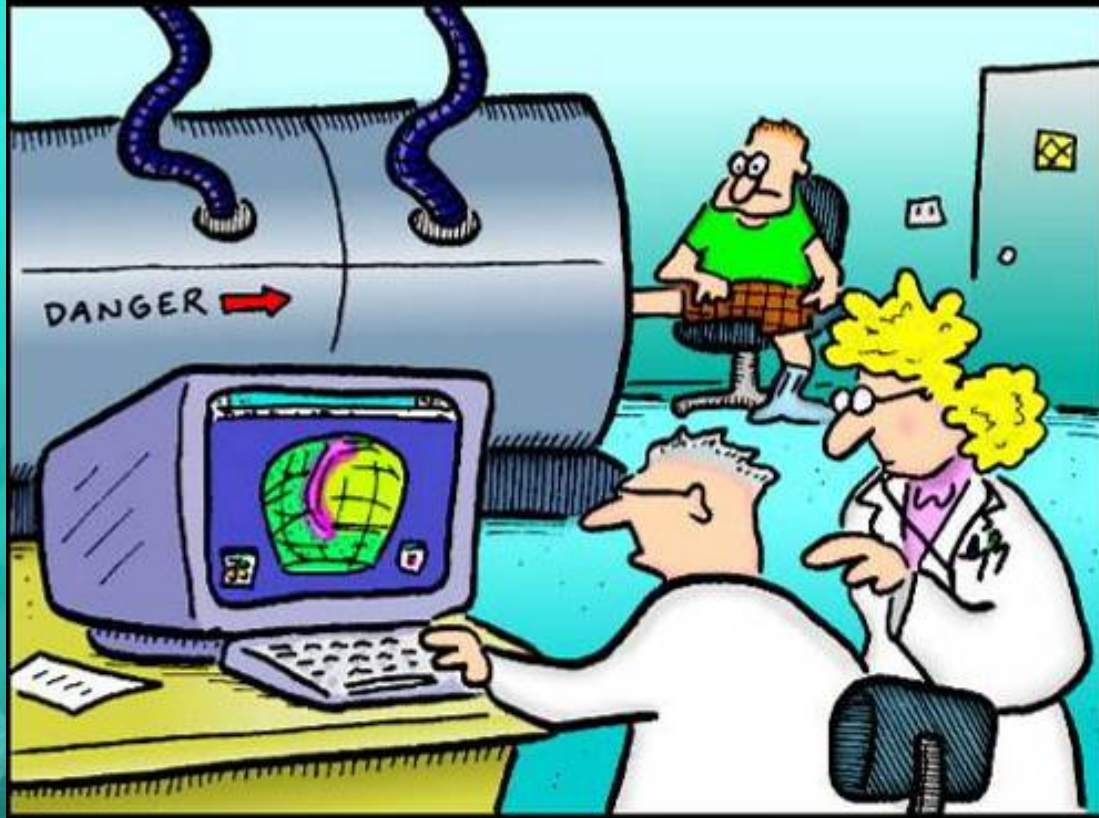


New Technologies for Surgery

ACCE 2008 Teleconference Series
December 18, 2008

Ismael Cordero
Senior Clinical Engineer
ORBIS International



