on top of AXS EyeSpy software technology. AXS is part of HPI Holdings, a publicly traded Swiss investment company, and has received additional investments from the international law firm Sonnenschein, Nash & Rosenthal, FastTrack Capital LLC (a DC-based investment company set up specifically to provide the venture funding needed to allow selected companies to participate in the Department of Defense's Fast Track program), European venture capitalist Martin Velasco, AXS board members Steve McManus (co-founder of USinternetworking) and Dick Aschman (formerly Kodak), and Annapolis private investors Tommy Closs and Bret Anderson

CBay Systems is an Annapolis medical transcription and healthcare business outsourcing company with a franchised transcription base in numerous locations in India and a development and process center in Bangalore. CBay was founded by Chairman V. Raman Kumar, who had managed transnational companies in the U.S., the UK, and the Middle East. Co-founder and President Donald L. "Skip" Conover had 20 years of experience managing international data entry businesses and was involved in setting up a private telecommunications network in India. The third co-founder, Mahidhar Reddy, who manages the India operations, had been a software consultant in India. CBay's funding has come from Connecticut and India-headquartered TDA Capital Partners, which specializes in equity investments in emerging markets; Elite Global Operations, India; Godrej International Ltd., a subsidiary of Godrej Industries (chemicals, food, medical diagnostics), which in turn is part of \$1 billion conglomerate Godrej Group in Mumbai (formerly Bombay); Kingdon Capital (NY); GMO, a Boston-headquartered global investment management firm; and Strategic Ventures Fund (Mauritius) Ltd, managed by New Jersey-based Frontline Strategy LLC and specializing in US-India opportunities.

Compugen, a Maryland Technology Development Center genomics-based drug and diagnostic discovery company using predictive models and discovery engines, started in the Sdeh Boker incubator in Israel. Now publicly traded on NASDAQ and the Tel Aviv Stock Exchange, Compugen received venture capital from Clal Investments & Industries (Israel); Israel Seed Partners; Compugen chairman Martin Gerstel; Israel Growth Fund; Evergreen; Palim Investments (Israel), Genesis Partners (Israel), Ampal (Israel).

DataNaut, based in Bethesda, provides informatics and IT solutions using a "hybrid onshore/offshore development" approach that pairs U.S. and Russian programmers. DataNaut is working with The Institute for Genomic Research (TIGR) on the next generation software platform for gene expression research.

Diagnosoft, a provider of software for magnetic resonance imaging, utilizes Egyptian software writers. It has received angel funding from Egyptian entrepreneur Amr A. Awadallah who worked at HP

and Nortel Networks. Awadallah sold his first start-up, VivaSmart, to Yahoo! Inc. and continues to work for the new Yahoo Search team and pursue a Ph.D. in computer systems from Stanford University.

Tela Sourcing was created in Baltimore City in 2003 by Adaptis, a Seattle-based customized business process outsourcing services provider to health plans, and MDIndia Healthcare Services, which provides third party administration services to the newly deregulated Indian health insurance market. Tela Sourcing sells claims processing and business process outsourcing services to the health care industry.

VENTURE CAPITAL

Venture capitalists have been responsible for starting a number of Maryland bioscience and biomedical companies, as well as supplying financing to many others; different venture capital firms have funded health informatics companies, which seem less likely to attract venture capital; corporate venture financing has been made available to several imaging companies.

Through October 2004, Oxford Bioscience Partners continues to be a primary source of funding for Maryland biostart-ups, in some cases creating the companies itself. Former general partners in Oxford have formed or joined other partnerships, extending the web of venture capitalists familiar with the state's potential. Dr. Michael Brennan, a founder of Oxford-funded Gene Logic, subsequently joined Oxford and last year established a Maryland arm of Los Angeles-based Coastview Capital along with two other former Oxford partners.

A different set of venture capital partnerships focus on healthcare technologies, including practice management and hospital information systems and claims automation. Individual and corporate investors have supported the growth of Maryland imaging companies.

