New Technologies for Surgery

ACCE 2008 Teleconference Series

December 18, 2008

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ORBIS International

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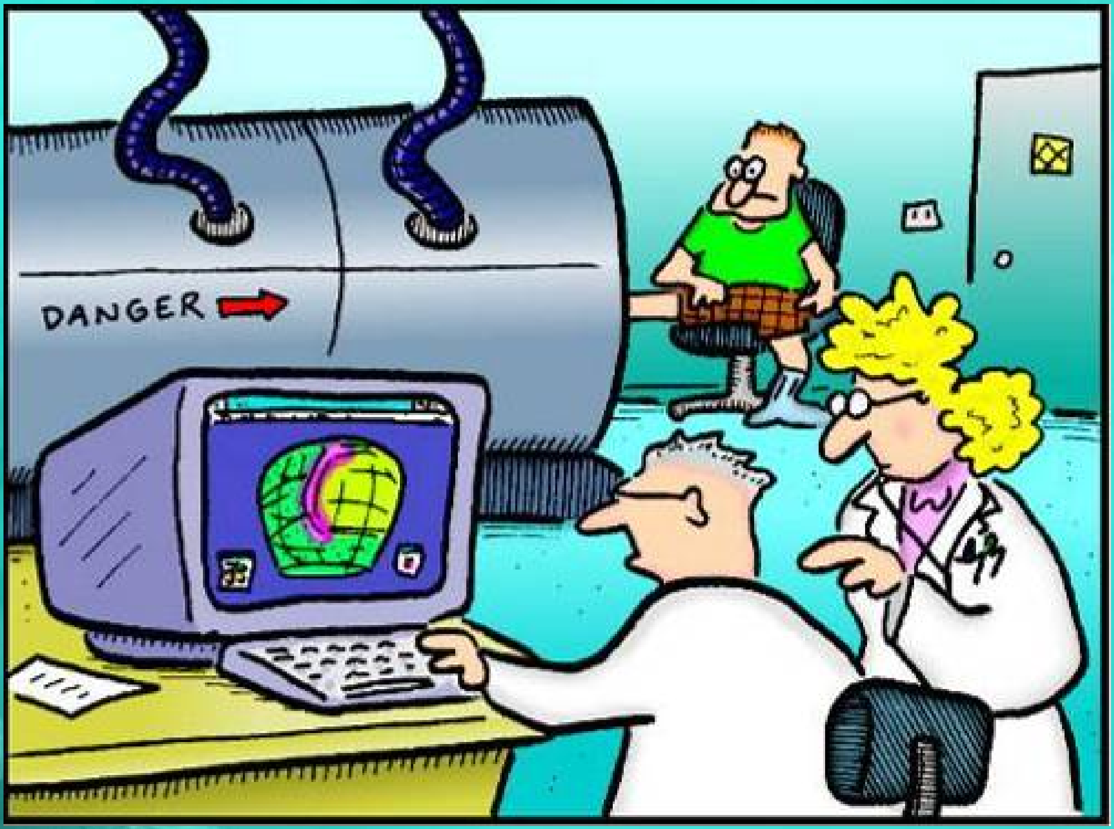
ACCE AMERICAN COLLEGE OF CLINICAL ENGINEERING



Using the latest in medical technology, modern podiatrists are able to study Phil's ingrown toenail in virtual reality.

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Two technology pillars that are improving surgery :

- Surgical Robotics
  - da Vinci S Surgical System
  - ROBODOC
  - TraumaPod
  - Penelope & Penelope CS
- Medical Simulation
  - VrMagic EYESi
  - Symbionix Mentor series

Surgical Robotics- Advantages

- Less bleeding
- Less scarring
- Lower risk of infection
- Less pain
- Quicker recovery
- Reduced hospital stay- by half
- Minimally invasive
- Eliminates surgeon tremor
- Increased dexterity precision and control
- More comfortable and less exhausting for surgeon

Surgical Robotics- Current Drawbacks

- Very expensive (about $1.2 million for a da Vinci system)
- Require very specialized training for multiple personnel
- Steep learning curve (12-18 patients to feel comfortable with da Vinci system)
- Procedures take longer than conventional surgery (45-50 minutes more on da Vinci system)
- Not designed for tight surgical sights (heart, pediatric)
- Loss of tactile sensation or haptic sensation

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Surgical Robotics

- Three kinds of robotic surgery systems:
  - Supervisory-controlled systems
  - Tele-surgical systems
  - Shared-control systems

da Vinci S System

- Made by Intuitive Surgical
- Biggest competitor was Computer Motion (makers of the Zeus system) but they bought them out
- FDA approval in July 2000
- Current FDA approval for: adult and pediatric use in urologic surgical procedures, general laparoscopic surgical procedures, gynecologic laparoscopic surgical procedures, general non-cardiovascular thoracoscopic surgical procedures and thoracoscopically assisted cardiotomy procedures.
- Installed base of more than 850 academic and community hospital sites
- Costs about $1.2 million

Three Main Components of the Da Vinci S System

Surgeon Console

Patient-side Cart

Vision System

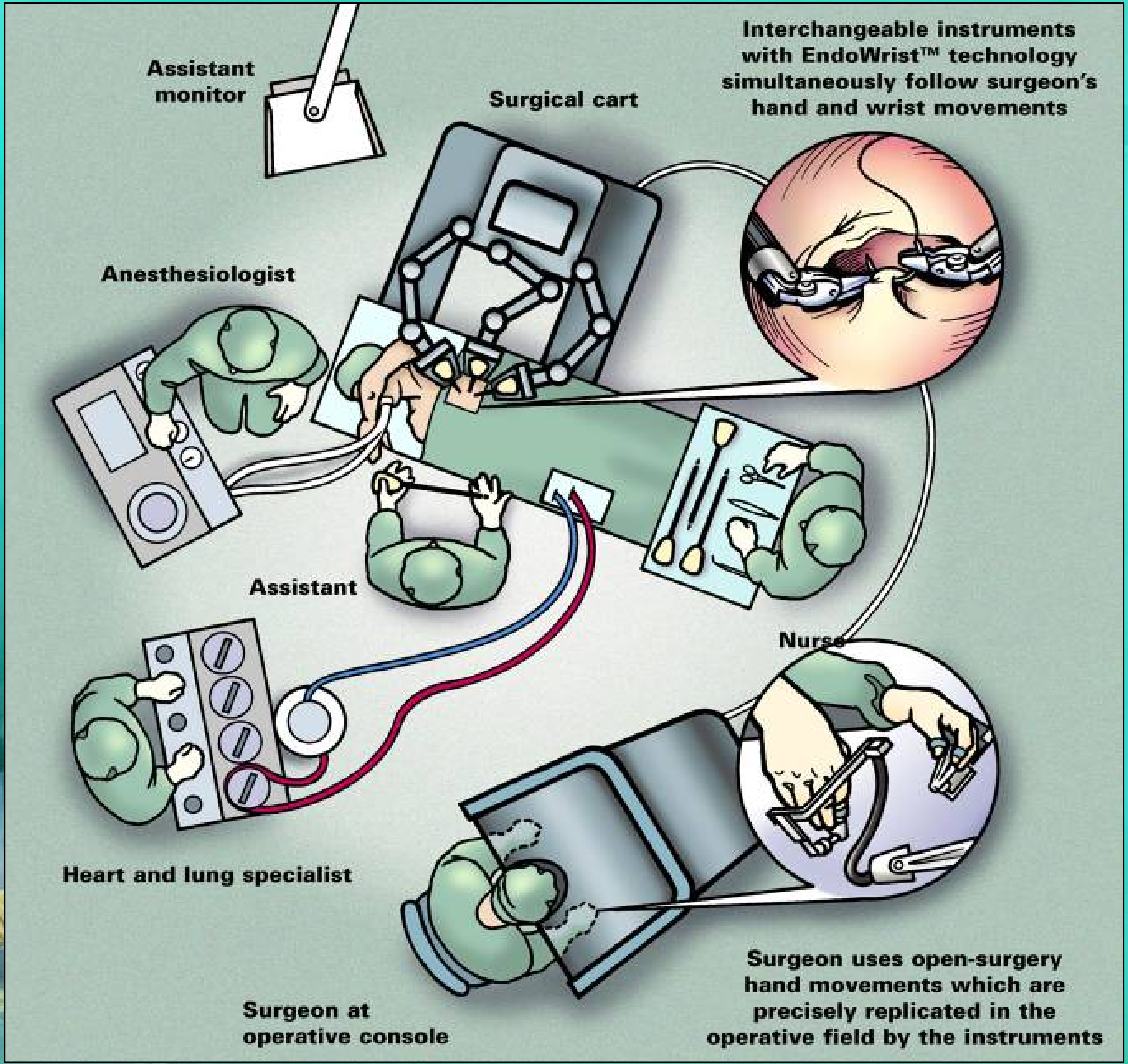
Three Main Components of the Da Vinci S System

Surgeon Console

Patient-side Cart

Vision System

Typical OR Configuration



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Set-up in Ohio State

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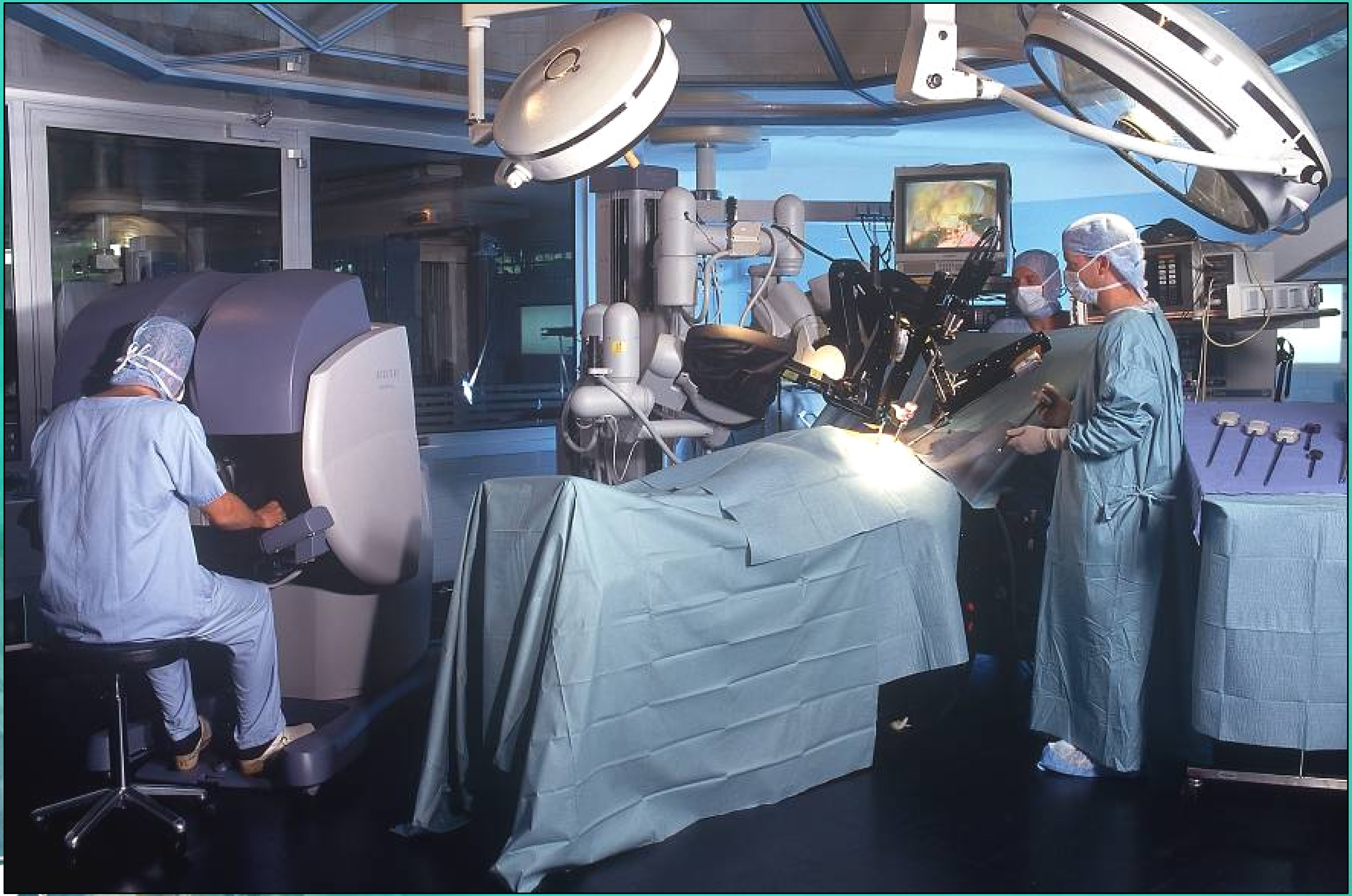
Set-up in Paris



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Surgeon Console

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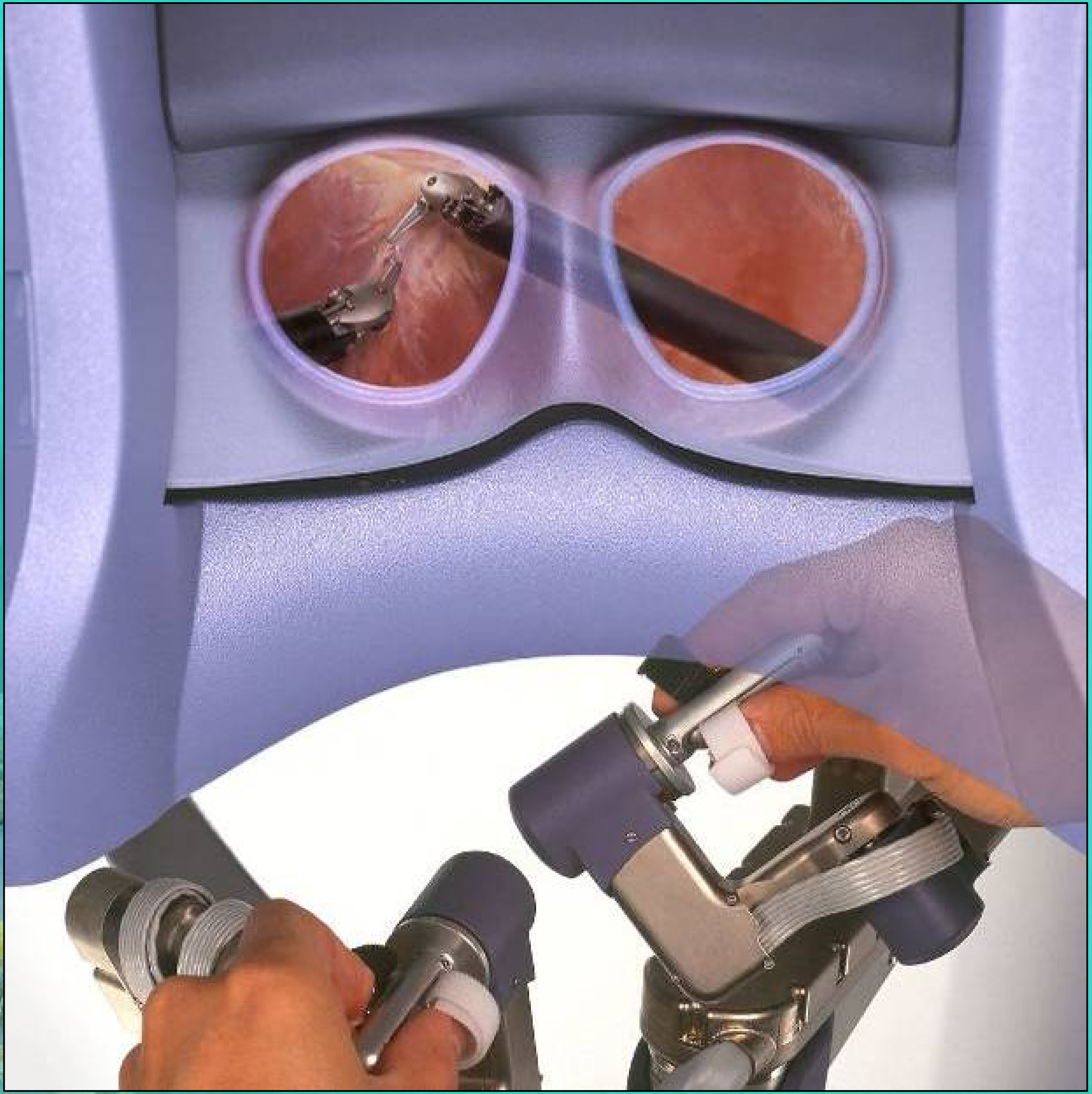
Surgeon Console

- Surgeon operates while seated at a console viewing a 3-D image of the surgical field.
- Image is magnified up to 15 times
- Surgeon’s head must be in the head rest in order for the system to function
- The surgeon's fingers grasp the master controls below the display, with hands and wrists naturally positioned relative to his or her eyes.
- The system translates the surgeon's hand, wrist and finger movements into precise, real-time movements of surgical instruments inside the patient.

