


# Medical Devices



**Technology for Life  
Scanning the Future**

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# Overview

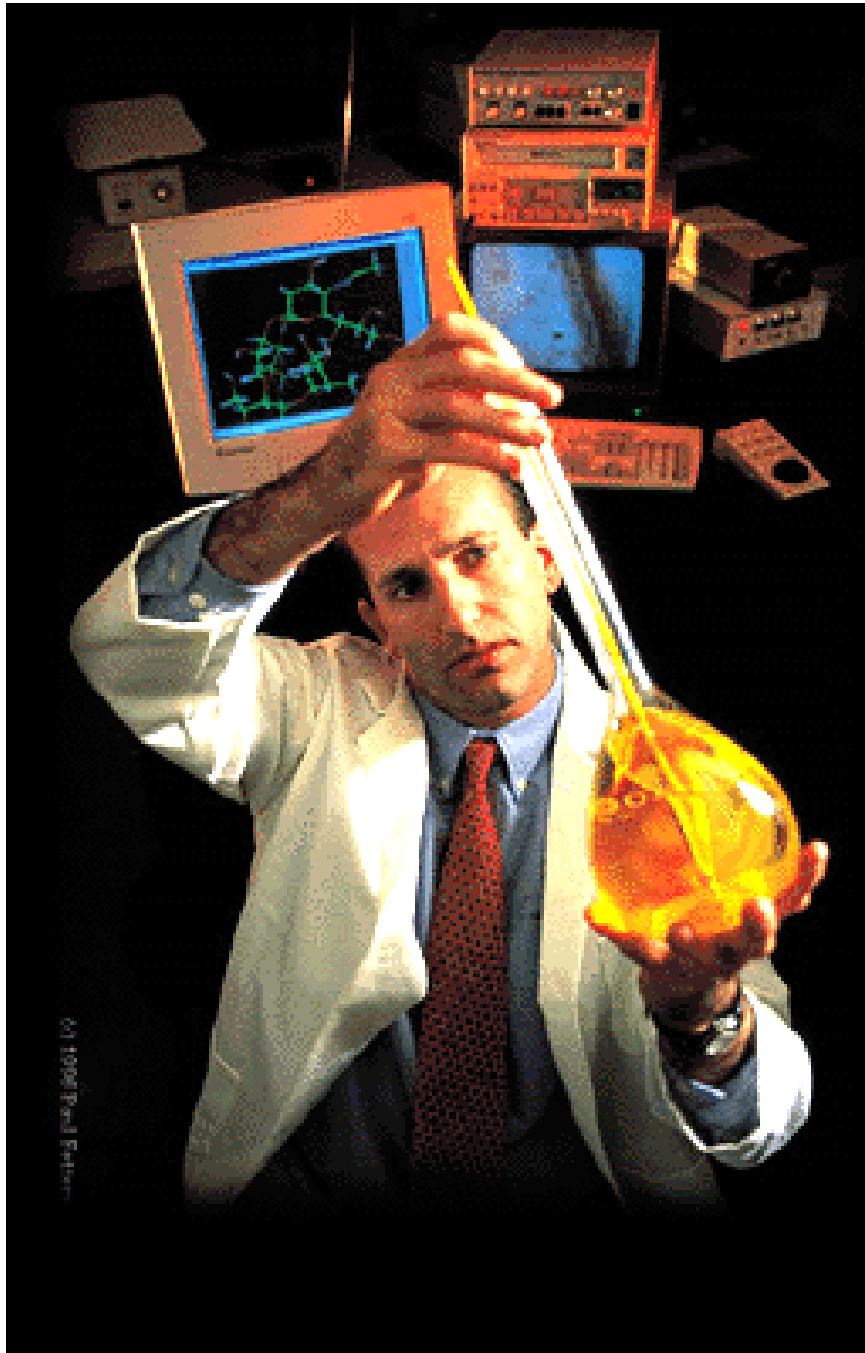
- **Historical Perspective:** Examples of some 20th Century technological breakthroughs. 
  - **Scanning the Future:** Progress is occurring rapidly, often faster than predicted, due to the knowledge explosion.
  - **Future Trends:** Technological advances are rapidly adapted for medical devices, to save and improve quality of life for millions of individuals.
  - **How to Participate:** What do you need to do to take part in the Medical Technology Revolution.
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# Historical Perspective

Examples of some 20th Century technological breakthroughs.