**Table BIO/MED/HEALTH IT 8.
Venture Capital for Maryland Bio/Med/Health IT Companies**

| Maryland Company | Venture Capital Investors |
|-----------------------------|---|
| 20/20 GeneSystems | 8/02: MD DBED: \$50K Challenge; MDBio Accelerator \$150K; \$50K TEDCO for collaboration w/NCI |
| APS Healthcare, Inc. | 1/04: H.I.G. Capital (Miami FL) acquired equity stake |
| Artesian Therapeutics, Inc. | Q1 2003: \$7.5m 1 st : Oxford Bioscience Partners, MD DBED, Alexandria Real Estate Equities, Cooley Godward LLP; 2002 Oxford Bioscience Partners |
| ArticSoft Ltd. | 5/03: Southeast Growth Fund (UK) |
| Atto Bioscience | 10/01 1 st : \$3m Emerging Technology Partners LLC; indiv from biotech commun, co founders and mgmt |
| Avalon Pharmaceuticals | Oxford Biosciences, AIG Global Investment Group, Alexandria Real Estate Equities, LP, CDP Capital – Technology Ventures, ETP/FBR Venture Capital LLC, EuclidSR Partners, LP, Forward Ventures, GATX Ventures, GeneChem, GIMV nv, H&Q Healthcare Investors, KBL Healthcare Ventures, MD DBED, MDS Capital, Novartis BioVentures Ltd., OrbiMed Associates LLC, Royal Bank of Canada |
| AXS Technologies Inc. | 2/01: \$2m international law firm Sonnenschein, Nash & Rosenthal, FastTrack Capital LLC, European venture capitalist Martin Velasco, AXS board members Steve McManus and Dick Aschman, and Annapolis private investors Tommy Closs and Bret Anderson; 11/02: \$3.2m HPI Holdings (Swiss) |

| Maryland Company | Venture Capital Investors |
|-------------------------------|---|
| BTE Technologies | Triax Covington (labor-sponsored, Toronto) is an investor in Hanoun, has seat on board of BTE-Hanoun merged co. |
| Capital Genomix | Artemis Strategies Fund (MD); Trinity Investors Fund (NY); South Korean investors |
| CBay Systems, Ltd. | 4/02: \$4m Kingdon Capital, TDA Capital Partners, Godrej Industries Ltd. (total of three rounds \$11.5m); 4/03: \$2.5 convertible debenture GMO Emerging Markets Fund |
| Celera Genomics | Strategic collaborations with Abbott, Merck, General Electric, Seattle Genetics |
| Compugen | Clal Investments & Industries; Israel Seed Partners; Martin Gerstel; Israel Growth Fund; Evergreen; Palim Investments, Genesis Partners, Ampal. |
| Correlogic Systems, Inc. | 2/04 Mitsui and Co., Ltd. |
| CyberSystem Technologies | Anthem Capital L.P. (Q1 1998); Anthem Capital L.P. (Q2 1998); Anthem Capital L.P. (Q1 1999) Anthem Technologies (Q2 1999) |
| Dakota Imaging | seed: Morgenthau Group (Ft. Lauderdale); 1 st : MCG Capital Corp (Arlington VA) \$6.5 m and Morgenthau Group \$5 million 7/02 |
| Diagnosoft | Amr A. Awadallah (interim CEO) |
| ElderHealth Inc. | Sprout Group (Q1, 1999); DLJ Venture Capital Fund (Sprout Group), New Enterprise Associates, Woodbrook Capital Inc. (Q2 1999) |
| FutureHealth | 3/03 \$4.7m The Argentum Group and First Analysis Corporation; 9/04 \$3.5m Series B Ticonderoga Capital, Argentum Group, First Analysis |
| Gene Logic | Oxford Bioscience Partners |
| GenVec | Highland Capital Partners (Q4 1998); EDF Ventures, Arch Venture Partners, Canaan Ventures; Sierra Ventures |
| HealthASPex, Inc. | Allied Capital, Fairfax Partners |
| HealthExtras, Inc. | 5/99 Health Partners (NY) \$5m (thru Capital Z Healthcare Holding Corp) |
| Human Genome Sciences | Oxford Bioscience Partners; HealthCare Investment Corp. (now HealthCare Ventures); RHO Ventures |
| ImageGuide | 2002 General Electric Medical Systems |
| Immersion Medical | 2000 Child Health Investment Corp. |
| InforMax | FBR Technology Partners and others (Q2 1999); Emerging Technology Partners |
| InforMedix | 2/00 Jeong Kim (Yurie founder) investment; 5/00 MD Angels Council; 12/03 \$1.5m private equity; 2/04 \$5m private placement |
| Intronn | 10/01 Series A: AEA Investors Inc. (NY, Stamford, CT & London), Research Corporation Technologies, Inc. (RCT) Tucson, Ariz |
| Marligen Biosciences | 5/04 \$2.3m Emerging Technology Partners, ASM Resources |
| MDanywhere Technologies, Inc. | Incube8.com (being managed by Daymark Capital Advisors) |
| MetriGenix | 7/01 \$15m led by Burrill Biotechnology Capital Fund; 3Q/03 Oxford Bioscience Partners, Infineon Ventures GmbH |
| Phoenix S&T, Inc. | DBED Challenge Fund & “private accredited investors with noted entrepreneurial accomplishments” |
| Physicians Practice | Newbury Ventures |
| Protiveris | 3/00 1 st : unknown investors |
| Psychiatric Genomics | 2000 Oxford Biosciences; Emerging Technology Partners |
| Rewards Plus | Grotech, Century Capital Management (Boston), Capital Z Group, Unum, US Bancorp (Piper Jaffray subsidiary), Prudential Financial, Centre |
| Usi | 1998 \$29.5 Phase I: Grotech Capital Group, Venrock Associates, Blue Chip Venture Company and Massey Burch Capital Corp; IPO 1999 |
| Vetcentric | Asset Management, Aurora Funds, Staenberg Private Capital, Three Arch Partners, Vantage Partners |
| Visicu (fka IC-USA) | Cardinal Health Partners (Q2 1998); Pacific Venture Group, Partech International, Abell Foundation, Cardinal Health Partners, Sterling Venture Partners, Pacific Life and Envest Ventures (10/00) |