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

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

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

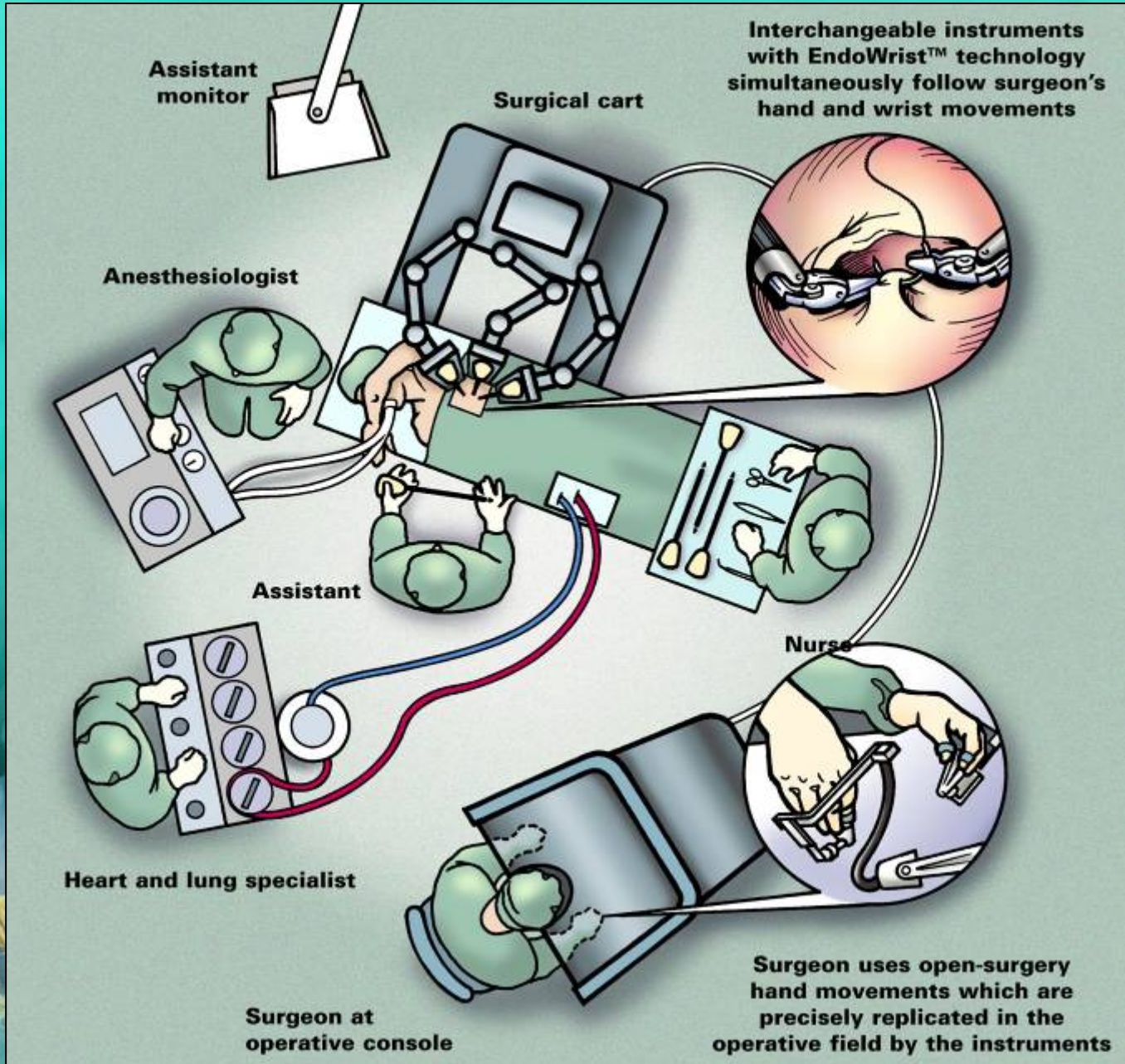
Surgeon Console

Patient-side Cart