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“Advances in 20th century medical technology have been astounding. Artificial organs, replacement joints, imaging technologies, and biomaterials are but a few of the engineered products that improve the quality of life for millions.”

**National Academy of Engineering 2000**

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# A Historical Timeline

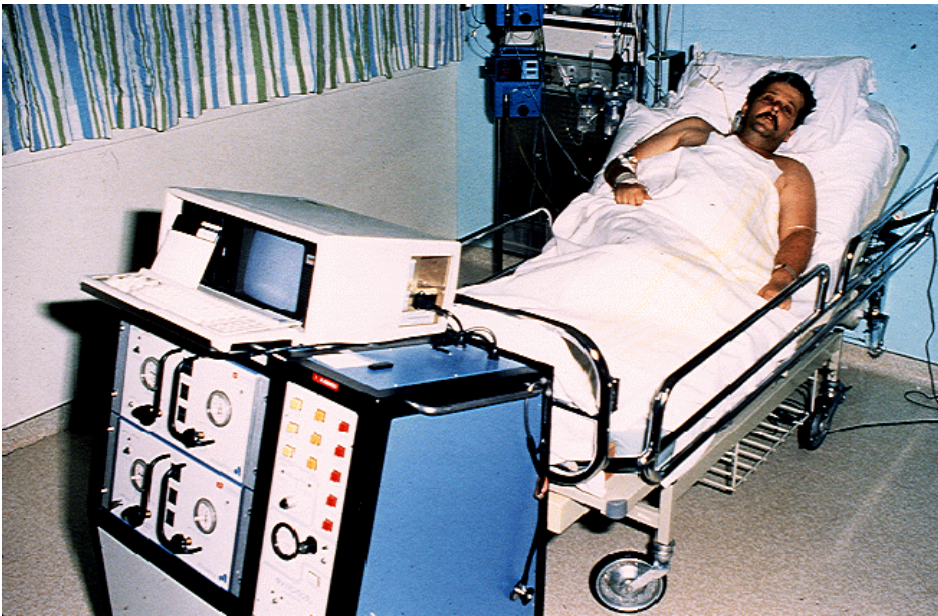
## Some Medical Device Examples

- 1903** Willem Einthoven, Dutch physiologist, develops electrocardiograph.
  - 1927** Iron lung developed by Phillip Drinker.
  - 1945** Artificial kidney developed by Willem J. Kolff.
  - 1950s** Charles Huntnagel pioneers prosthetic heart valves.
  - 1953** First application of a heart-lung machine, John H. Gibbon, Jr.
  - 1960** First totally implanted pacemaker.
  - 1973** Computerized tomography (CAT scan).
  - 1986** Dr. W. J. Keon implants first Jarvik Artificial Heart in Canada.
  - 1992** Canadian Artificial Heart Team led by Dr. T. Mussivand, develops the worlds first totally implantable VAD (HeartSaver VAD).
  - 1998** Dr.'s Keon and Mussivand demonstrate Trans-Atlantic Remote Patient Monitoring between Canada and Germany.
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# Artificial Hearts

## The First Generation



**Jarvik Artificial Heart (1980's)**  
**University of Ottawa Heart Institute**  
**(Dr. Keon)**

- **Proven ability to save lives**
  - **Utilized in over 8,000 patients**
  - **Rapidly emerging as a viable heart failure treatment**
  - **Increasing experience of patient recovery**
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# Artificial Heart

## The Next Generation



- Pulsatile Ventricular Assist Device (VAD) developed at the University of Ottawa Heart Institute:
  - Implantable in Thoracic Cavity
  - No Percutaneous Connections
  - Remotely Monitored/Controlled
  - Capable of out of Hospital Use
  - Long Term Support Capability
  - Minimal Limitations for Patients