Like most other industries, the bio/med/health IT world is seeing substantial consolidation, particularly in the healthcare-related companies. Maryland companies have been among both the acquired and the acquiring.

Seven billion-dollar Automated Data Processing Corp.'s (Rosedale, NJ) bought Integrated Medical Solutions (Rockville) to provide medical claims software for property and casualty insurers that are ADP's major customers.

**Table BIO/MED/HEALTH IT 9. Maryland Bio/Med/Health IT
Company Mergers and Acquisitions**

| Maryland Company | Acquired by | Acquisition | Merger |
|--|---|---|---|
| ADP Integrated Medical Solutions | Integrated Medical Solutions bought by Automated Data Processing Inc. (ADP) Roseland, NJ | | |
| Adventa Health Education | HealthOnline (10/99) | | |
| Amisys Synertech | Was Jurgovan & Blair (1970s); became Amisys Managed Care Systems; HBOC; McKesson HBOC; Platinum Equity (which combined it with Synertech 7/01); Whitney & Co LLC (5/03) | | |
| APS Healthcare, Inc. | | Principal Behavioral Healthcare (9/97) | |
| Atto Bioscience | BD (7/04) | Cytoprint, Inc. (Santa Fe, NM) 9/03 | |
| BTE Technologies | | | Baltimore Therapeutic Equipment and Hanoun Medical (UK) Ltd. 1/1/04 |
| Capital Genomix | | Dynex Technologies div of Thermo Electron Corp.(MA) 12/02 | |
| CBay Systems, Ltd. | | Arrendale Associates 9/02; Advanced Transcription Solutions 8/02 | |
| Celera Genomics | | Axys Pharmaceuticals 11/01 | |
| Dakota Imaging | WebMD, Englewood NJ (4/04) | | |
| Digital Angel (fka Medical Advisory Systems) | | Owns a 12% equity interest in Paris -based CORIS Group, which provides it with the ability to offer its services in over 30 countries worldwide | |
| Gene Logic | | Oncormed, Inc.(9/98); TherImmune Research Corporation (4/03) | |
| GenVec | | Diacrin Inc. (8/03) | |
| GloboMax | ICON plc 9/03 | | |