Vision System



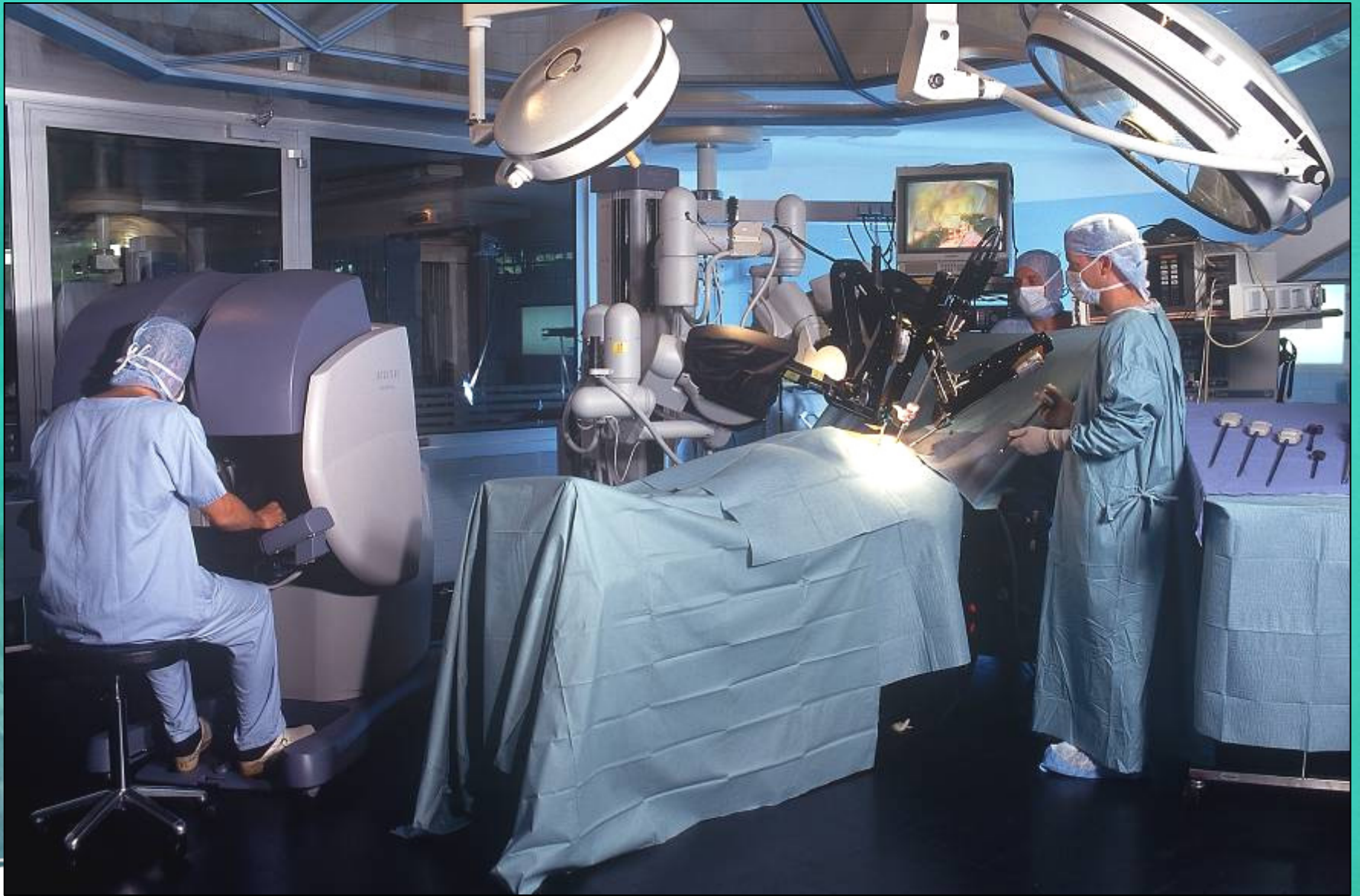
Typical OR Configuration



Set-up in Ohio State



Set-up in Paris



Surgeon Console



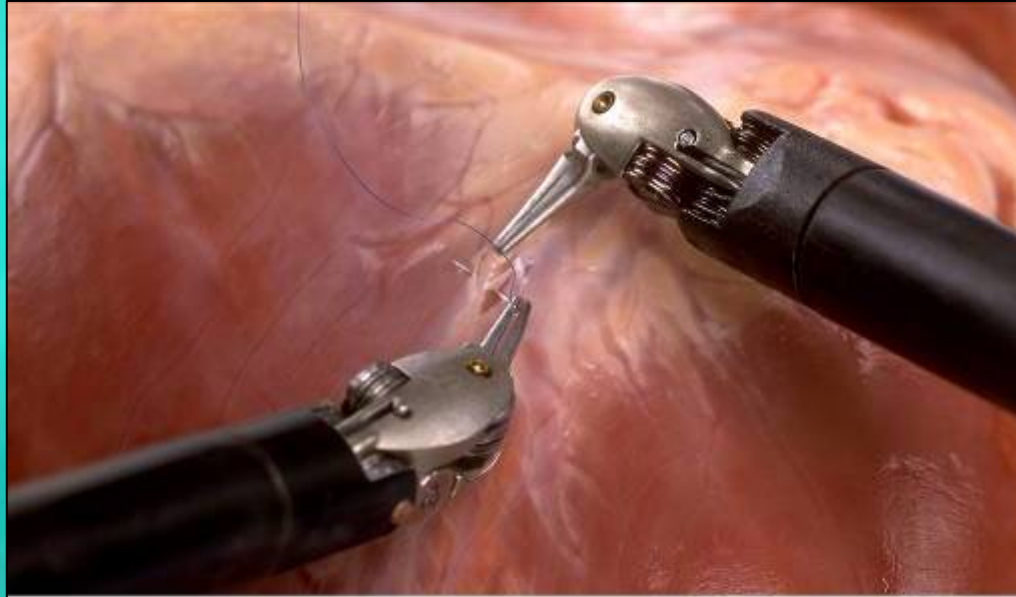
Surgeon Console