Surgeon Console



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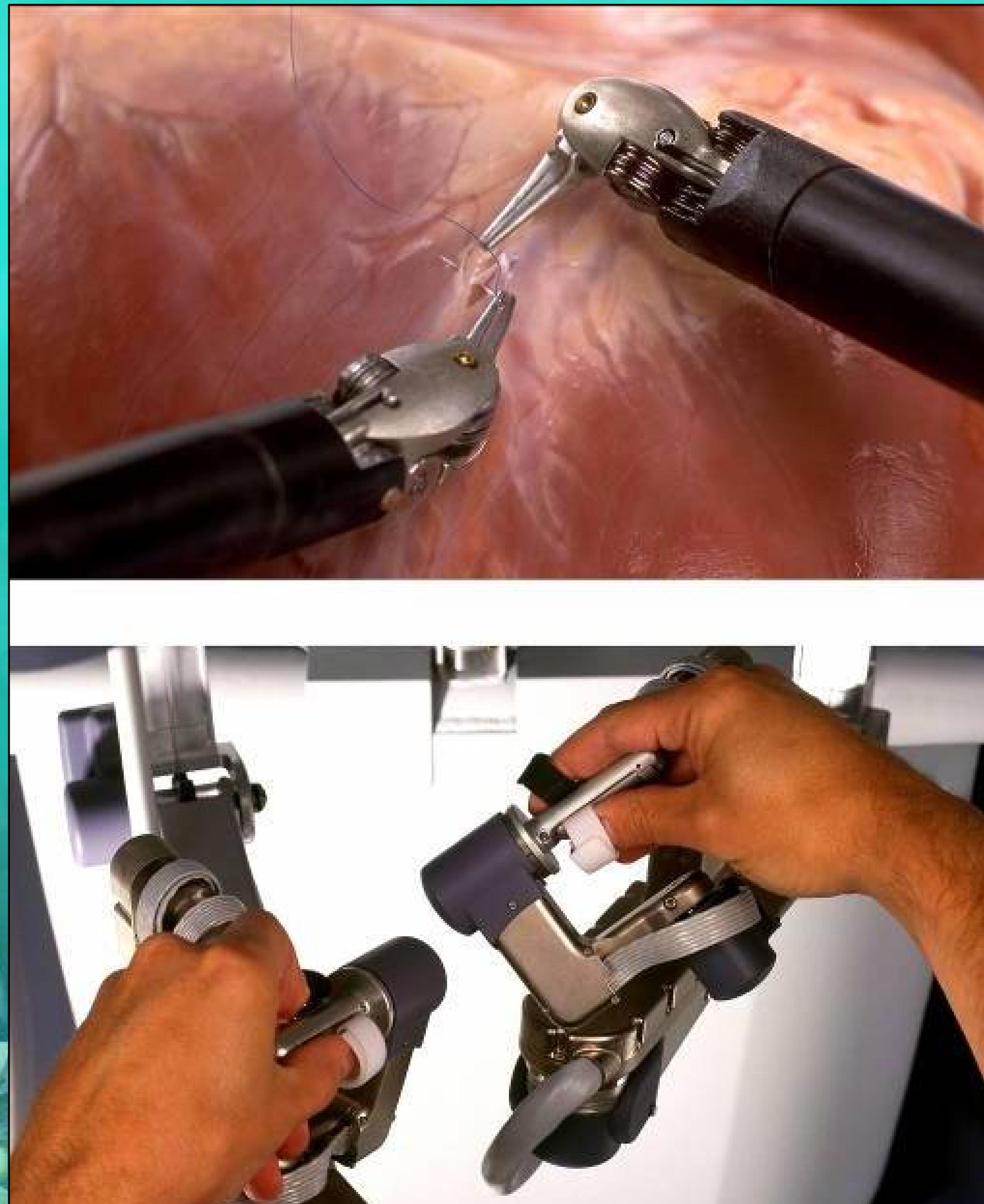
Surgeon Console

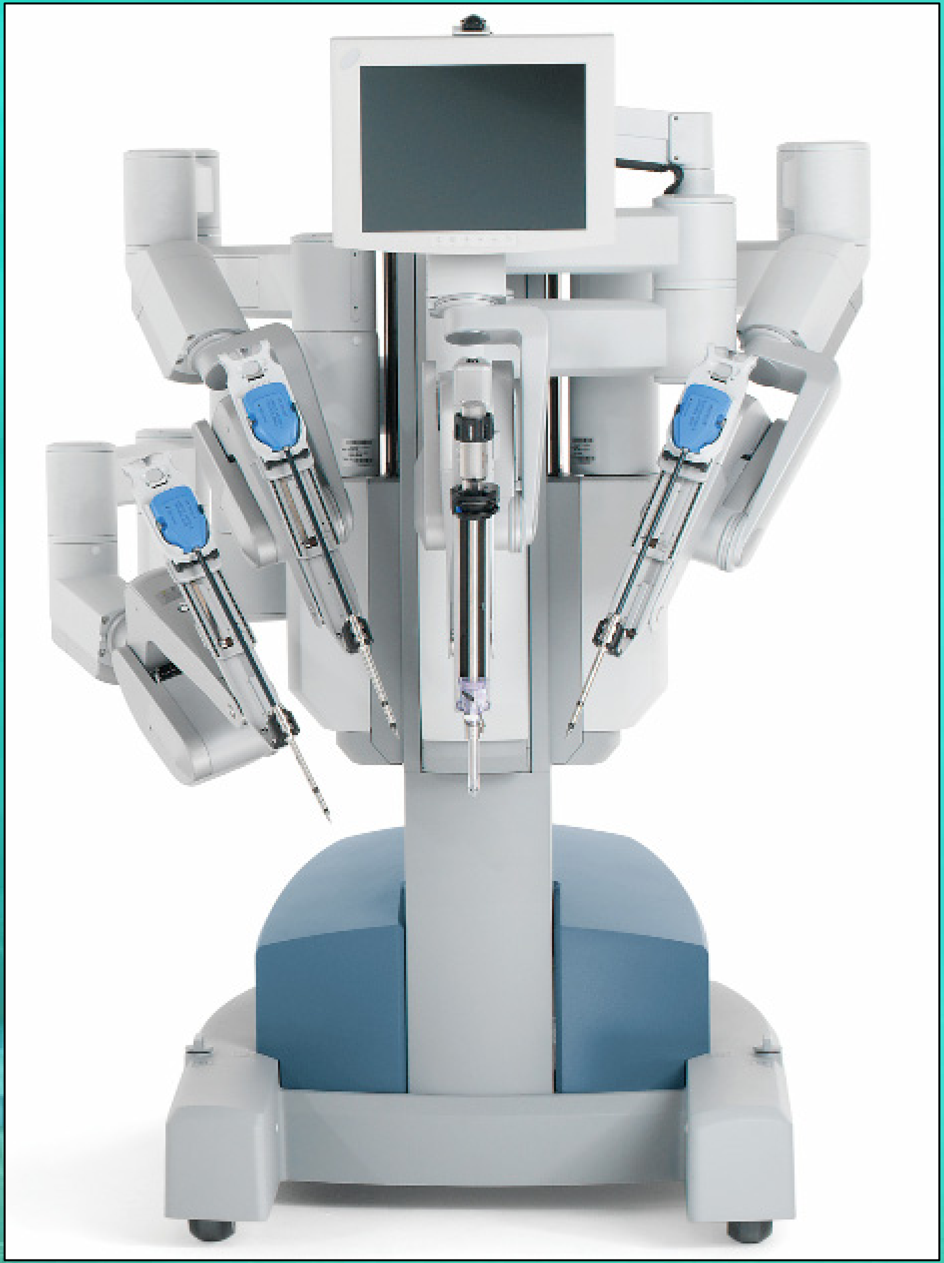


Patient-side Cart

- Provides either three or four robotic arms—two or three instrument arms and one endoscope arm—that execute the surgeon's commands.
- The laparoscopic arms pivot at the 1-2 cm operating ports, eliminating the use of the patient's body wall for leverage and minimizing tissue damage.
- Supporting surgical team members assist in installing the proper instruments, prepare the 1-2 cm port in the patient and supervise the laparoscopic arms and tools being utilized.

Instrument Arm

Patient-side Cart



EndoWrist Instruments

EndoWrist Instruments

- Full range of proprietary instruments available to support the surgeon while operating
- Each instrument has a specific function: clamping, suturing, tissue manipulation, etc.
- Seven degrees of motion that mimic the dexterity of the human hand and wrist
- Quick-release levers speed instrument changes during surgical procedures

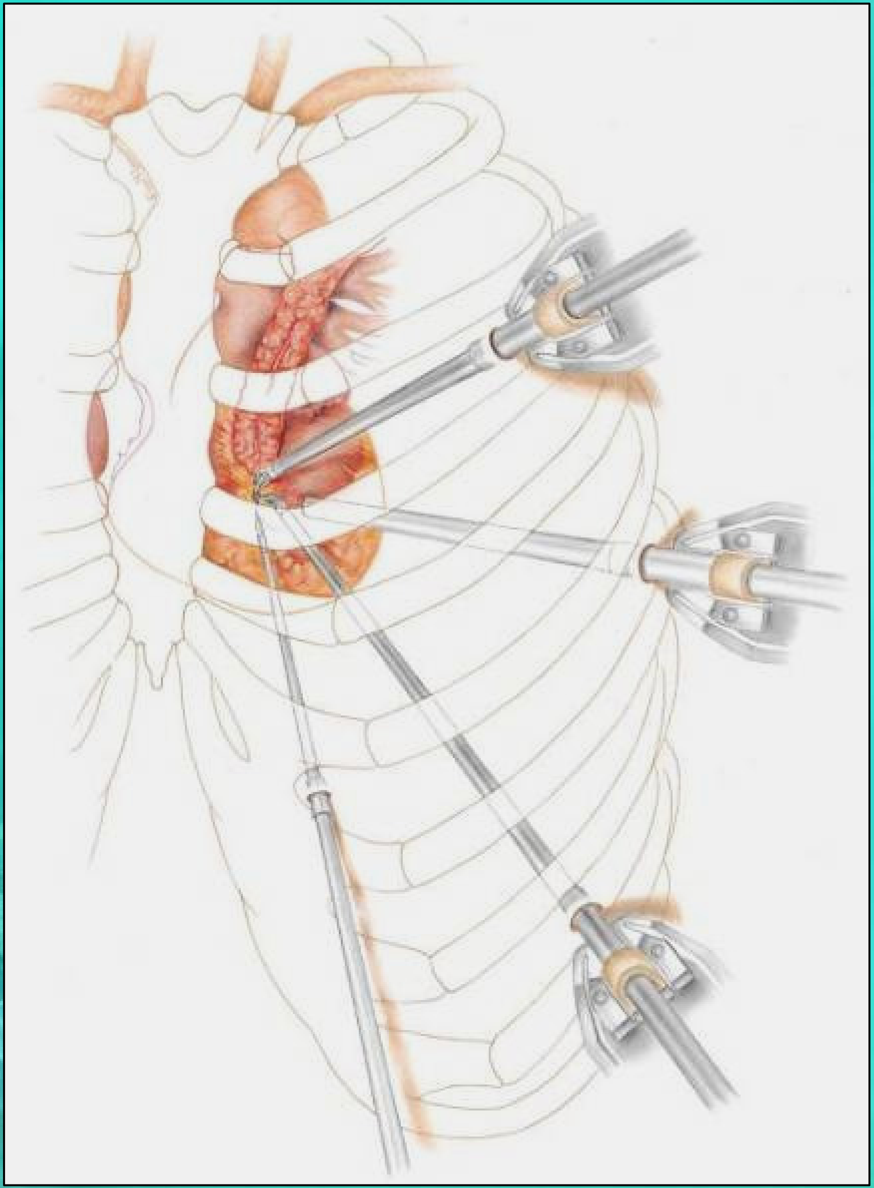
EndoWrist Instruments

Camera Arm

Endoscope

- Two cameras
- A light source

Cardiotomy Procedures



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ROBODOC

- Manufactured by the ROBODOC company (formerly Integrated Surgical Systems)
- For knee and hip replacement procedures
- Used in over 24,000 joint replacement procedures worldwide
- FDA clearance in August 2008
- Less traumatic for the patient and more precise than manual preparation techniques.
- Two components:
  - ORTHODOC- for pre-operative planning using 3-D CT scan data and implant models for surgical planning
  - ROBODOC- for exact bone cutting and implant placement