| Maryland Company | Acquired by | Acquisition | Merger |
|---------------------------------------|---|--|--|
| HealthBizNow | Woodbourne Solutions (1/01) | Findaresident.com (5/00); sold to American Assn of Medical Colleges (8/00) | |
| HealthObjects | Wholly owned subsidiary of NeighborCare pharmacies, became indep 1996; 2000 became part of Genesis Health Ventures family; (Genesis bought NeighborCare 1996), spun off 11/03 | Automated HomeCare Systems 1995 (AHS) home infusion therapy market | |
| InforMax | Invitrogen (San Diego, CA) 10/02 | | |
| InfoSoft | PracticeWorks (GA) 1/01 for \$32m | | |
| LifeART | Lippincott Williams & Wilkins (1998), a Wolters Kluwer (Neth) company (1999) | | |
| Marligen Biosciences | | Clairus Technologies (8/02) | |
| OAO Corporation | Lockheed Martin (12/01) | EZ-CAP software div from QuadraMed (8/01) | |
| RxNT | | | Script-Fast (4/04) |
| SoftMed Systems Inc. | | | Innovative Health Systems (2000) |
| Solucient (formerly HCIA) | | | HCIA and subsidiary of VS&A Communications Partners III, LP -- an affiliate of Veronis Suhler & Associates (Nov 17 1999); Sachs Group of VNU Marketing Information and HCIA of VS&A (Nov.29 1999) became HCIA -Sachs; HCIA-Sachs and HBS International (2000) became Solucient |
| VIPS Healthcare Information Solutions | 1993 \$30m by company that was then acquired by First Data Corp (Western Union, TeleCheck); spun out by First Data; 1998 Cornerstone Equity Investors, LLC acq'd controlling interest; 2004 \$160m by WebMD (NJ) | CB Technologies (Exton PA), creator of MetaTrial suite of clinical solutions | |

Bio/Med/Health IT Entrepreneurship in Maryland: Implications for Policy and Programs

The paths of entrepreneurship in fields that feature the application of information technology to biomedicine and health care are quite different. Many of the genomics entrepreneurs share a link to the National Institutes of Health (NIH), or the schools of medicine at Johns Hopkins University or the University of Maryland. However, the medical and health informatics entrepreneurs are just as likely to have had experience in federal laboratories other than NIH, or in university computer science departments and hospitals in addition to medical school academic departments. They frequently were involved in the health care segment of large corporations or consulting practices. This suggests that a wider and deeper outreach effort is needed.

We need to provide an open-armed experience for graduate students and post-doctoral and visiting fellows while they are in Maryland, exposing them if possible to some of the state's successful bioscience entrepreneurs.

We need to work with universities and federal laboratories to identify and encourage interdisciplinary initiatives and research groups that are focused on the intersections of information technology and bioscience and health care. TEDCO is ideally suited to a targeted initiative of this type, using its federal laboratory and university partnership programs. We need to support university/federal lab/corporate research centers of excellence at the frontiers of grand challenges in these fields, including NSA's informatics initiatives, NSF-supported computer-assisted surgery, molecular imaging, and bioinformatics data mining.

Many of the potential bio/med/health IT entrepreneurs, particularly those in health care fields, belong to professional associations that are either headquartered in Maryland or the District of Columbia, or have state chapters here.

We need to have a regular presence at the gatherings of these associations, for two purposes. First, we need to make a concentrated effort to get to know bio/med/health IT company managers and to celebrate their successes. We need to understand the dynamics and needs of their fields, and to work together on policy initiatives, standards, and other efforts to strengthen these hybrid industries in which Maryland has competitive strengths. Secondly, we need to foster the start-up of new companies, knitting them into existing networks of support for Maryland entrepreneurs.