- 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



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

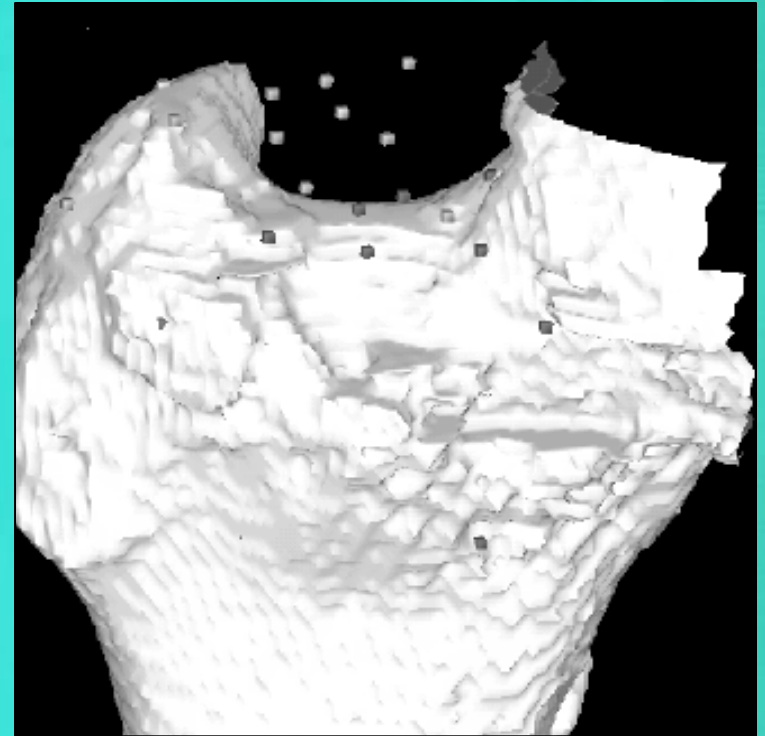
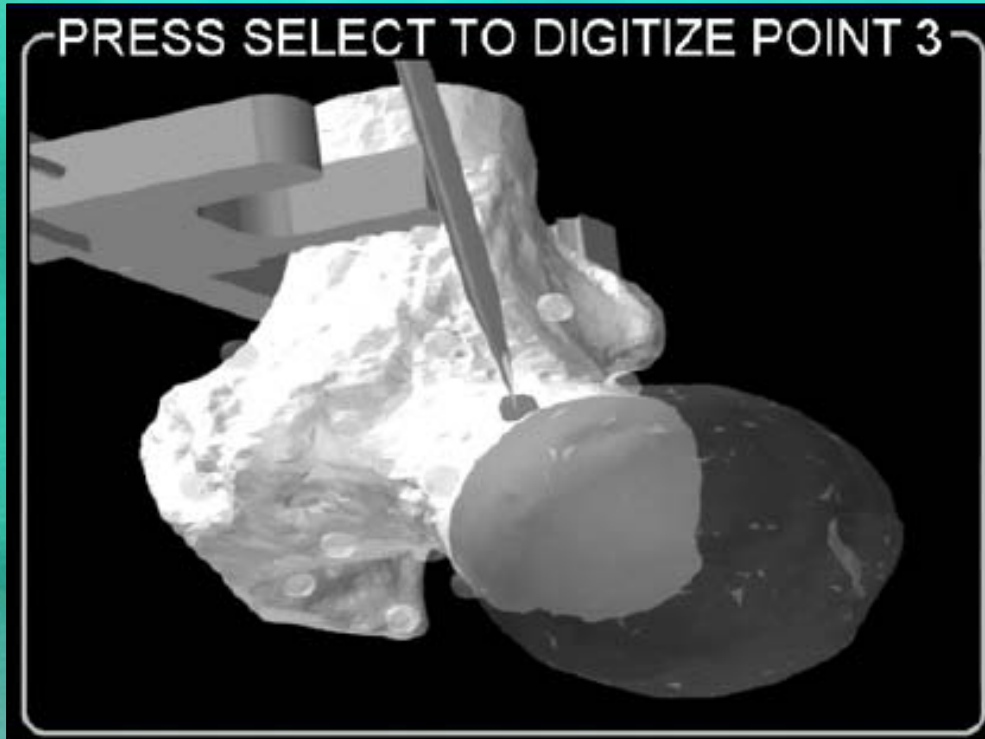
Cardiotomy Procedures



