Emerging Technologies in Healthcare: Disruptive Effects in Disease Management

Presentation for the National Disease Management Summit

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National Academy of Sciences Awards

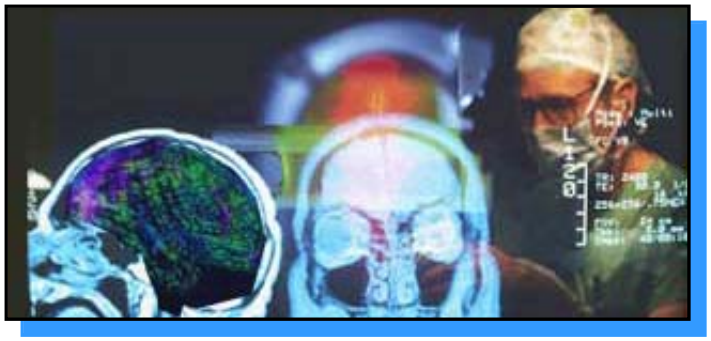
Greatest Engineering Achievements of the 20th Century

Health Technologies

The Challenges of a Rapidly Changing Landscape...

- A bulging pipeline of new technologies
- Consumers excited by the promise of longer and healthier lives
- Regulatory bodies unable to moderate demand
- Competition for resources escalates
- New strategies for safety, quality and workforce productivity emerge

Leadership challenges in planning for technology



Health Technology Center

The Vision

Advance the use of new technologies to make people healthier

The Mission

To create a trusted source of objective, expert and useful information about the future of healthcare technologies

HealthTech Strategic Partners

11 New members in 2002

Baylor Health Care System
Bon Secours Health System
Carolinas HealthCare System
Catholic Healthcare West
Centers for Medicare and Medicaid Services
CHRISTUS Health
Medisys Healthcare System
Parkview Health
Partners HealthCare System
Presbyterian Medical Services
The Queen's Medical Center
Ryan Community Health
Veterans' Health Administration

Partner Driven: *Users set research agenda and co-design strategic planning tools*