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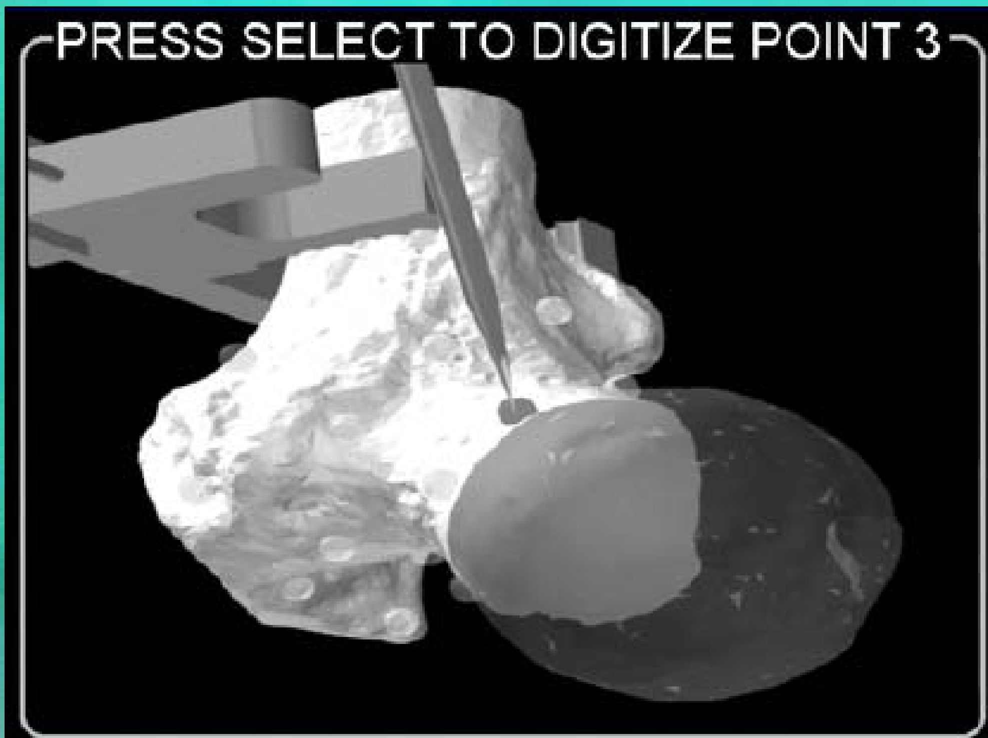
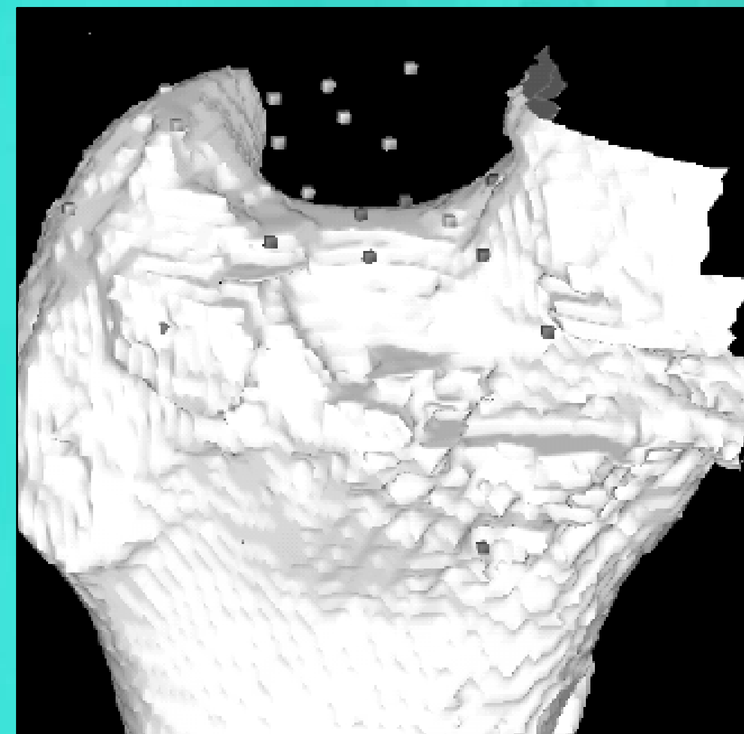
ROBODOC- Registration





Establishing a transformation (conversion) from one coordinate system to another

- CT coordinates (preoperative plan)
- Robot coordinates (surgery)

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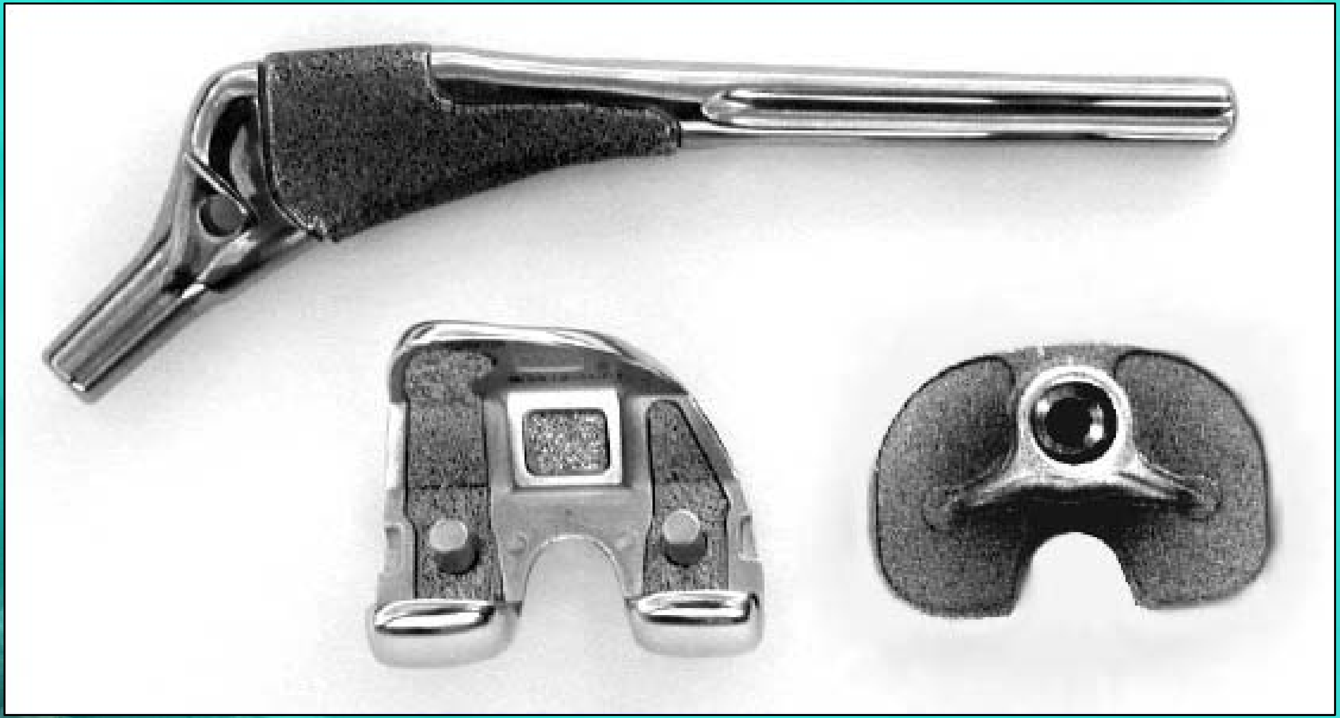
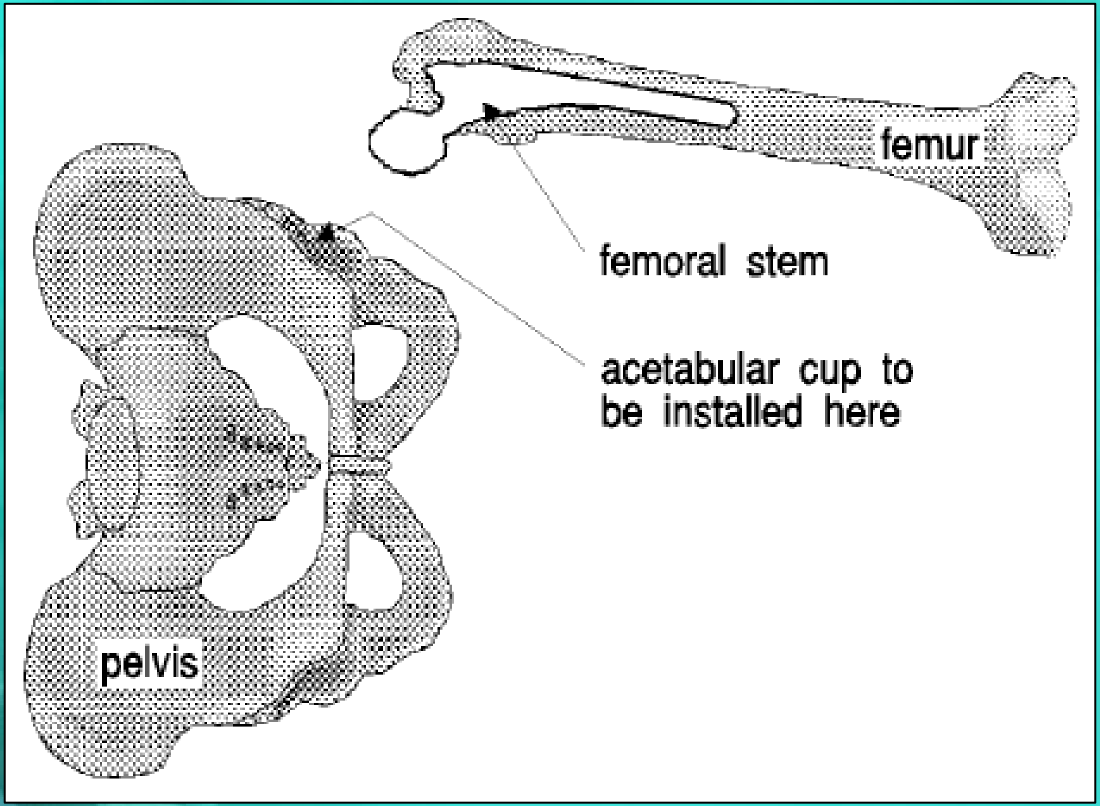
ROBODOC