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

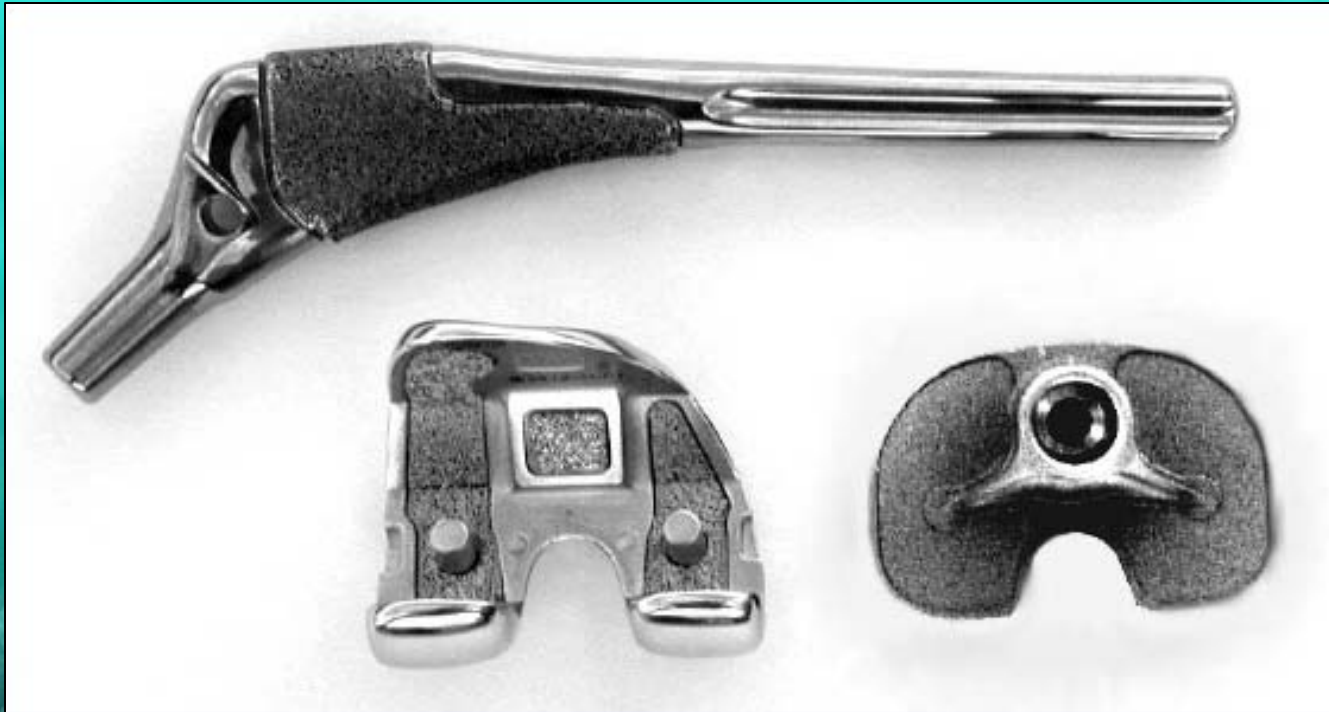
ROBODOC- Registration



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

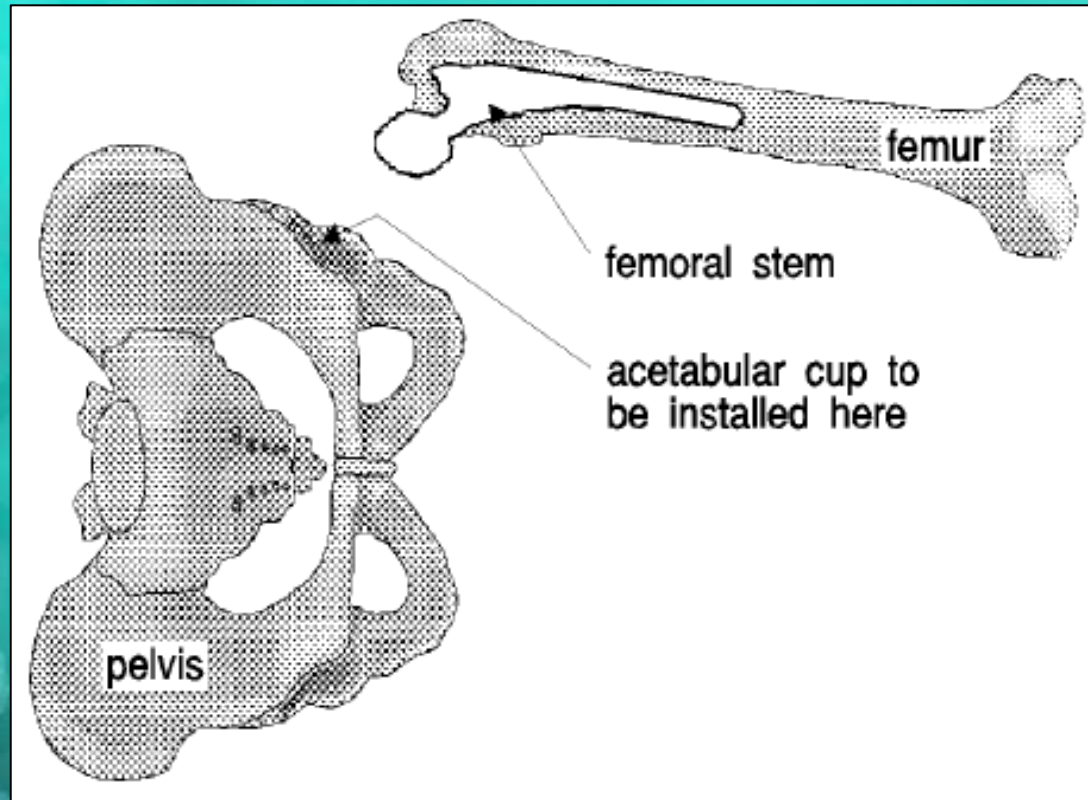
- CT coordinates (preoperative plan)
- Robot coordinates (surgery)