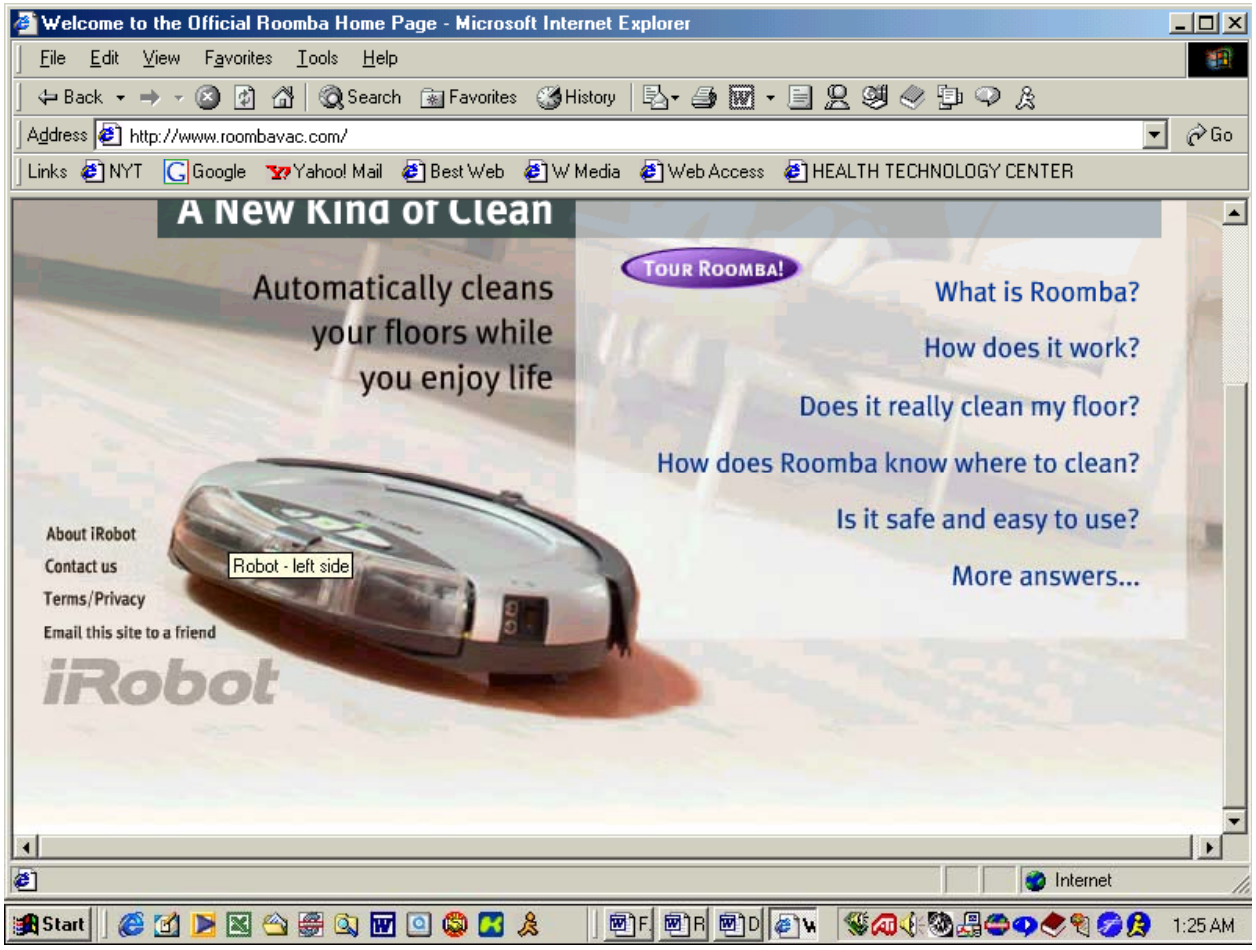
Founding Members

Ascension Health
CAPH
Group Health Cooperative
Kaiser Permanente
Mills-Peninsula Health Services
PeaceHealth
Premier, Inc.
Providence Health System
Sequoia Healthcare District
Sutter Health
VHA Inc.
WellPoint Health Networks

New members – 2003

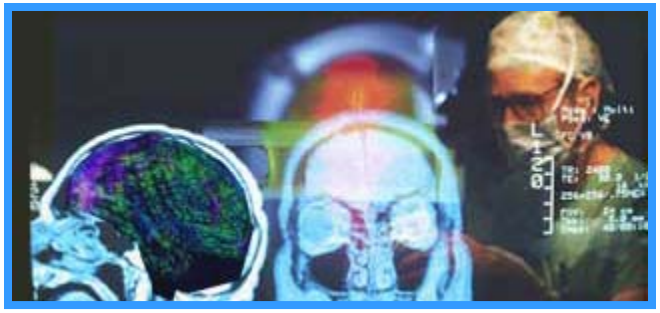
Texas Health Resources
El Camino Hospital

Nudging the Diffusion Curve



Key Technologies That Will Disrupt Disease Management

- Remote Patient Management
- Organ Assistance and Substitution
- Novel Drug Delivery
- Imaging and PACS
- Sensors for Monitoring
- Mobile Computing



Technology Breakthroughs

Laparoscopic cholescystectomy

Inhaled therapies

Remote chronic disease monitoring

Drivers and Barriers

- Technology Breakthroughs
- Target Conditions: Scale, Expenditures and Severity
- Convergence of Technologies
- Competing and Substituting Technologies
- Liability: Malpractice, Institutional Liability

Malpractice:
Electronic Fetal Monitoring

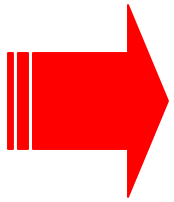
Sensors:
Microprocessing and
power management

Cardiac disease
and LVADs

Disruptive Technologies - I

Established and Disruptive Technologies in Healthcare

Established Technology	Disruptive Technology
Physicians	Advanced Practice Nurses
General Hospitals	Outpatient Clinics, Home Care
Open Surgery	Arthroscopic and Endoscopic Surgery
CABG	Angioplasty
MRI + CT	Ultrasound
Office Visit	Email



(After Christiansen)

Disruptive Technologies - II

Christiansen's Typology of Technology in Healthcare:

Established Technology	Disruptive Technology
Physicians	Advanced Practice Nurses
General Hospitals	Outpatient Clinics, Home Care
Open Surgery	Arthroscopic and Endoscopic Surgery
CABG	Angioplasty
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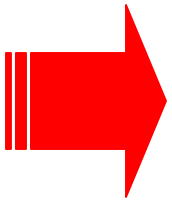
(Christiansen)