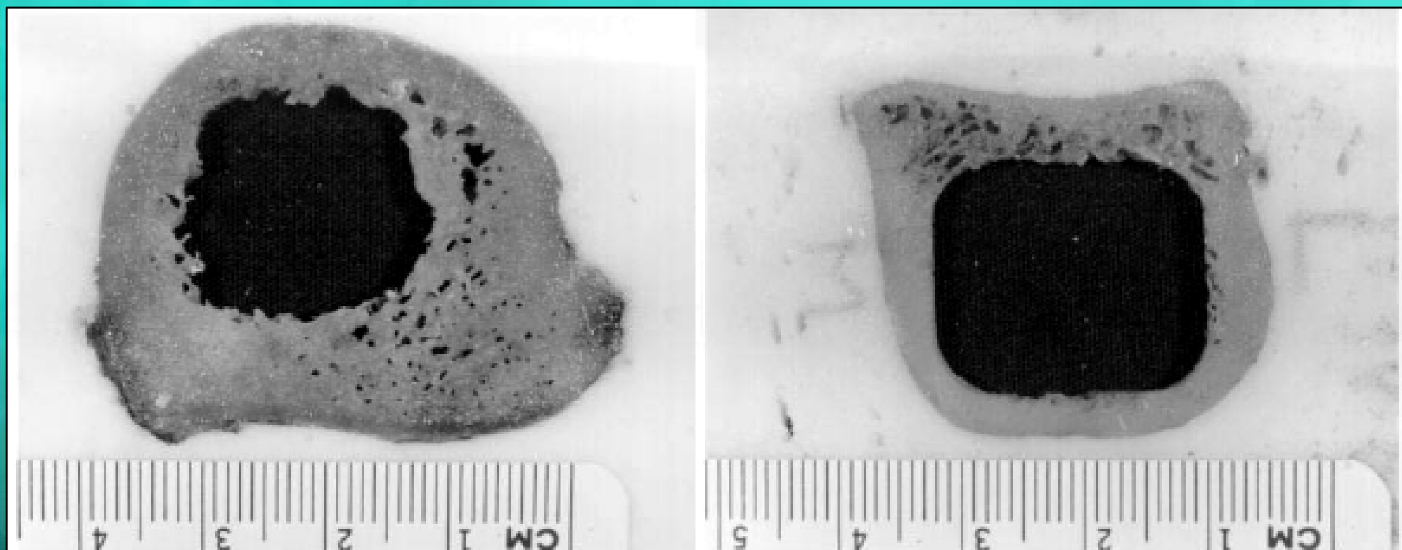


Orthopedic Implants

ROBODOC


femur
femoral stem
acetabular cup to be installed here
pelvis

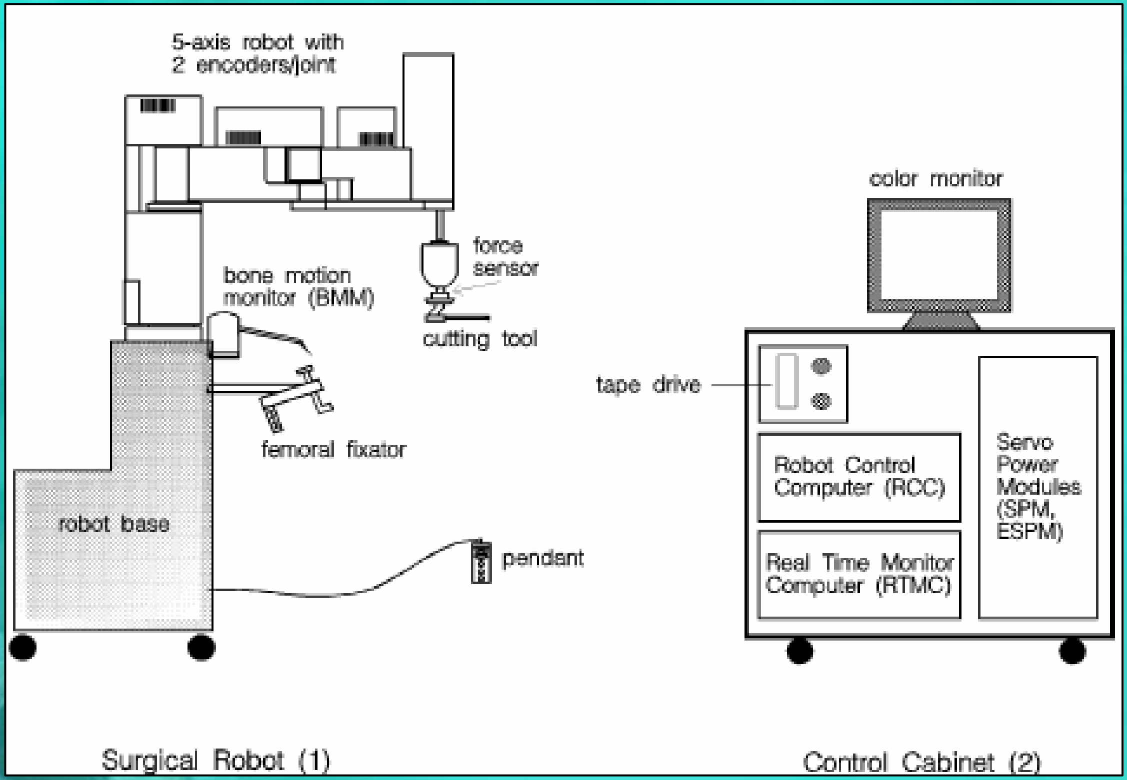
ROBODOC



Cavity made by surgeon

Cavity made by ROBODOC

ROBODOC



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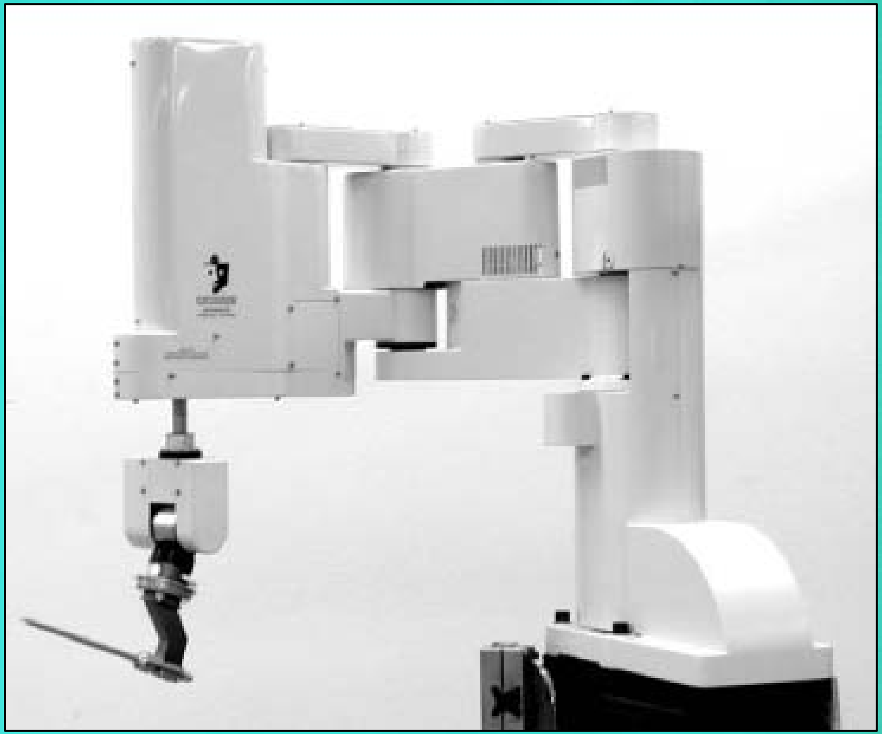
ROBODOC



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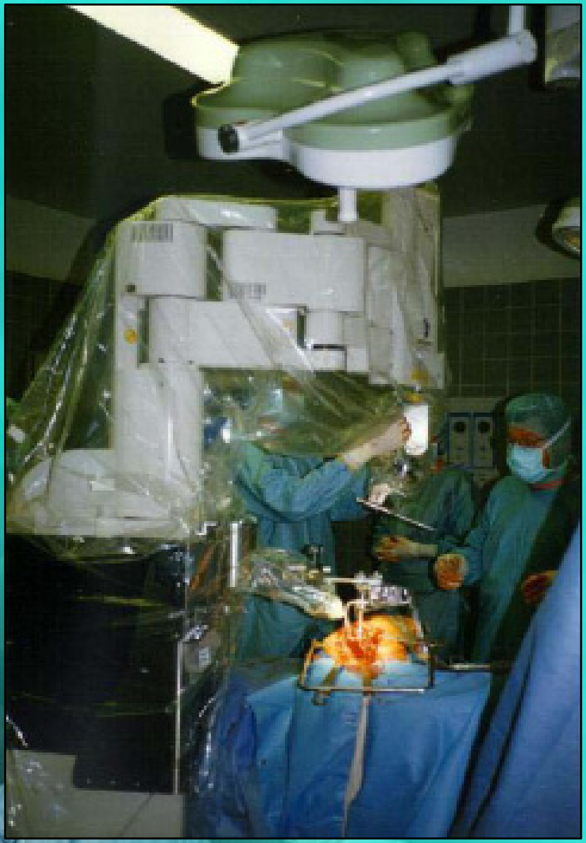
ROBODOC



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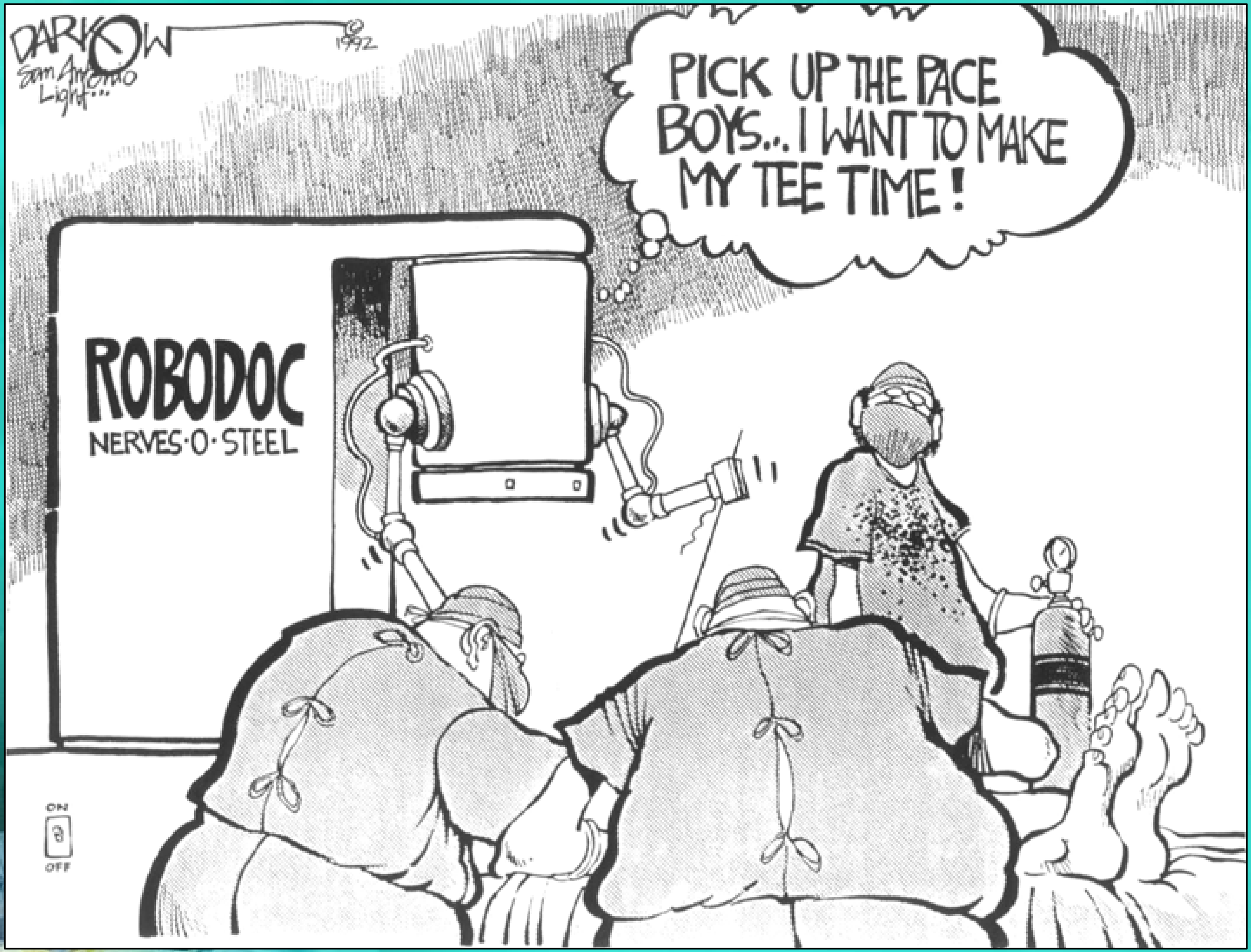
DARKOW ©1992 San Antonio Light...
PICK UP THE PACE BOYS... I WANT TO MAKE MY TEE TIME!
ROBODOC
NERVES·O·STEEL
ON
OFF

Penelope

- Made by Robotic Systems & Technologies Inc. (RST)
- Designed to eliminate the possibility of surgical instruments and supplies being left inside the patient
- Performed first surgery on June 2005 at New-York Presbyterian Hospital
- Not FDA approved
- Major components:
  - Robotic arm
  - Voice recognition
  - Machine vision
  - Cognitive architecture- counts instruments and predicts what will be needed next.
- Will sell for about $100,000

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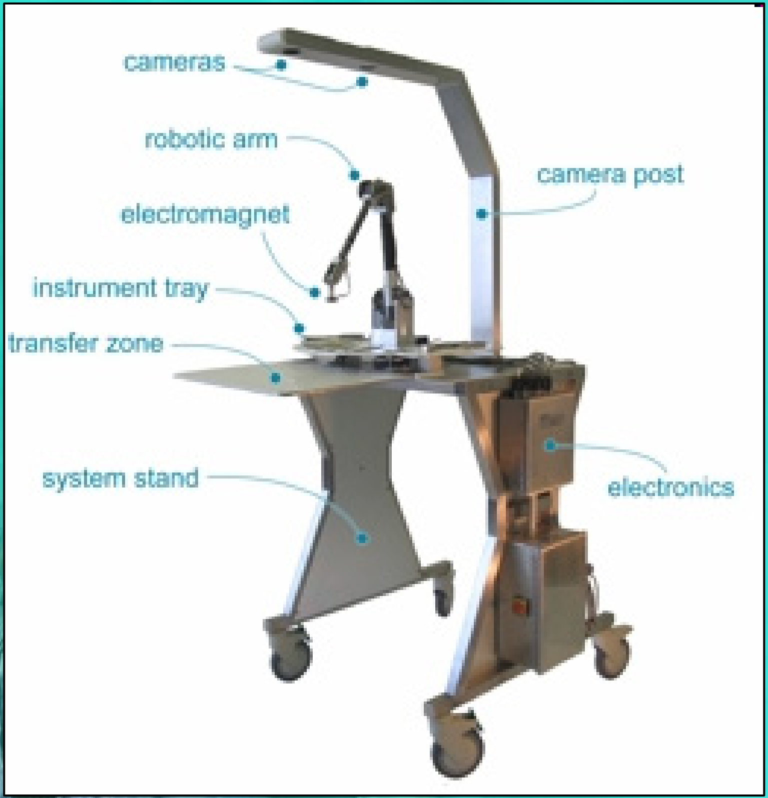
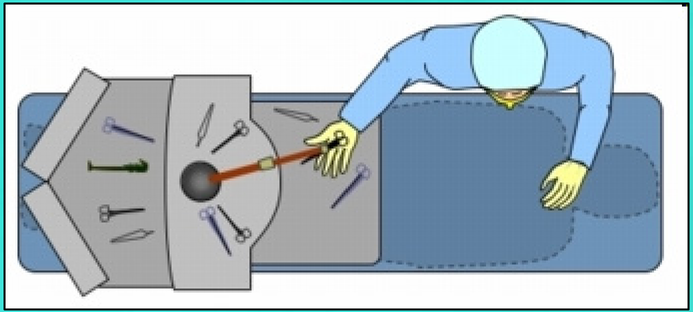
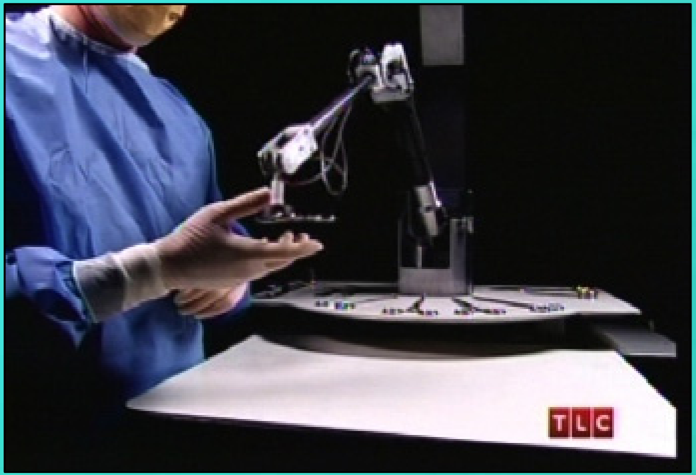
Penelope

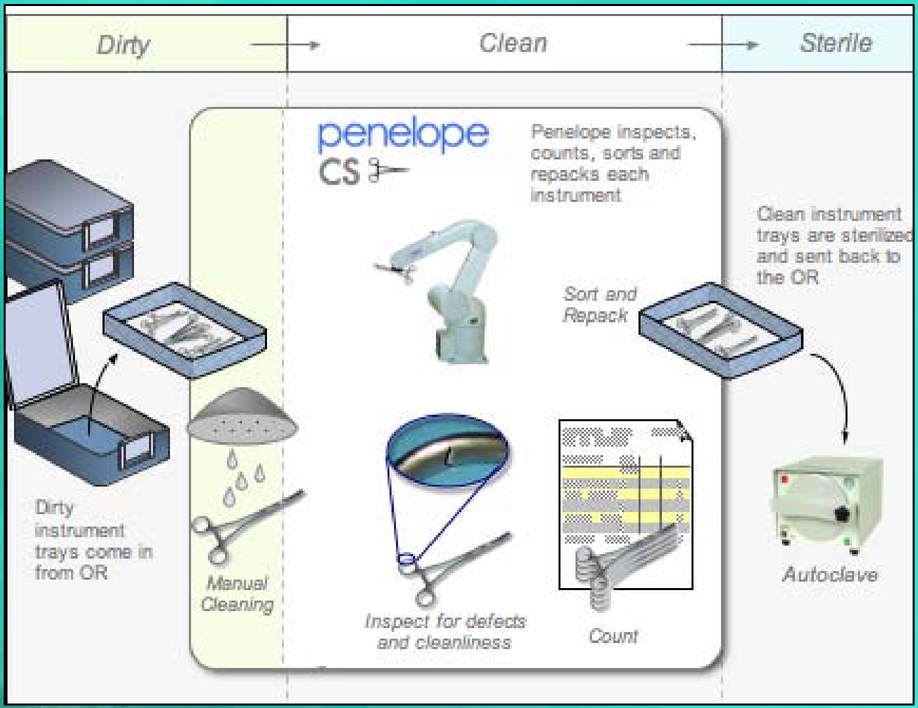

cameras
robotic arm
electromagnet
instrument tray
transfer zone
system stand
camera post
electronics



Penelope



Penelope CS



Dirty
Clean
Sterile
penelope CS
Penelope inspects, counts, sorts and repacks each instrument
Clean instrument trays are sterilized and sent back to the OR
Sort and Repack
Dirty instrument trays come in from OR
Manual Cleaning
Inspect for defects and cleanliness
Count
Autoclave

TraumaPod Project

- Project funded by DARPA
- Project aims to save lives by getting medical assistance to wounded soldiers while keeping surgeons and medics out of harm's way
- Focuses on airway management, head wounds and controlling bleeding.
- Scheduled for deployment in 2009
- Collaboration with several teams including SRI International, General Dynamic Robotics Systems, Oak Ridge National Laboratory, University of Texas, University of Washington, GE Global Research, Intuitive Surgical, RST, and University of Maryland
- RST's (makers of Penelope) Machine Vision System (MVS) technology used for counting supplies such as sutures.