ROBODOC

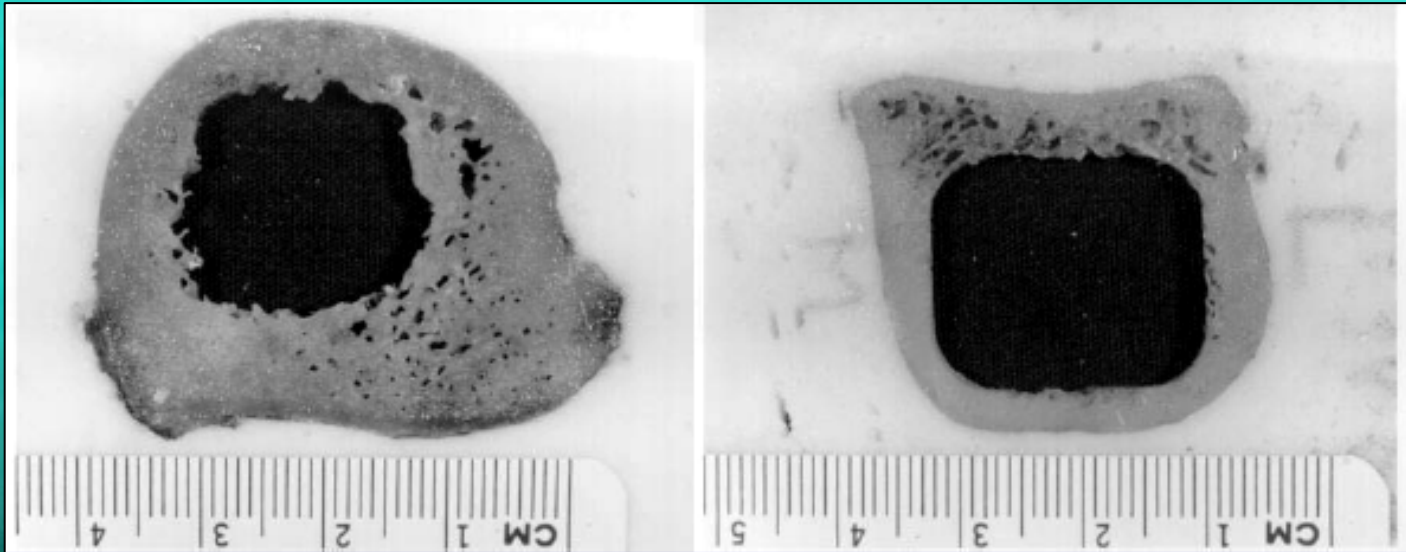


Orthopedic Implants

ROBODOC



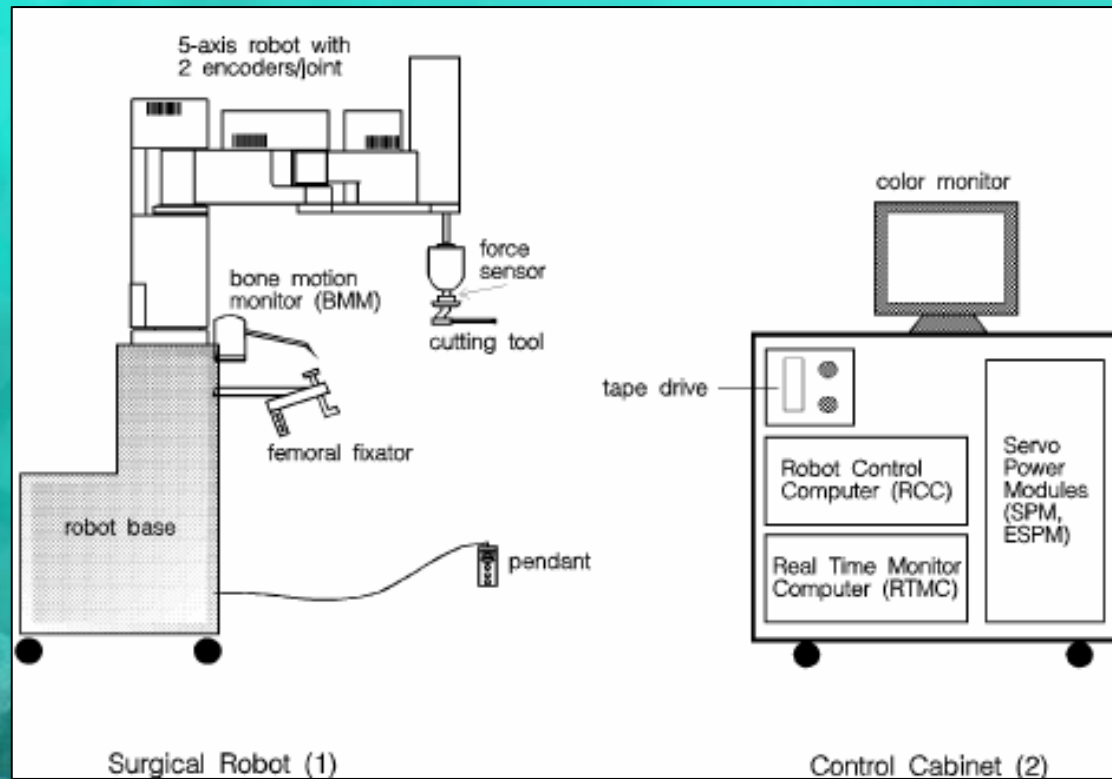