Technologies for the Diffusion of Innovations in Healthcare

Established Technology

Journals, CME
Accreditation
Media Coverage
Patient Education



Disruptive Technology

Decision Support Integrated EMR
Leapfrog
DTC Advertising
Closed-loop Systems

Disease Management Systems

Remote Patient Monitoring and Management

A rocky road for new products

Remote Patient Management: Chronic Disease

Health Hero's Experience - Adoption of Beneficial Technology

Home-based Telemedicine for Uninsured, High-risk Diabetic Population

Inpatient Admissions	▼ 32%
Emergency Room Encounters	▼ 34%
Outpatient Visits	▼ 49%

(Diabetes Technology & Therapeutics Journal, 2002)

Asthma Self-management for High-risk Pediatric Population

Activity Limitation	▼ (p = .03)
High Peak Flow Readings	▼ (p = .01)
Urgent Calls to Hospital	▼ (p = .05)

(Arch Pediatr Adolesc Med. 2002)

Care Coordination: Hypertension, Heart Failure, COPD, and Diabetes

Emergency Room Visits	▼ 40%
Hospital Admissions	▼ 63%
Hospital Bed Days of Care	▼ 60%
Nursing Home Admissions	▼ 64%
Nursing Home Bed Days of Care	▼ 88%

(Disease Management, 2002)

Where will advances in RPM occur?

- Increased diversity and capability of sensors
  - E.g size, form-factor, ability to transmit, power usage
- Advances in imaging and image acquisition
  - E.g. Image processing, low-light, color fidelity, etc.
- More affordable and available telecommunications
  - E.g. range, speed, coverage, and cost
- Increase in computing power
- Improved power consumption
  - E.g. Battery life, power consumption of chips, thermal efficiency, etc.

What will drive RPM adoption?

Drivers

- Shortage of specialists and need for more efficient distribution of the healthcare workforce
- Simplification of enabling technologies
  - wireless, less intrusive
- Cost reductions in enabling technologies
  - previously reduced per-patient expenditures, but expensive to implement
  - make large scale implementation more efficient
    - communication costs drop
    - technology allows response to actual point downward trajectory begins
- Employer incentives to delivery systems
- Homeland security leading to greater awareness of sensor potentials
- Commercial availability of enabling technologies (POC testing)

Drivers/Barriers

- RPM has been ‘tethered’
  - private homes: what they have and how it is installed difficult to predict
  - wireless with range and bandwidth is key.
- Wireless:
  - real-time applications (audio, video) not on near-term horizon
  - roaming and coverage - 2 years, 4 years rural
  - packet loss - 5 year problem
  - cost generally increases
  - form factors:
    - Most are PCMCIA, not all
    - heavily dependent on market demand
    - Likely to get patchwork coverage, cell available only in some areas
  - electromagnetic compatability inadequate (EMC)
    - UWB (ultrawideband) could solve ? 5 years

What will hinder RPM adoption?

Barriers

- Medicare reimbursement does not support RPM
- High cost of logistics, scheduling, records management, and telecommunications
  - Many platforms only task-specific
  - next generation is integrated platform with built-in web browser
  - Information gathering richer than direct biological monitoring
    - cognitive testing
    - conditional modification of questioning
- Lack of workforce in underserved areas
- Physician fears
- Licensing and credentialing of providers
- **Lack of high-bandwidth infrastructure in rural areas – beyond 5 years. [256 kilobits/sec)**
- **Significant training requirements for patients and providers**