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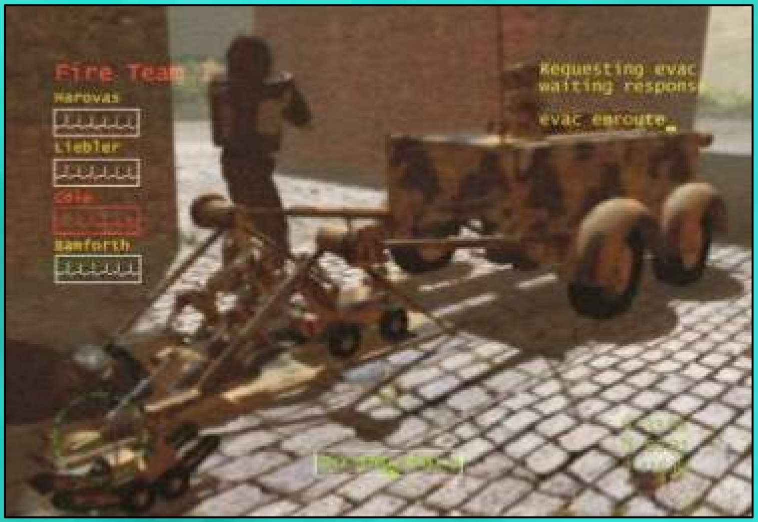
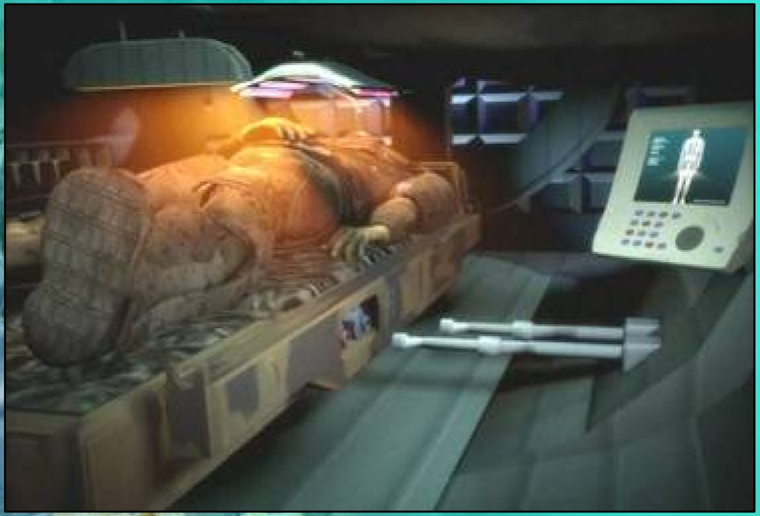
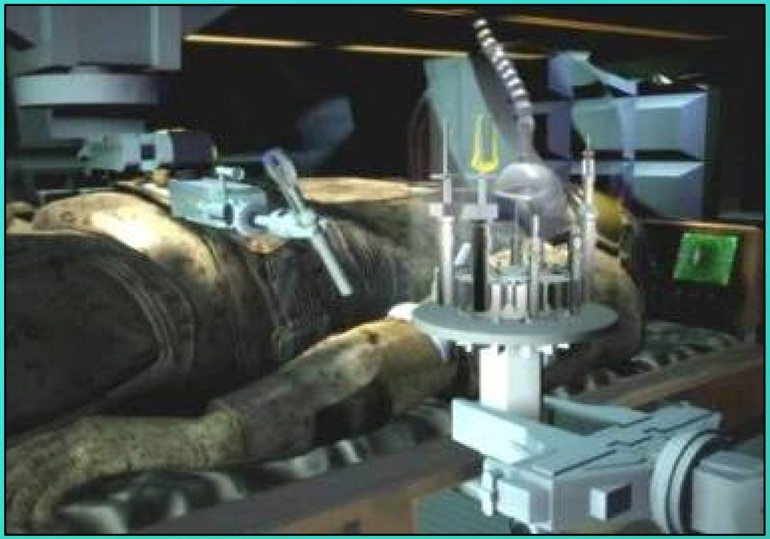
DARPA TraumaPod Project







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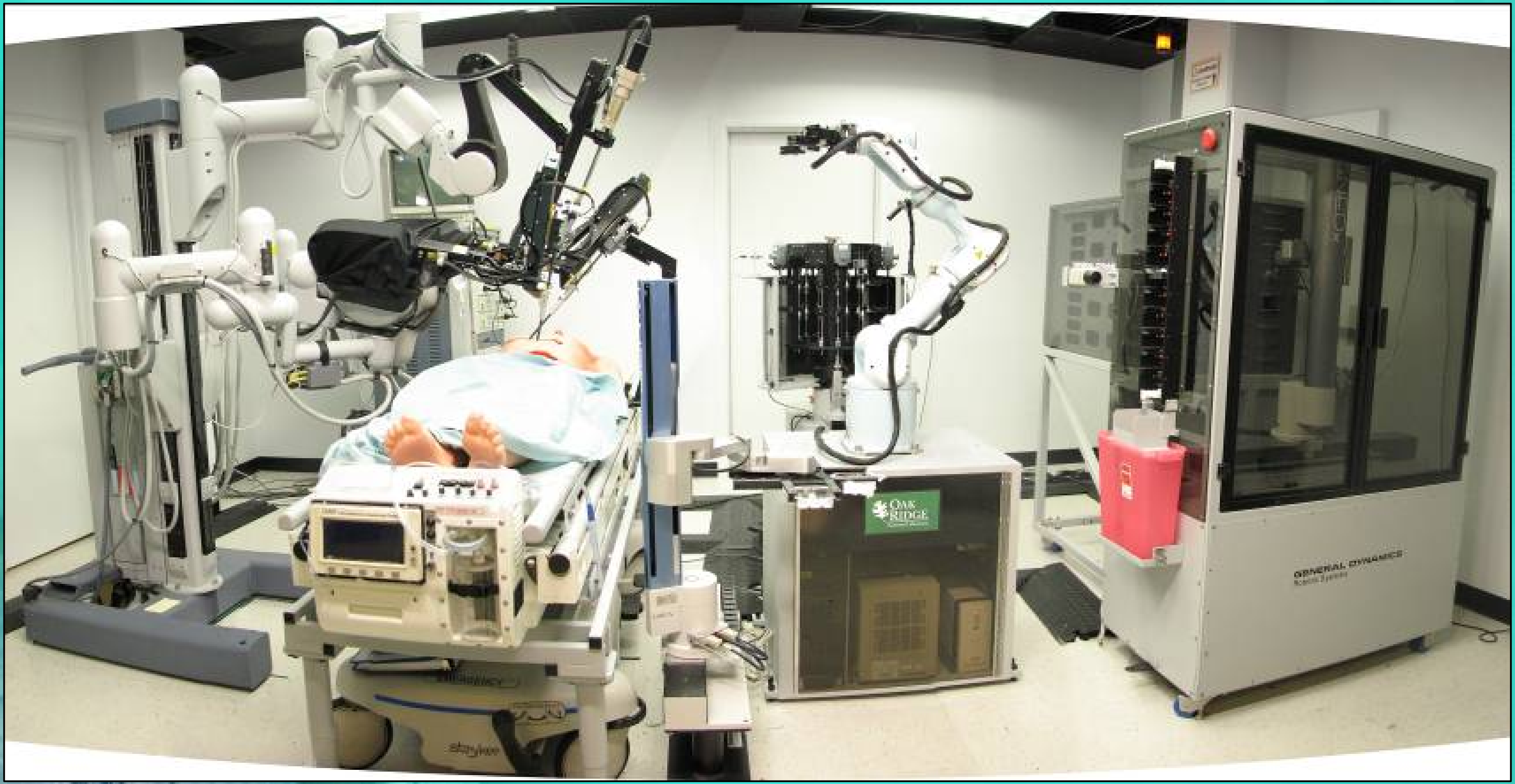
DARPA TraumaPod Project



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Further Development for Robotics in Surgery

- Improved tactile feedback (haptics)
- Artificially- generated visualization enhancements
- Context-based operator assistance
- Miniaturization for microsurgery, pediatric and cardiac surgery
- Reduction of costs

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Medical Simulation

- Traditional method of learning new surgical techniques is to observe or read about it, then attempt it on a patient
- Medical simulators enable learning a medical technique without involving patients
- Simulators can provide objective measurement of skill and chart progress

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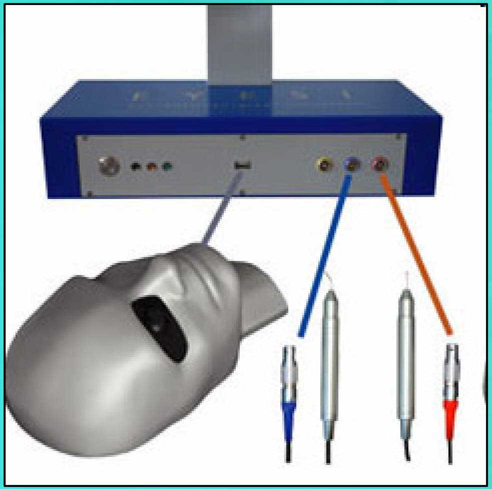
Anybody here know how to play Microsoft's Flight Simulator?
Quirk

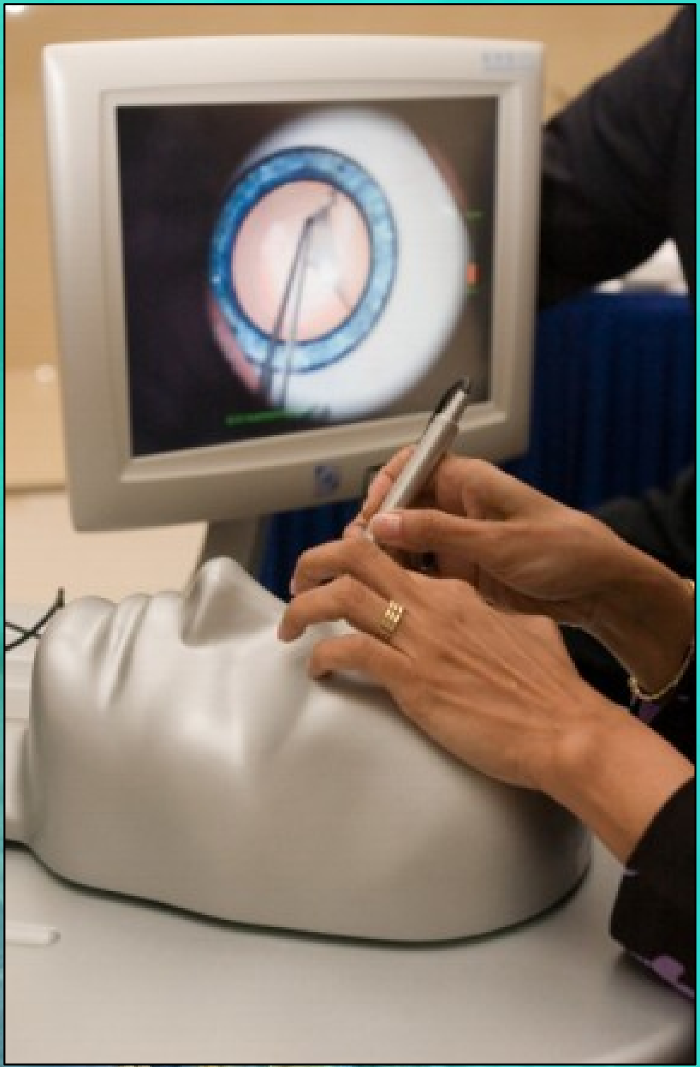
EYESi Simulator

- Provides objective assessment of eye surgery skills within a structured training plan
- Current modules available for phacoemulsification and retinal surgery
- Costs about $150,000

EYESi Simulator



EYESi Simulator



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EYESi Simulator

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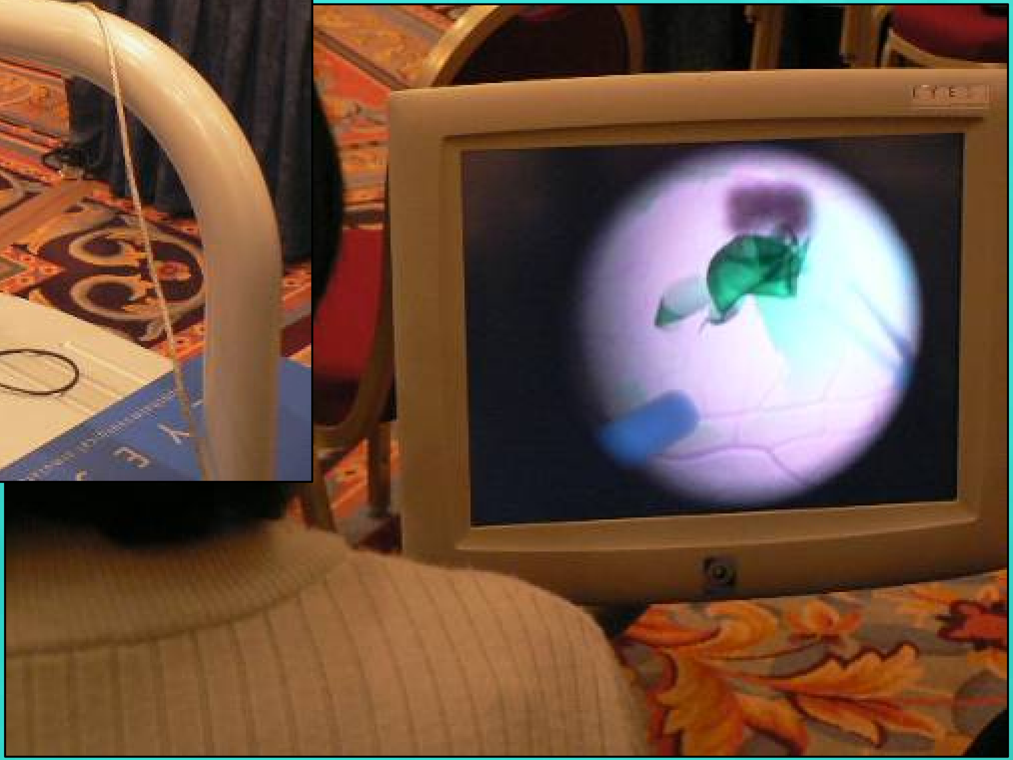
EYESi Simulator