ROBODOC



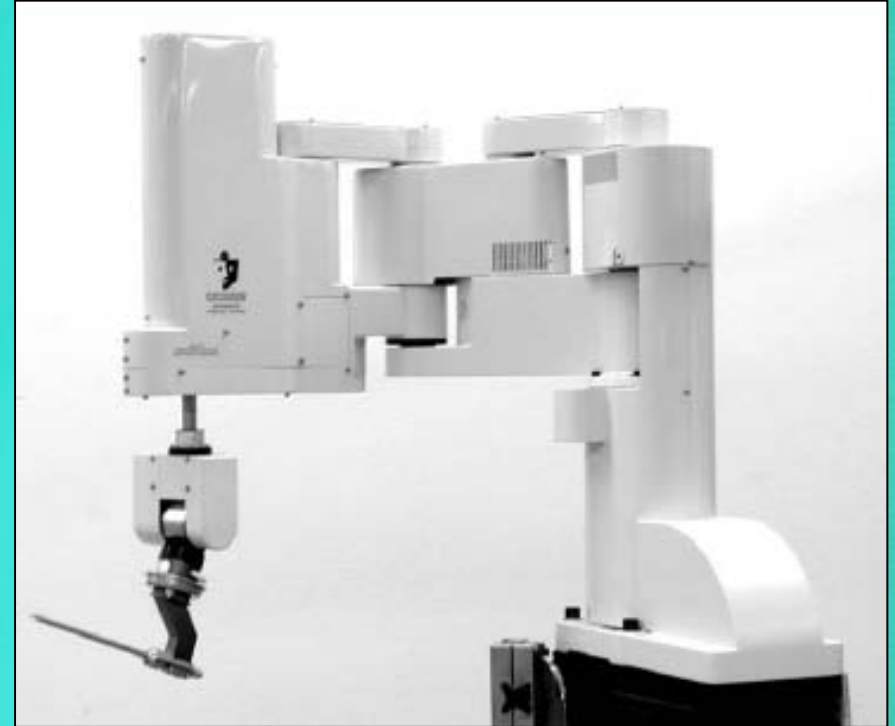
Cavity made by surgeon

Cavity made by ROBODOC

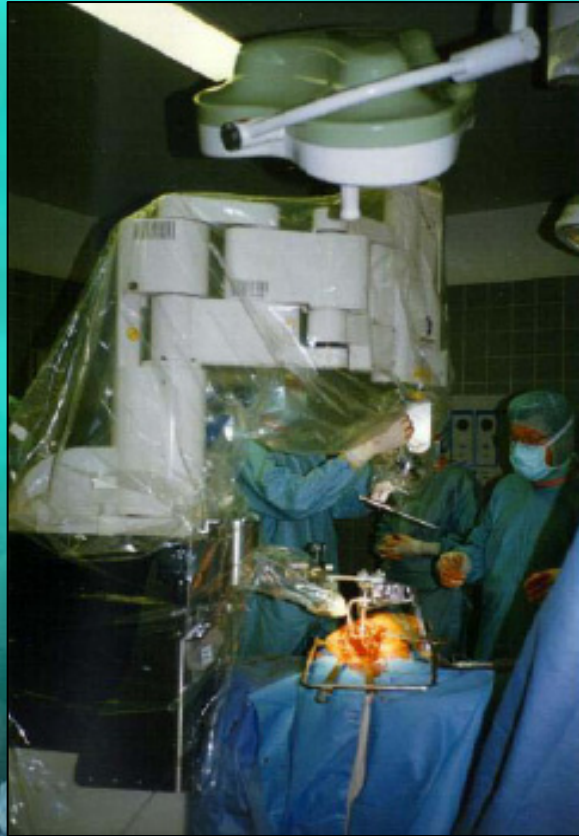