**HeartSaver VAD (2000's)**  
**(Canadian Artificial Heart)**  
**World Heart Corporation**

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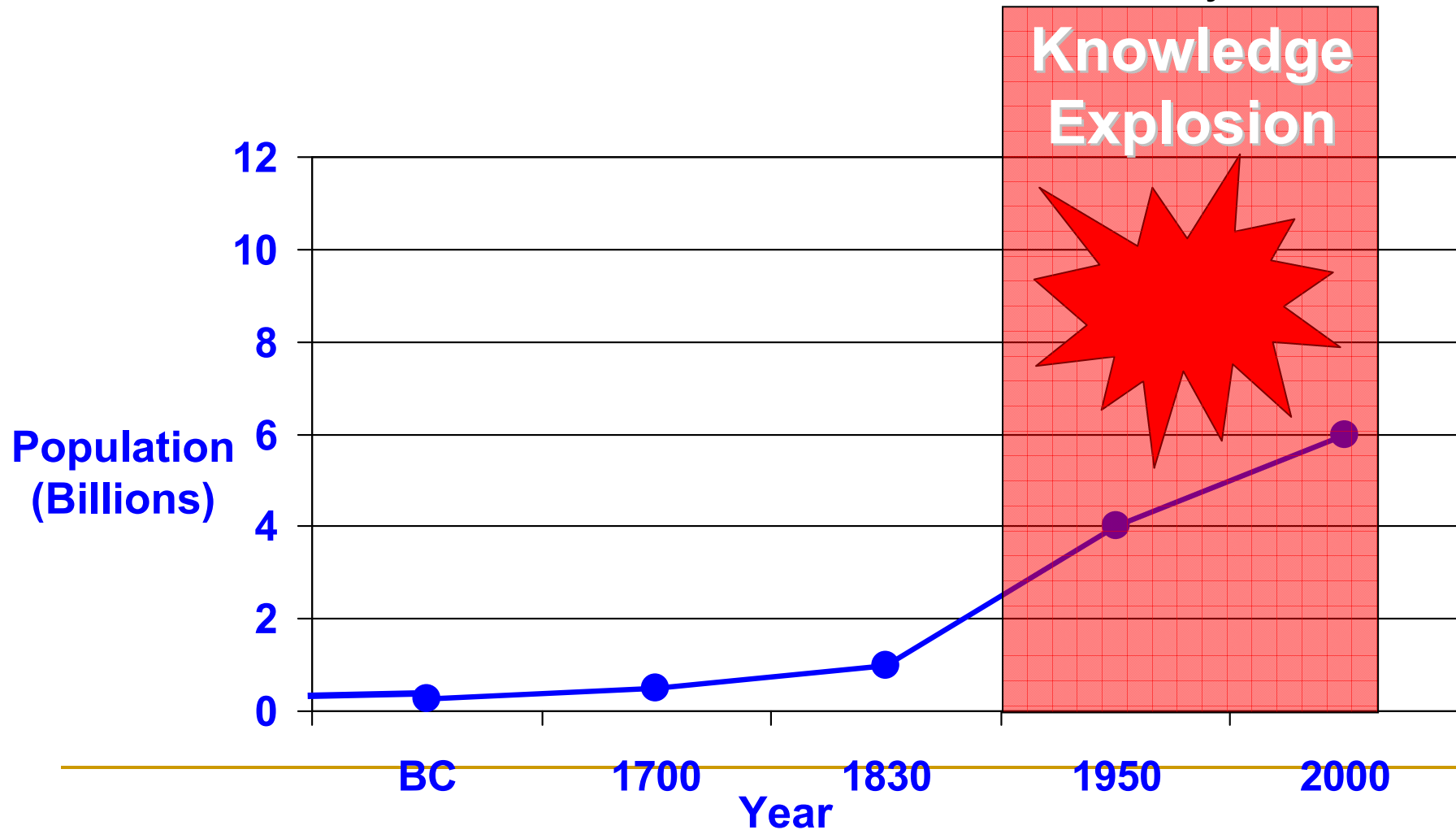
# Major Results of the Knowledge Explosion

- Electrification, Automobile, Airplane,
  - Water Supply and Distribution, Electronics,
  - Radio and Television, Telephone, Computers
  - Agricultural Mechanization,
  - Air Conditioning, and Refrigeration,
  - Highways, Spacecraft, Internet, Imaging,
  - Household Appliances, Health Technologies,
  - Petroleum and Petrochemical Technologies,
  - Laser and Fiber Optics, Nuclear Technologies,
  - High-performance Materials,
  - and many, many more...
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# The Knowledge Explosion

Virtually all major scientific and technological advances have occurred in the 20th Century.