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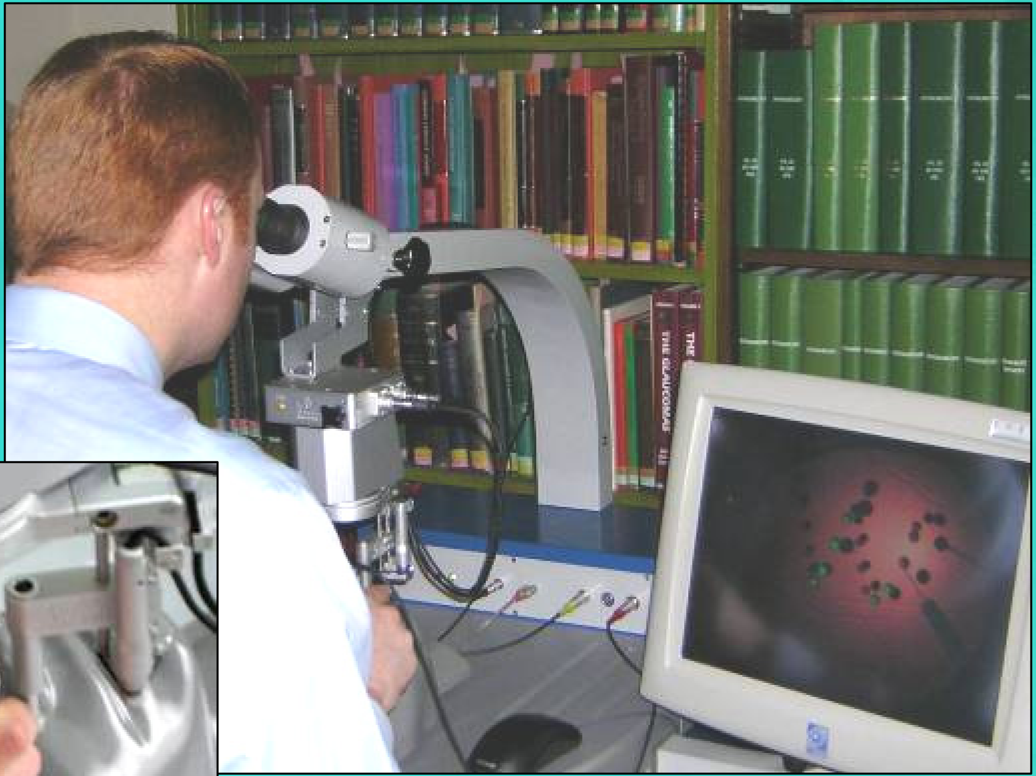
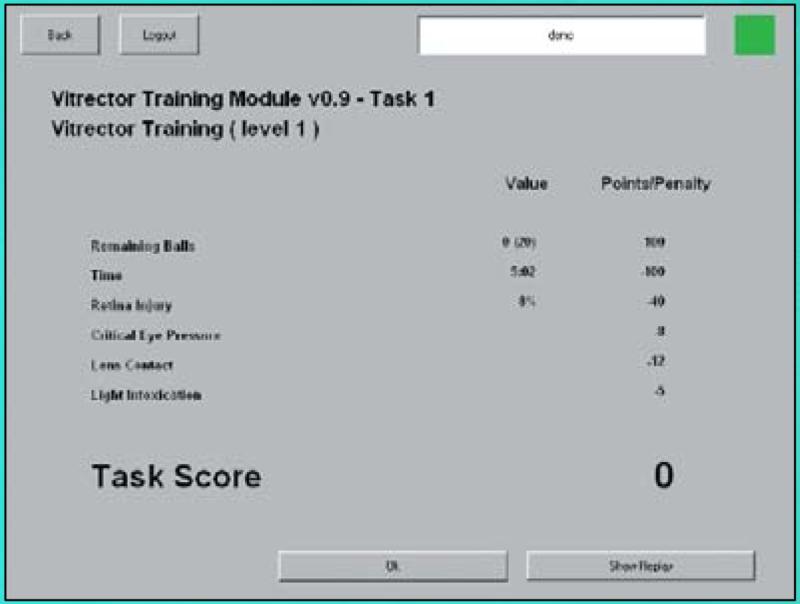
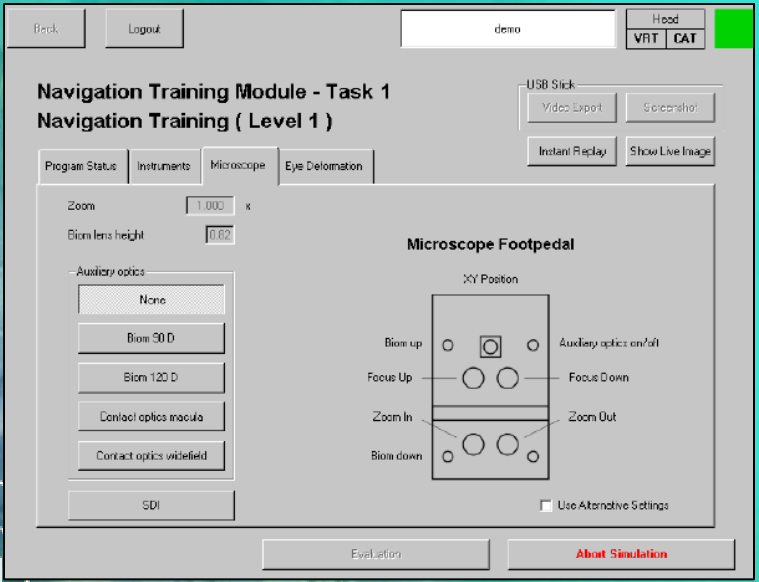
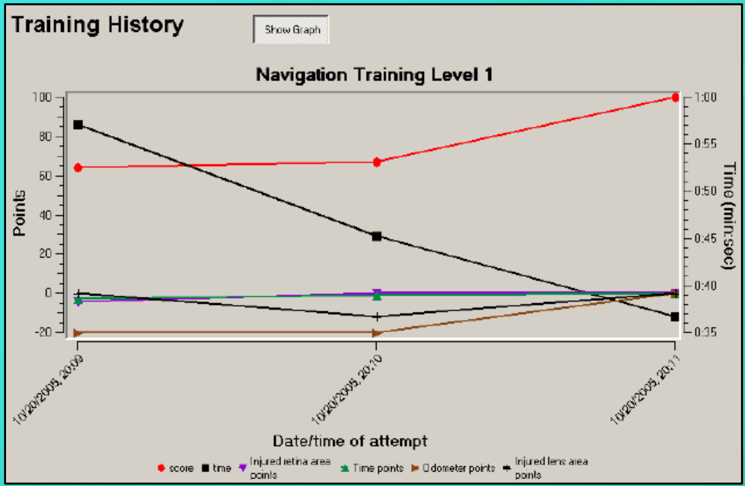
EYESi Simulator



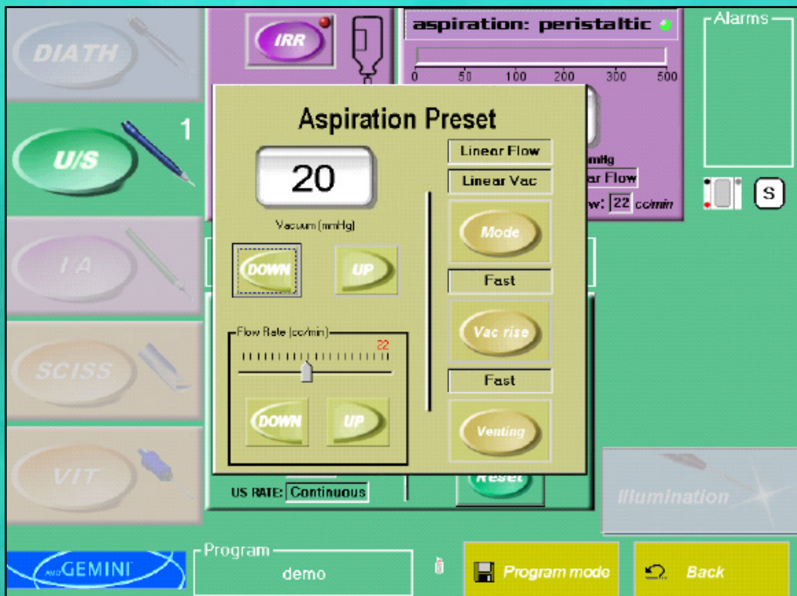
EYESi Simulator

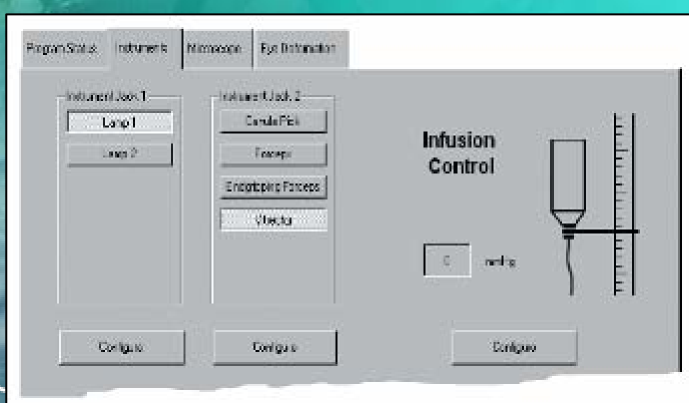


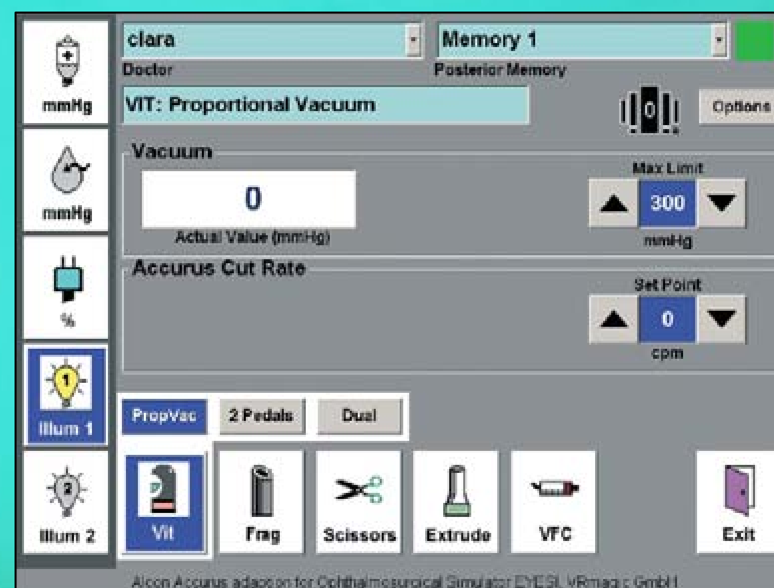




EYESi Simulator







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EYESi Simulator

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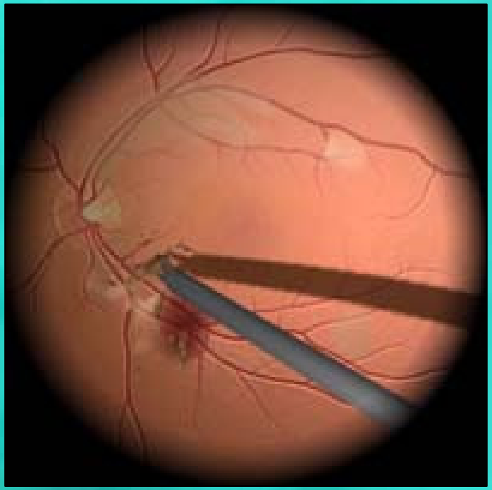
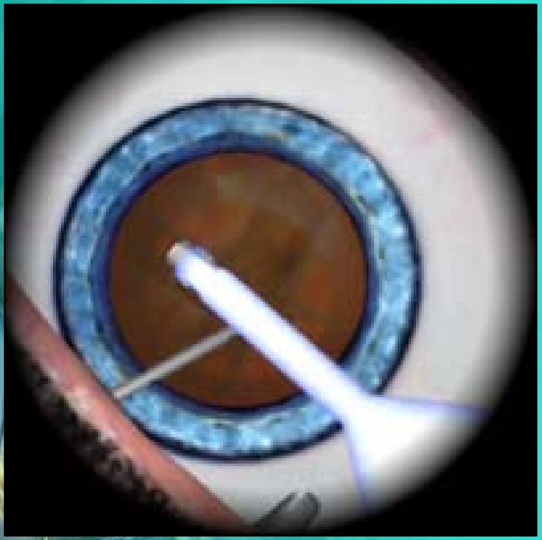
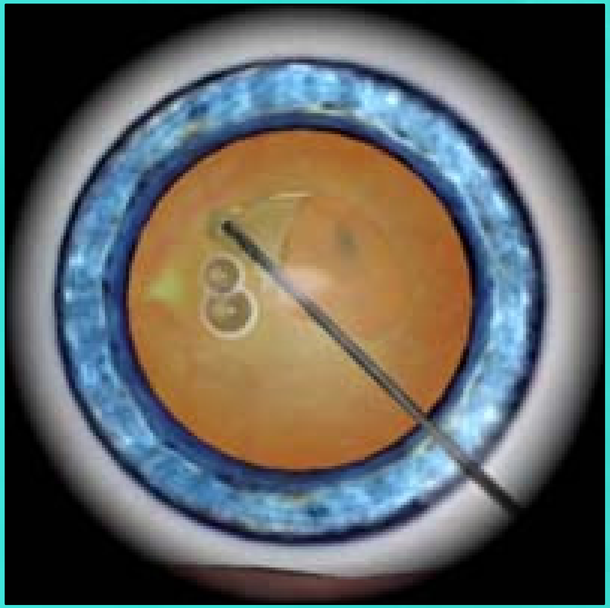
EYESi Simulator







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Simbionix Line of Medical Simulators

- Realistic hands-on experience performing Minimally Invasive Surgery (MIS) and interventional procedures, at no patient risk
- Simulators for general laparoscopy, endo-urology, percutaneous access, gastro intestinal and angiography procedures
- Simulators designed for training and assessment
- Metrics for skill assessment
- Cost between $50,000 & $100,000