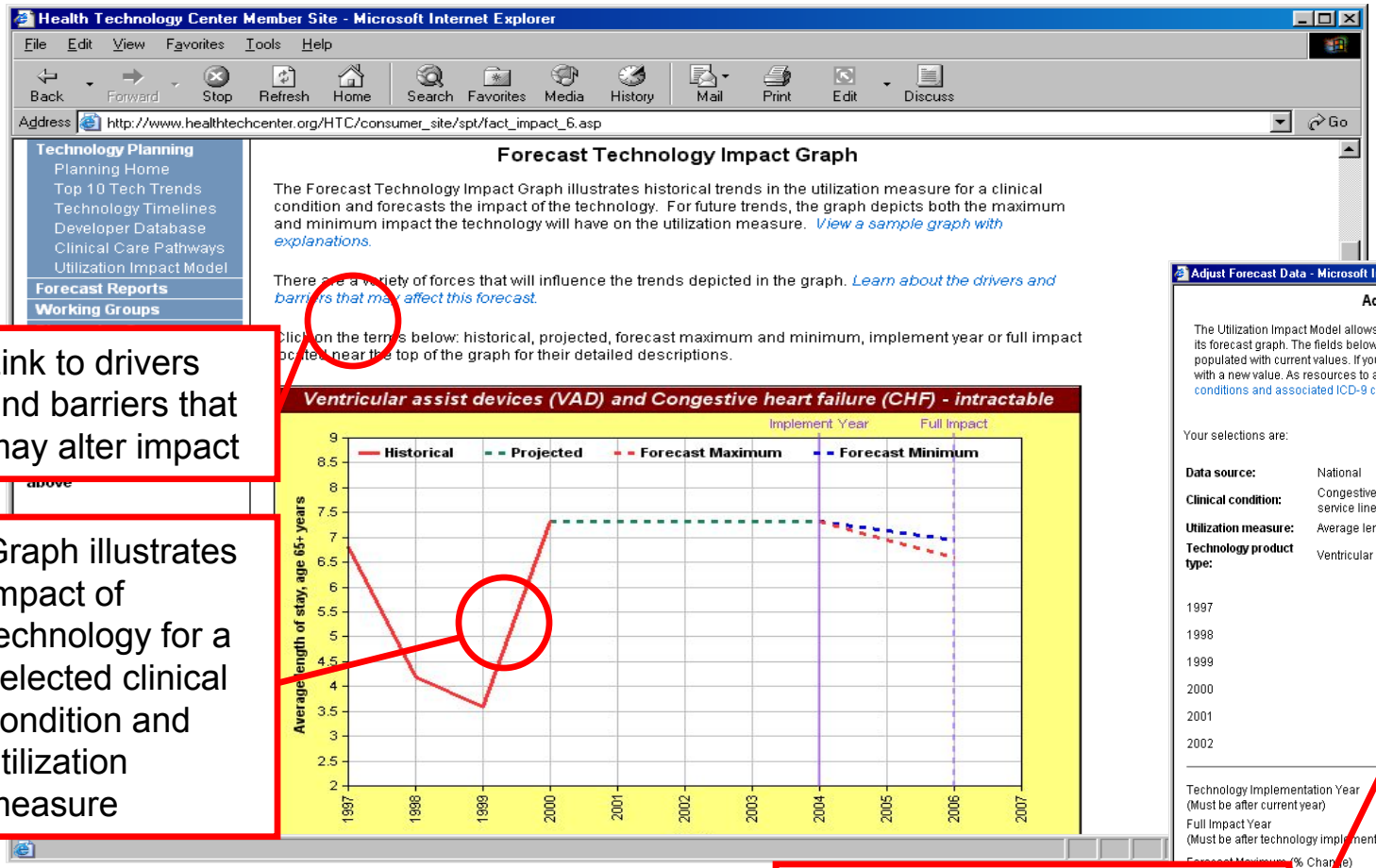
Business Models

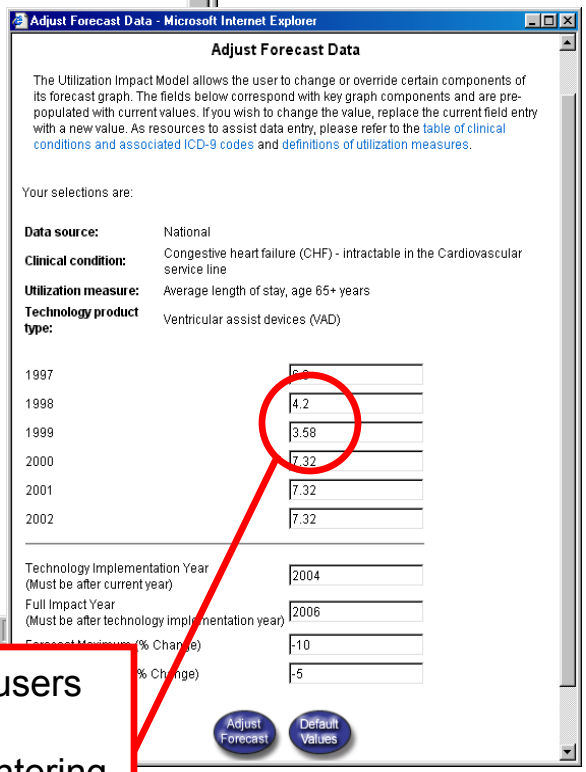
- Web, device, and the (Inter)net enable disruptive business models
- Businesses organized as ‘call centers’ to integrate data streams and determine when providers need to be alerted
- Current lead - pacemaker companies making implantable sensors (potential reimbursement – interrogation of device with ‘800 mile cord’ (Medtronic)
- Home-based dialysis for CHF: ‘ultra-filtration’ for fluid removal