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# Resulting Improvements for the Welfare of the Human race

- Increased life span
  - Better healthcare
  - Improved comfort
  - Relieved pain
  - Enhanced mobility
  - Increased accessibility of information
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# Most Shocking Discovery of the 20th Century

**How little is known, and how much  
remains to be discovered**

Example: Science cannot truly understand many of the benefits of eastern or holistic medicine. In fact, we are seeing an increase in the use of the holistic approach to complement orthodox medicine  
*(i.e. Eastern meets Western Medicine)*

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# Scanning the Future

Progress is occurring rapidly, often faster than predicted, due to the knowledge explosion.

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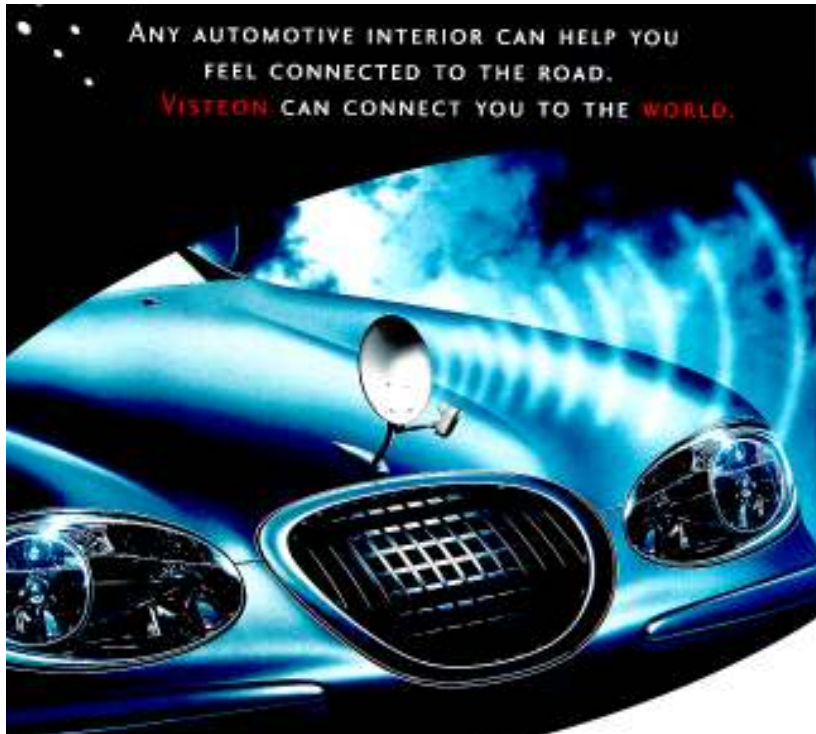
# Thoughts on the Future - 1989



“Furthermore, it drives itself, leaving you free to use the fax and talk on the phone.”

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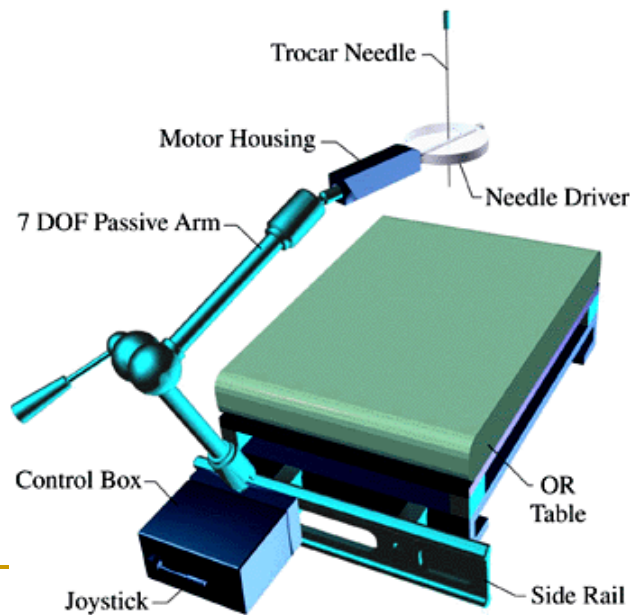
# The Future is Now !!!



- In-car personal computer.
- Allows access to the Internet and e-mail.
- Provides both visual and audible navigation help.