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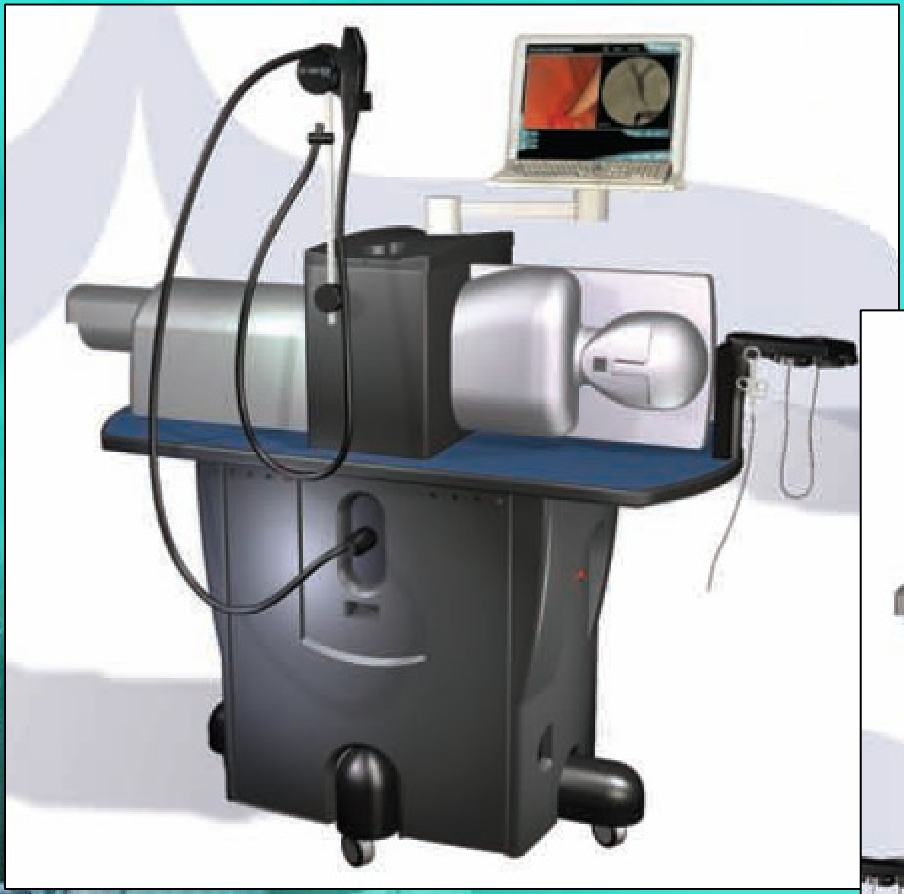
GI Mentor



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ANGIO Mentor

URO Mentor

LAP Mentor

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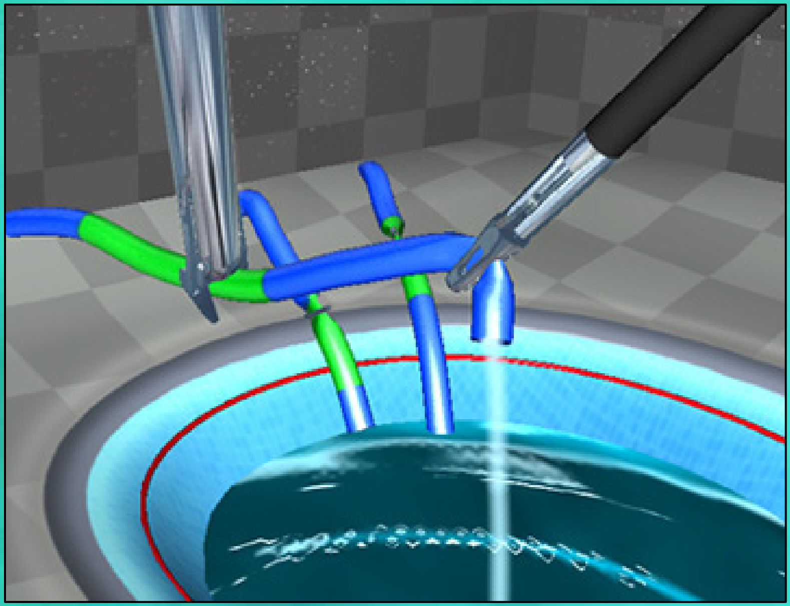
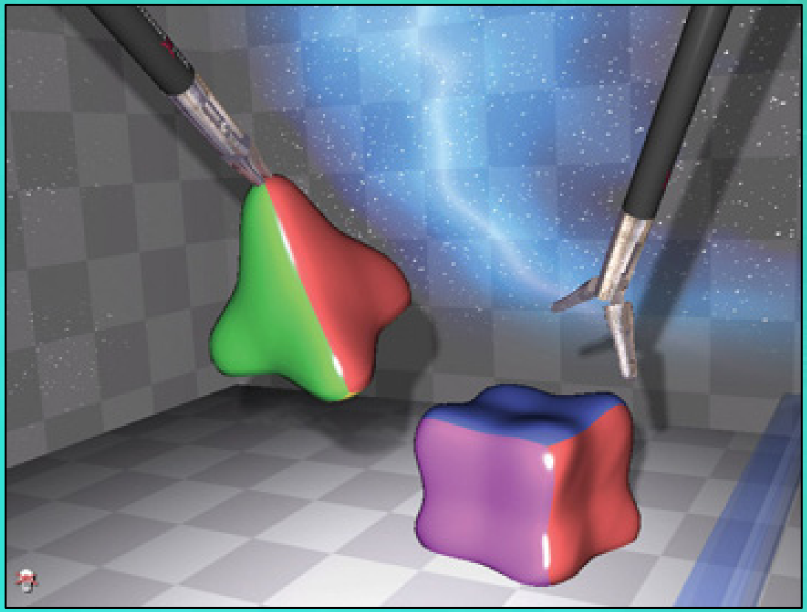
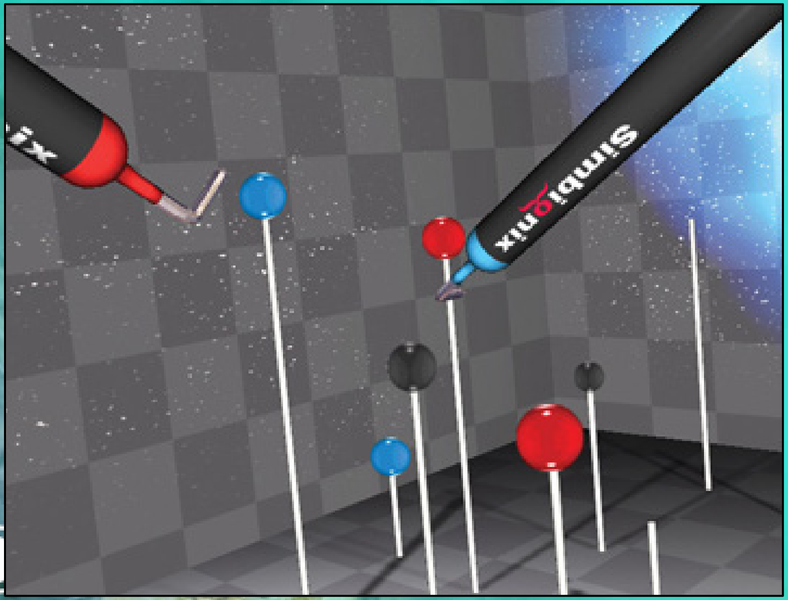
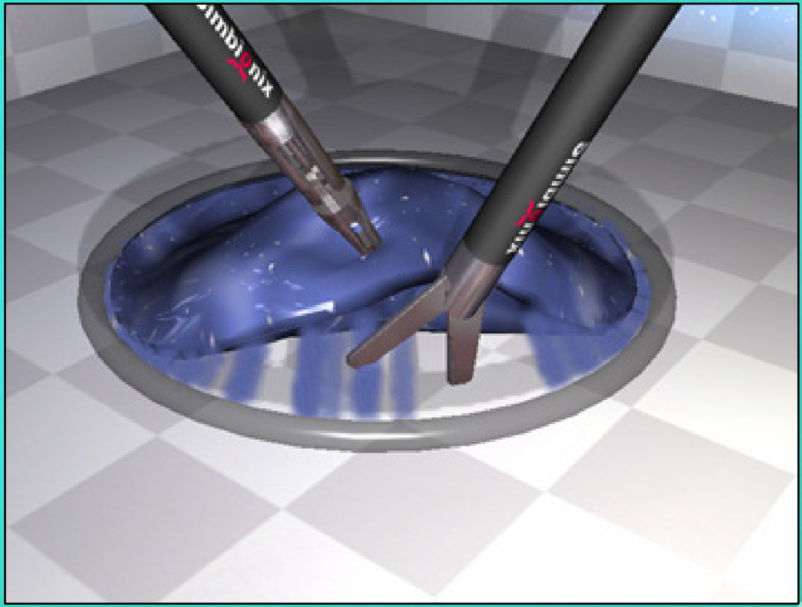
Dexterity Exercises