Maryland's rich array of bio/med/health IT companies and resources make it an ideal place to which companies started elsewhere might move, and for entrepreneurs to start new companies. It is also a critical resource for biotech, biomedical research and development, drug development, and health care companies the state is seeking to attract or retain.

We need to include bio/med/health IT strengths in Maryland's marketing and promotion strategies and collateral materials. MDBio's excellent inventory and promotions of the state's bio-tools infrastructure can be usefully incorporated into the state's marketing efforts. Bioinformatics companies generally require less specialized facilities than drug development bioscience companies,

and therefore are more footloose. Precious assets that are highly coveted by other states, they deserve a concerted retention effort.

Maryland is fertile ground for the emergence of bio/med/health IT entrepreneurs because of its strengths in biomedical research and health care. These enterprises not only spawn new companies but also are their primary customers. Hospitals, physicians, surgeons, nurses, researchers, and drug developers buy the tools and services produced by the industry in order to improve the health care they deliver, the management of their health care enterprises (including compliance with regulations), and/or the productivity of their research.

We need to create opportunities for Maryland buyers and sellers of bio/medical/health IT products and services to interact. Vendors benefit from deeper understanding of purchaser needs and requirements, and purchasers benefit from increased awareness of what is available from local suppliers. Both may find that co-development of new custom-designed products may not only solve an immediate problem, but also open up new markets.

The bio/medical/health IT “industry” is very fragmented. From the customer’s viewpoint, however, many of the biggest challenges they are facing require system approaches. Diagnostic tools, including images, need to be delivered seamlessly (and without additional effort by the user) to support decisions at the bedside. The avalanche of data unleashed by the genomics revolution, not all of equal quality, has made the hoped-for goal of streamlined culling through potential drug candidates an elusive one. Systems integration expertise in data mining, modeling, and visualization, and distributed software engineering needs to be tapped to help realize the potential of the scientific breakthroughs.

We need to provide opportunities for enhanced interaction among Maryland providers and users in order to facilitate partnering that better responds to customer needs. We need to take advantage of NIH, NSF, and other federal funders’ support for collaborative tools.

We need to foster advances in telemedicine that enhance access to state-of-the-art health care throughout Maryland, another benefit of regular interaction among Maryland providers and users of bio/med/health IT products and services.

Maryland is fortunate to have the attention of several unusual venture capitalists who prefer to build companies from scratch rather than investing at a later stage. They have proven by their actions that they believe Maryland to be fertile soil for fledgling bioscience (particularly genomics) companies, often moving start-ups (and their scientific founders) here from elsewhere. It is also clear that early endorsement by these pioneers has moved other financiers to join in later rounds of financing. Regular consultation with Alan Walton and James Cavanaugh (and Wei-Wu He as he follows this same path) should be used to determine what supportive roles other Maryland organizations might play in enhancing the chances for success of their new companies.

We need to find ways to redouble support for the financiers who are matching cutting edge science with seasoned management to launch new bio companies in Maryland.

Many of the service companies in this cluster of industries will not be candidates for venture capital, and yet are important assets to the state's life sciences economy and its ability to deliver quality health care to its citizens.

We need to understand the financing requirements of all types of companies in this cluster of industries, and make sure that private and public resources are available to support their growth.

Over the past several decades, all aspects of health care, bioscience research, and drug development have been dramatically transformed by advances in computing. The future holds more of the same.

We need state education and training systems that anticipate and respond to the requirements for a robust pipeline of new skilled bio/med/health IT workers, and continuing education for health care, research, and drug development workers to keep up with new technology developments.

Bioscience research and development is global, and its universities, companies, entrepreneurs, and venture capitalists all have international connections that can be exploited to reach other bio companies and bio-entrepreneurs around the world. Several of the state's health informatics entrepreneurs are foreign-born, have developed offshore IT outsourcing partnerships, and attracted venture capital from their home countries.

We need to fully exploit Maryland's international networks to reach bio/med/health IT companies and entrepreneurs around the world.