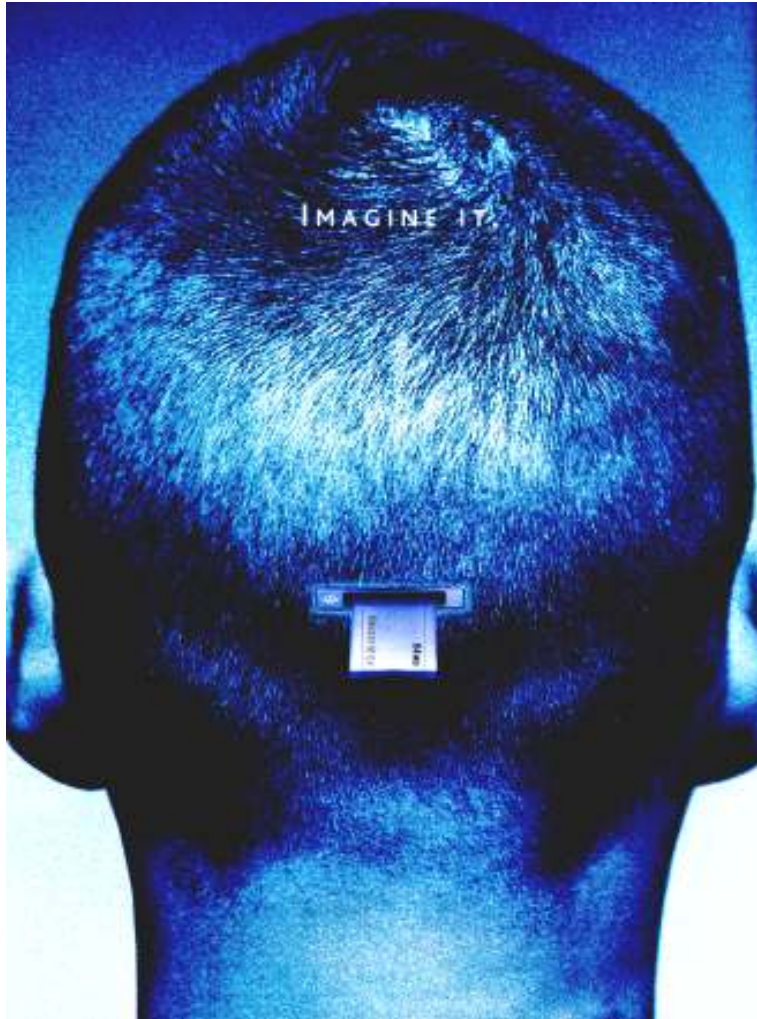
- **Wired Magazine prediction in 1995:**
  - 2002 - Telesurgery on a Living Human
- **The Future is now:**
  - In 1998, Dr. Kavoussi performed percutaneous renal access on a patient in Italy using a surgical robot, controlled from his Baltimore office.



**Telesurgery Console**



# Wired Humans



**Sony Advertisement**

**Early 2000**

## I Am Cyborg

By implanting a computer chip into his arm, one man hopes to establish the most direct link yet between man and machine.