Future Program Considerations

- Wireless developing as a patchwork, so implementing disease management using RPM will have to make a series of complex decisions in these areas (3-4 year forecast)
  - Chose a hardware platform, to support the..
  - Wireless network, to support the..
  - Operational model (go to hot spot and sync while traveling, live transmission, who gets access)
  - Disease and comorbidities addressed
  - Scope of program:
    - Testing/ monitoring
    - Evaluation
    - Medication / therapeutic compliance
    - Real-time consultation

Utilization Impact Model





Link to drivers and barriers that may alter impact

Graph illustrates impact of technology for a selected clinical condition and utilization measure

Pop-up window allows users to adjust forecasted technology impact by entering their own data values

Who will adopt which applications?

- Provider/patient settings:
  - Structured clinical messaging
  - Home-based RPM technologies
  - Synchronous & asynchronous RPM consultations
    - synchronous dependent on wireless and high bandwidth, about 4-5 years out
    - quality of service, even at high bandwidth, is the issue
    - Value-added providers guarantee reliability but market not large enough
- Primary care clinician practices (pending reimbursement)
  - Live and store-and-forward RPM
  - Chronic disease management
  - Structured clinical messaging
- Specialists
  - Live and store-&-forward RPM
  - ICU-based RPM
- Delivery systems and plans
  - Chronic disease management– nurses
  - Structured clinical messaging
  - Specialty access
  - Home care– home health aides and nurses

Other Key Technologies Changing Disease Management

- Organ Assistance and Substitution
- Novel Drug Delivery
- Imaging and PACS
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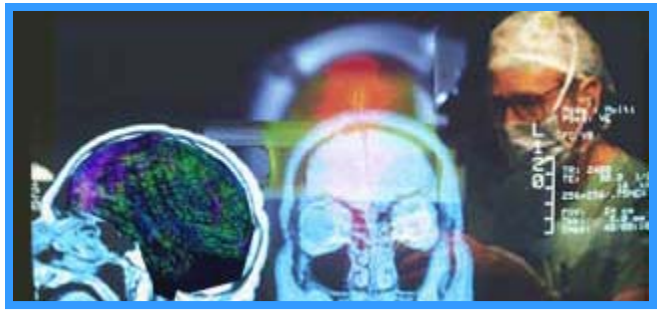
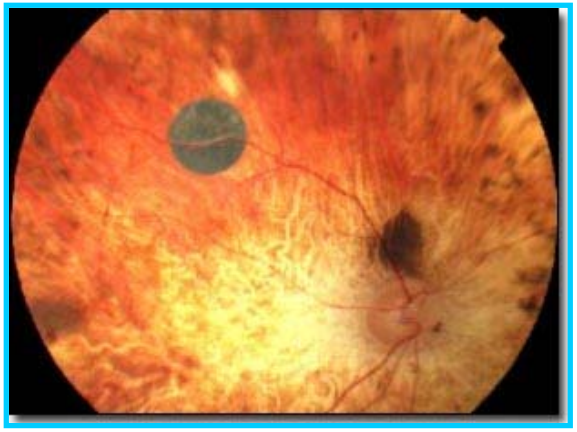


Organ Assistance and Substitution

Current Developments:

- Bioartificial liver assist device that utilizes live hepatocytes
- Intravenous membrane oxygenator (IMO), that will perform short-term rescue in patients with acute respiratory distress
- Artificial retina that can restore limited sight in blind patients with retinal diseases
- Ventricular assist devices for extended use/destination therapy



Optobionics' Artificial Silicon Retina (ASR)

Thoratec LVAD

Organ Assistance and Substitution

Two to five years:

- *Ventricular assist devices* (VADs) with complete or near-complete implantability
- A completely *implantable total artificial heart* as destination therapy
- An artificial lung (IMO) performs short-term rescue in patients with acute respiratory distress

Beyond five years:

- An *implantable, closed-loop, artificial pancreas system*
- An *implantable artificial lung* for chronic lung failure

Organ Assistance and Substitution Implications for Workforce

Key Issues:

- Continuing education and on-site training are integral
- Community physicians, EMTs, and home care workers will need to be trained on how to care for patients with implantable devices
- Niche market for highly-trained technicians will develop for the adjustment or repair of devices
- Monitoring of patients with OAS devices primarily by nurses and technicians
- ED as ‘repair stop’

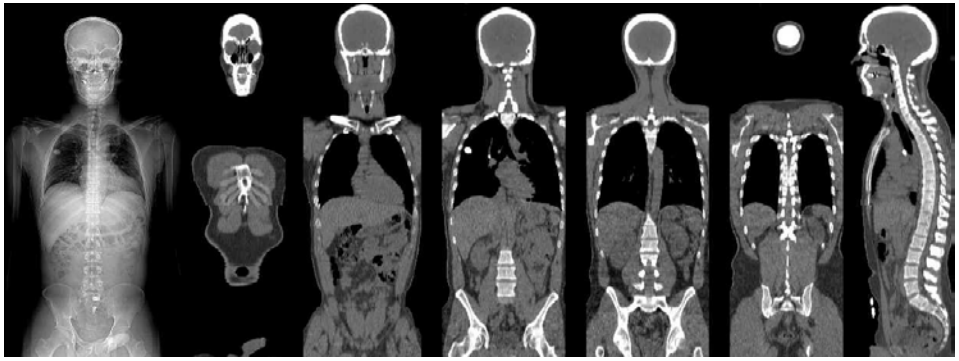
Drug Delivery Systems

- Closed-loop implantable devices:
  - artificial pancreas
  - *Medtronic*
- Pulmonary delivery systems:
  - interleukin-2 for lung cancer
  - antibiotics for pneumonia
  - corticosteroids for asthma and COPD
  - inhalable insulin for diabetes
  - *Aradigm, Inhale Therapeutics*
- Implants and microchips:
  - long-term, controlled drug release
  - pain medication, hormones
  - *MicroCHIPS Inc., Ben-Gurion University*
- Technicians required to maintain and re-calibrate devices
- Pharmacists responsible for patient education, initial device set-up, and refills

Picture Archiving and Communication Systems (PACS)

Current Developments:

- Increasing ability to move images and data inside and outside of organizations
- Platform for broadband data transmission in other institutional and home settings
- Business model conflicts between hospital-based delivery systems and other data integrators/system operators



Opening the Door for Strategic Action

- The anticipation of drivers and barriers and potential benefit opens the door for strategic action
- Federal government
  - CMS
  - HRSA
  - FDA
  - NHII
- Public Interest
  - IOM
  - Connecting for Health (Markle Foundation, eHealth Initiative)
  - eHealth Initiative
- Private Leadership
  - Leapfrog
  - Health plan coverage decisions
  - Delivery system responses

Four Key Strategies for Intentional Disruption

Intentional Disruption

- *Emphasize strategies that target organizations*
- *Anticipate the disruptive effects of technology*
- *Adopt new approaches to research and policy*
- *Employ economic incentives and invest in information technology*

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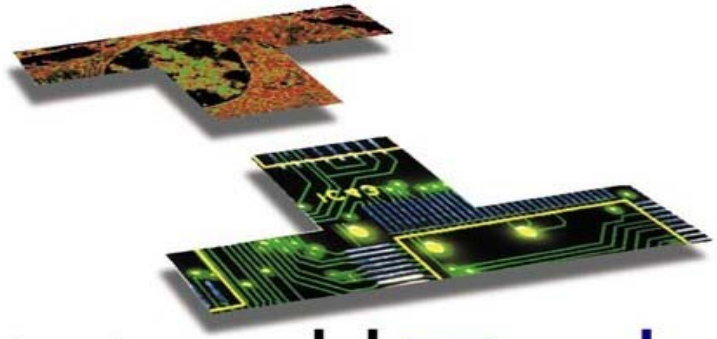
Health Technologies



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