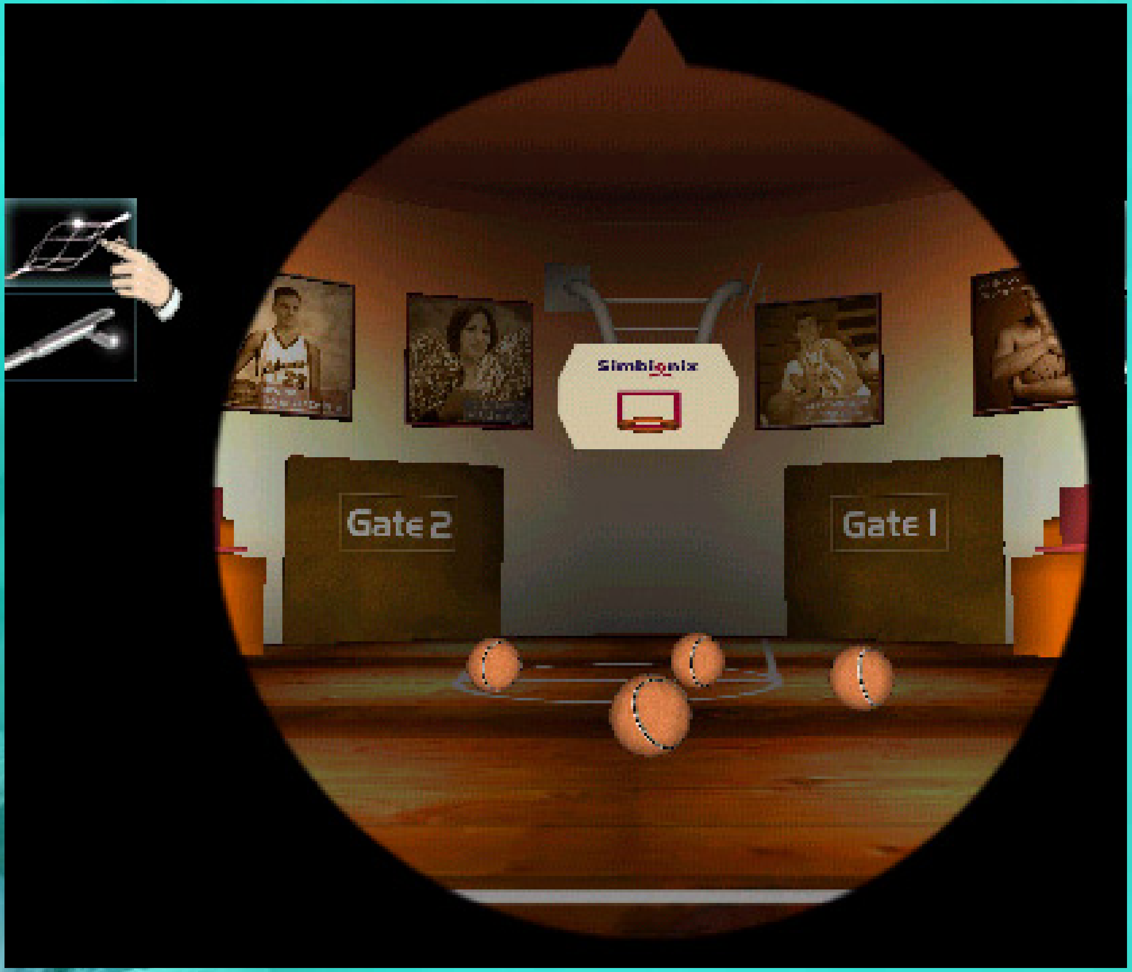




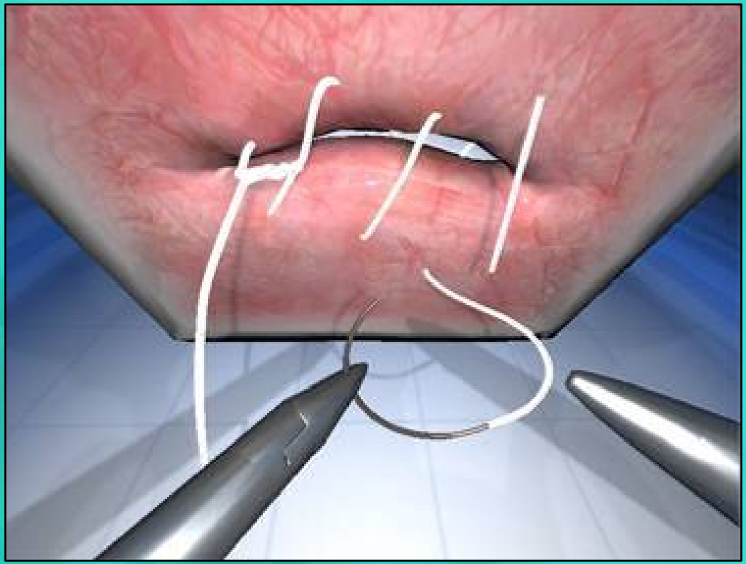


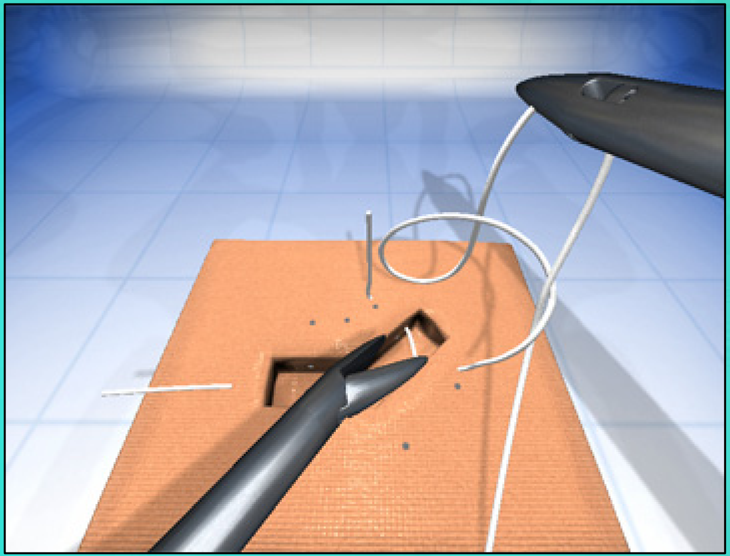


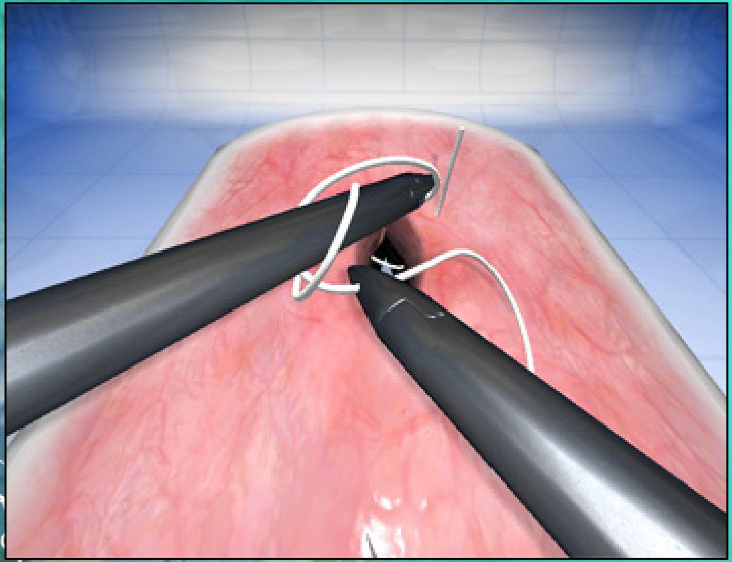
Dexterity Exercises

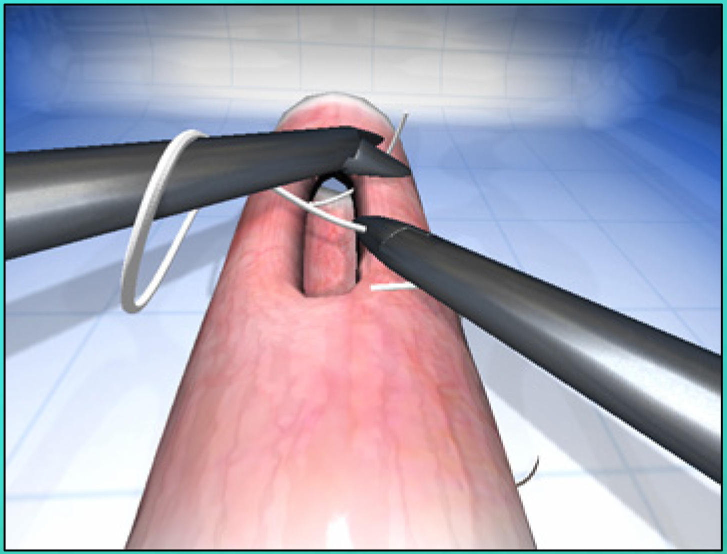


Basic Tasks Training

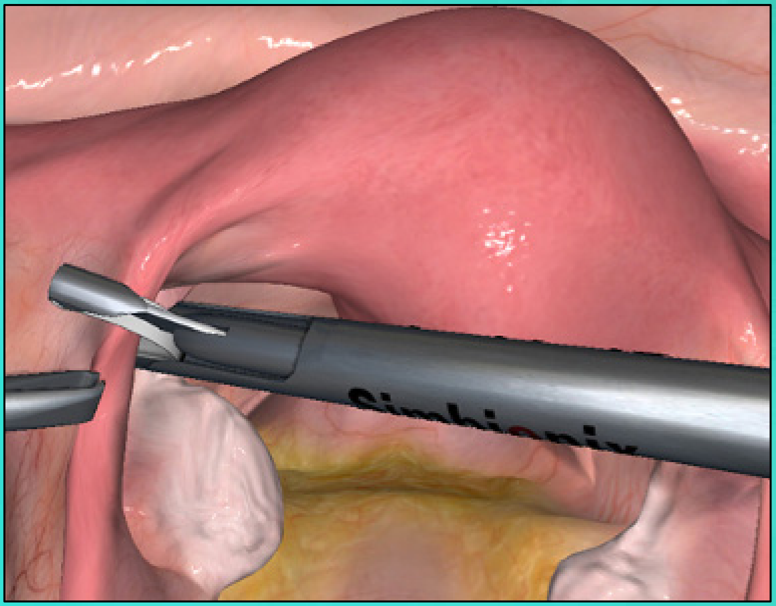


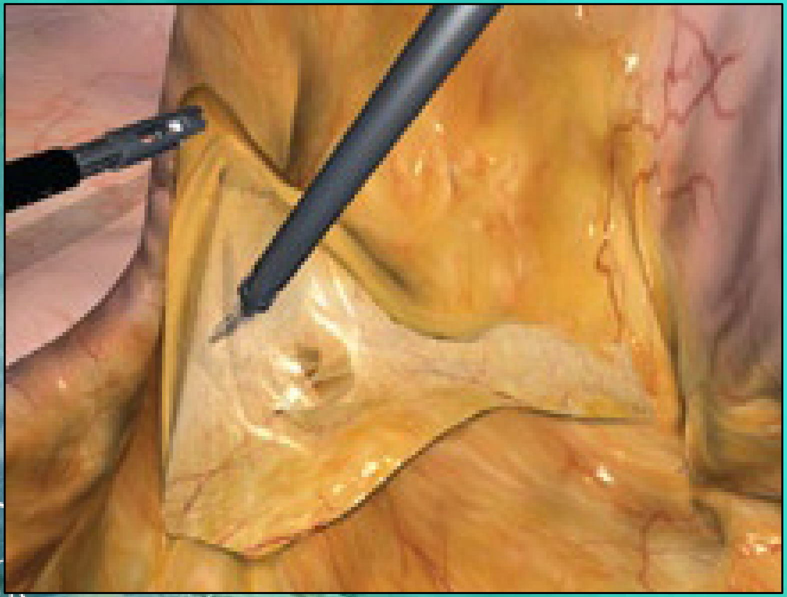




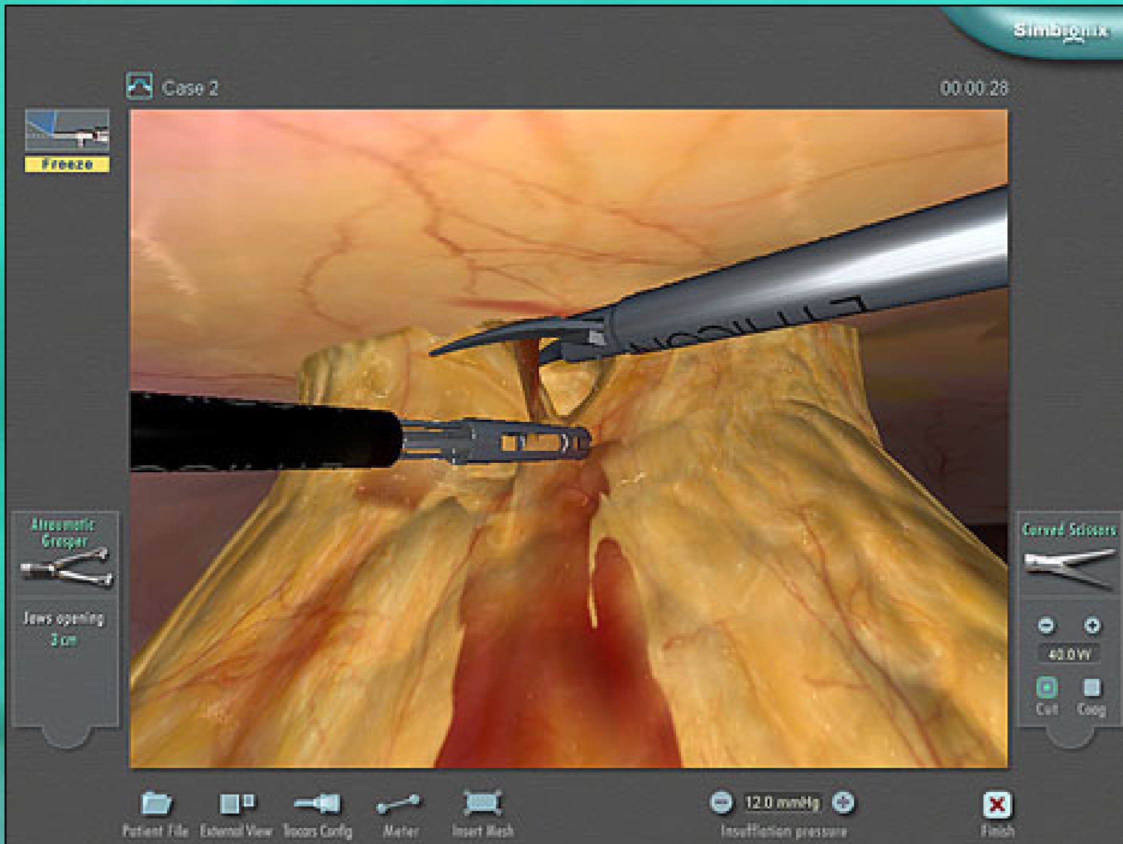


Procedure Training





Procedure Training



Hemorrhage simulation

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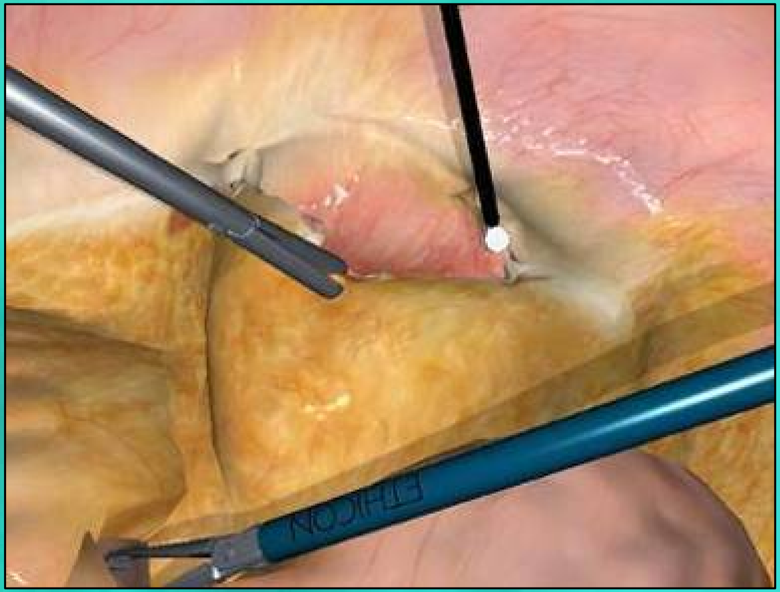
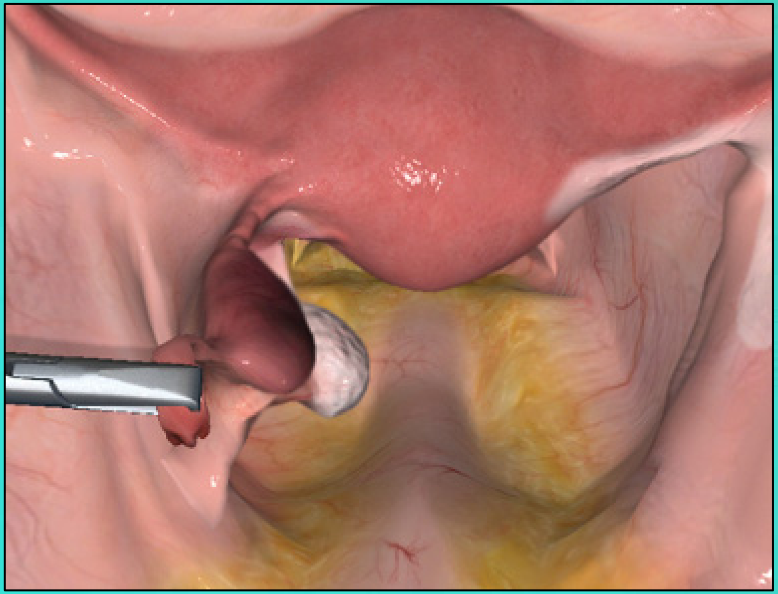
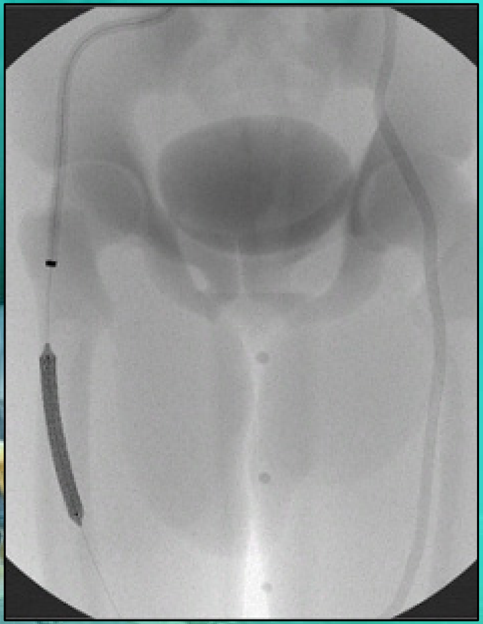
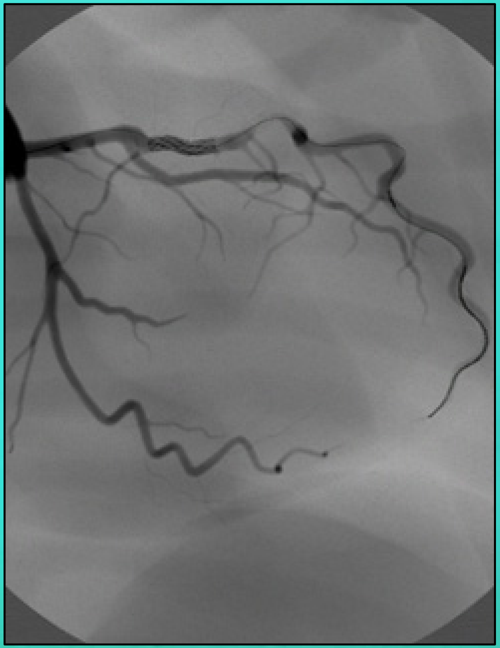
Procedure Training









Further Development for Medical Simulation

- Improved tactile feedback (haptics)
- Complication and decision making modules
- Institutionalization/integration into competency-based residency training curriculum
- Prediction: FDA will require surgeons to train on simulators for new products/procedures

"Nurse, get on the Internet, go to SURGERY.COM, scroll down and click on the 'Are you totally lost?' icon.

Involvement of Clinical Engineering

?

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Resources

- Center for Advanced Surgical and Interventional Technology (CASIT)
  http://casit.ucla.edu
- Center for Integration of Medicine and Innovative Technology (CIMIT)
  http://www.cimit.org
- National Science Foundation Computer Integrated Surgical Systems and Technology Engineering Research Center (CISST ERC)
  http://www.cisst.org
- Telemedicine and Advanced Technology Research Center (TATRC)
  http://www.tatrc.org
- MIT Touch Lab
  http://touchlab.mit.edu/index.html
- Excellent site on surgical robotics prepared by Brown University students
  http://biomed.brown.edu/Courses/BI108/BI108_2005_Groups/04/index.html

- ROBODOC- Makers of the ORHTODOC and ROBODOC
  http://www.robodoc.com
- Intuitive Surgical- Makers of the da Vinci system
  http://www.intuitivesurgical.com
- Robotic Systems & Technologies Inc. (RST)- Makers of Penelope
  http://www.roboticsystech.com
- VrMagic- Makers of the EYESi system
  http://www.vrmagic.com/en
- Simbionix- Makers of the GI Mentor, ANGIO Mentor, LAP Mentor, URO Mentor
  http://www.simbionix.com

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