**Real Life**

**Late 1999**



# Wired Patients



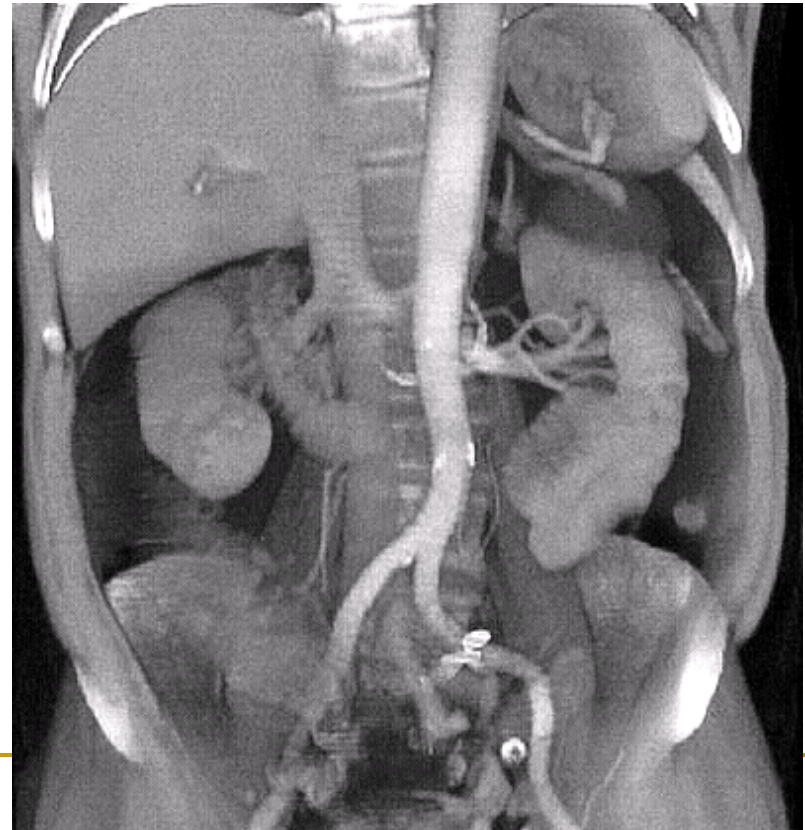
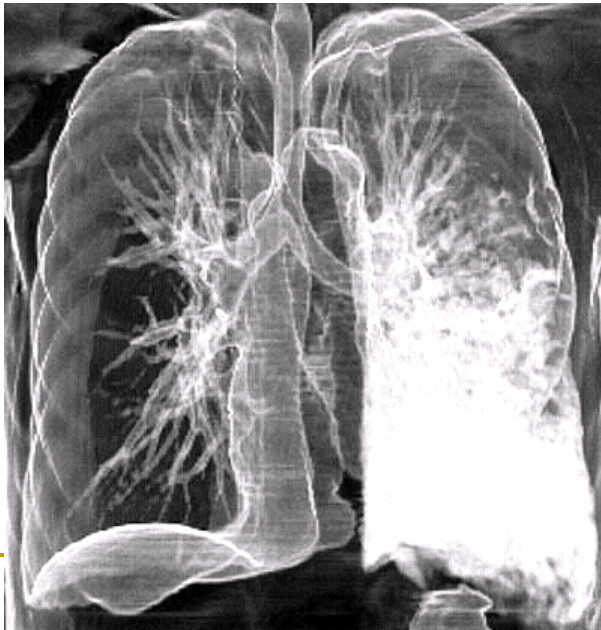
- Device is attached to high risk patients when entering the hospital
- Automatically recognizes a heart attack and provides life saving shock treatment.

IT CAN TAKE even the best hospital staff 5 minutes to respond to a heart attack—a loss of valuable time in combating tissue damage. So Cardiac Science developed the Powerheart, a defibrillator that automatically recognizes a heart attack and administers shocks. A monitor is attached as each heart patient enters the hospital. Cardiac Science, 1176 Main St., Bldg. C, Irvine CA 92617.

# Hollywood meets Medicine

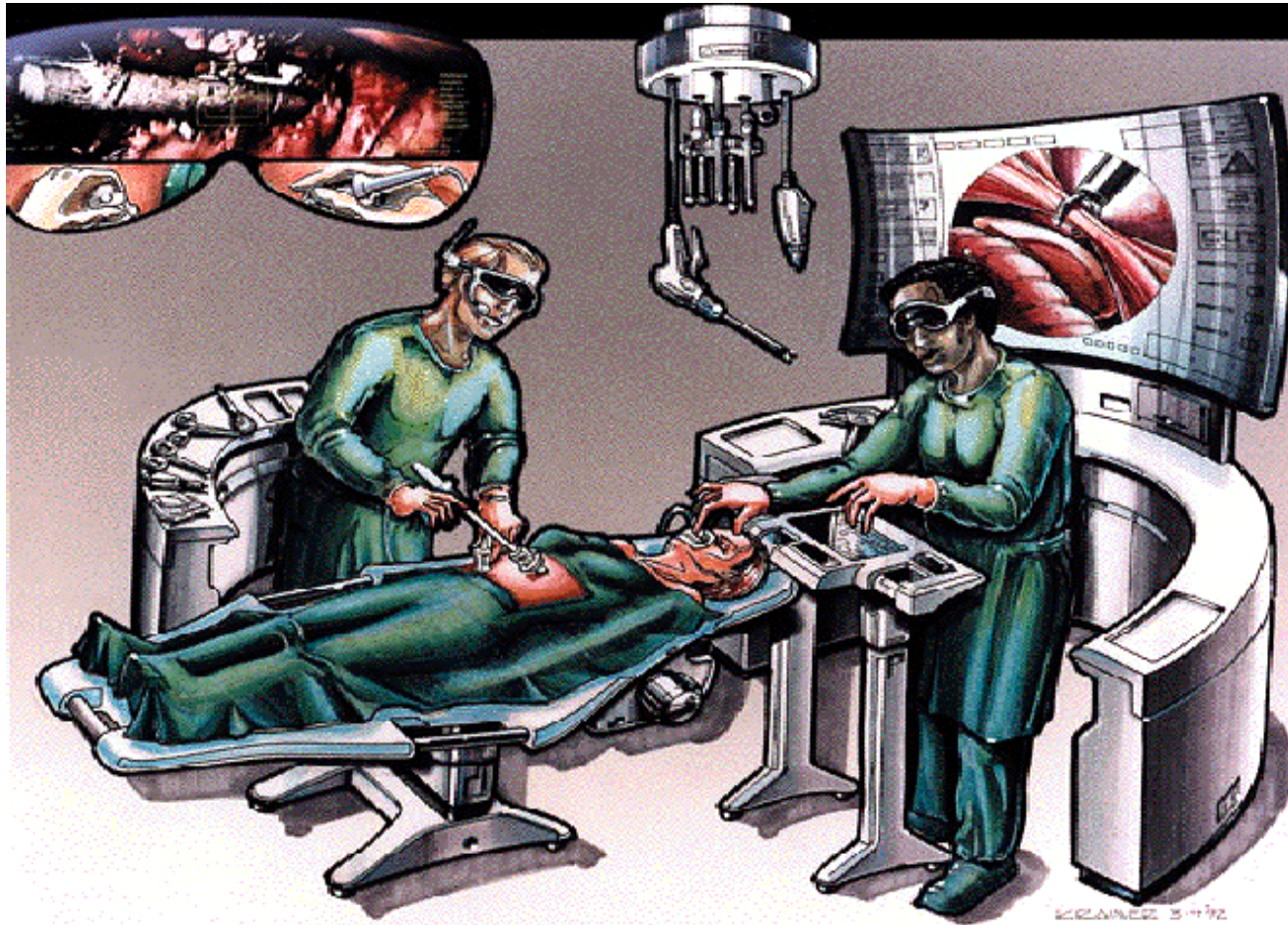
John Hopkins University and George Lucas have been working for years to apply computer equipment and software programs behind the special effects in "Star Wars" and other films, to advanced medical imaging.

P  X A R





# Operating Room of the Future ?



Courtesy of Northrop Grumman Corp.  
Advanced Technology and Development Center

# Operating Room Today



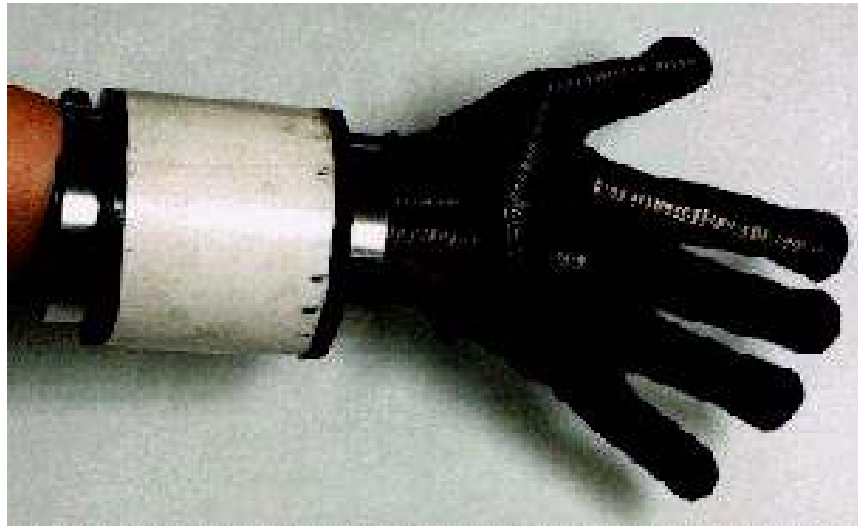
← **da Vinci Computer  
Enhanced Surgical System**

**Closed Chest Bypass Surgery  
Dr. Boyd, in London Ontario  
(trained by Dr .Keon)** ↓



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# The Virtual Surgeon



- A prototype glove-like device that senses the positions of the surgeon's fingers and wrist with its index, thumb, and wrist flex sensors and wrist rotation sensor has been designed.
  - The glove can provide a more natural means of control than current minimally invasive tools.
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# Future Trends

Technological advances are rapidly adapted for medical devices, to save and improve the quality of life for millions of individuals.

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# Projected High Growth Areas in Medical Devices

- ❑ computer-related technologies,
- ❑ molecular medicine,
- ❑ home- and self-care,
- ❑ minimally invasive procedures,
- ❑ device/drug hybrid products, and
- ❑ organ replacement/assist devices using both hardware and tissue-engineered components.

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Source: Center for Devices and Radiological Health, FDA, 1998.



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# Technology & Specific Device Groups

**BIOSENSORS:** Biosensors, Genetic diagnostics, Laser diagnosis & treatment, Minimally invasive devices. **BLOOD VESSEL PROSTHETICS:** Genetic therapy, Tissue engineered devices. **BONE PROSTHETICS/GROWTH:** Artificial organs, Tissue engineered devices. **CARDIAC STIMULATION:** Intelligent devices, Microminiatured Devices. **CARTILAGE PROSTHETICS:** Tissue engineered devices. **COMPUTER AIDED CLINICAL LABS:** Computer aided diagnosis, Networks of devices. **DRUG IMPREGNATED DEVICES:** Device/drug/biological products. **ENDOSCOPY:** Minimally invasive devices, Telemedicine, Virtual reality. **GENETICS - CANCER:** Genetic diagnostics, Genetic therapy. **HEARING AIDS:** Intelligent devices, Microminiaturized devices, Nonimplanted sensory aids. **HEART PUMPS:** Artificial organs. **HEART VALVES:** Artificial organs, Tissue engineered devices, Device/drug/biological products. **HOME DIAGNOSTICS:** Home/self monitoring & diagnosis. **IMAGE CONTRAST AGENTS:** Medical imaging. **IMAGING - FUNCTIONAL CONTENT:** Medical imaging, Minimally invasive devices, Networks of devices. **IMPLANTED DRUG DELIVERY SYSTEMS:** Biosensors, Device/drug/biological products, Home/self therapy, Intelligent devices, Robotic devices. **INTEGRATED PATIENT MEDICAL INFO SYSTEMS:** Computer aided diagnosis, Networks of devices, Telemedicine. **KIDNEY PROSTHETICS:** Artificial organs, Home/self therapy, Tissue engineered devices. **LASER SURGERY:** Laser diagnosis & treatment. **LIVER PROSTHETICS:** Artificial organs, Tissue engineered devices. **MIN. INVASIVE CARDIOVASCULAR SURGERY:** Minimally invasive devices. **MIN. INVASIVE NEUROSURGERY:** Minimally invasive devices. **MRI:** Medical imaging. **NANOTECHNOLOGY:** Microminiaturized devices. **NERVE REGENERATION:** Tissue engineered devices. **NEURAL STIMULATION:** Artificial organs, Electrical stimulation, Intelligent devices. **NEUROMUSCULAR STIMULATION:** Electrical stimulation, Home/self therapy. **OCULAR PROSTHETICS:** Artificial organs, Electrical stimulation, Intelligent devices. **PANCREAS PROSTHETICS:** Artificial organs, Tissue engineered devices. **PATIENT SMART CARDS:** Computer aided diagnosis, Networks of devices, Telemedicine. **PET IMAGING:** Medical imaging. **ROBOTIC SURGERY:** Microminiaturized devices, Robotic devices. **SKIN PROSTHETICS:** Tissue engineered devices. **TELEMEDICINE - HOME USE:** Home/self monitoring & diagnosis, Telemedicine. **TELEMEDICINE - RADIOLOGY,** Telemedicine. **VIRTUAL REALITY - EDUCATION:** Virtual reality.

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Source: Center for Devices and Radiological Health, FDA, 1998.



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# How to Participate

What do you need to do to take part  
in the Medical Technology  
Revolution.

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# By Thinking we Create the Future

**Perception**



**Formation  
of Thoughts**



**Chemicals**



**Emotional &  
Physical  
Action**