ROBODOC

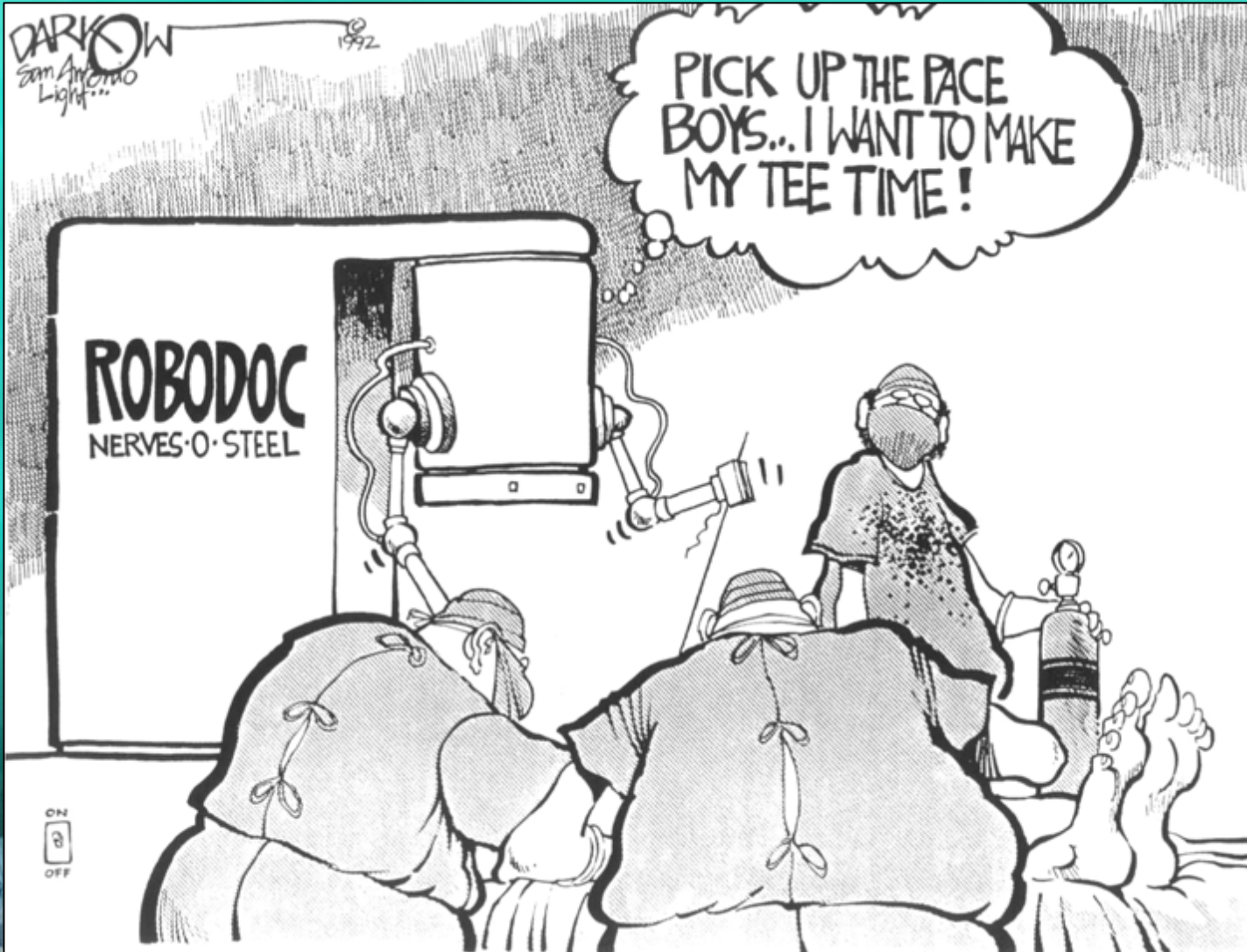


ROBODOC



ROBODOC

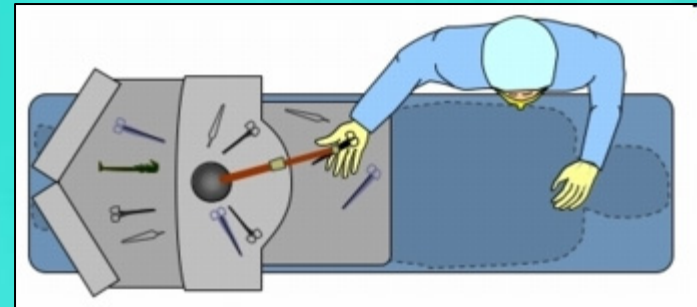
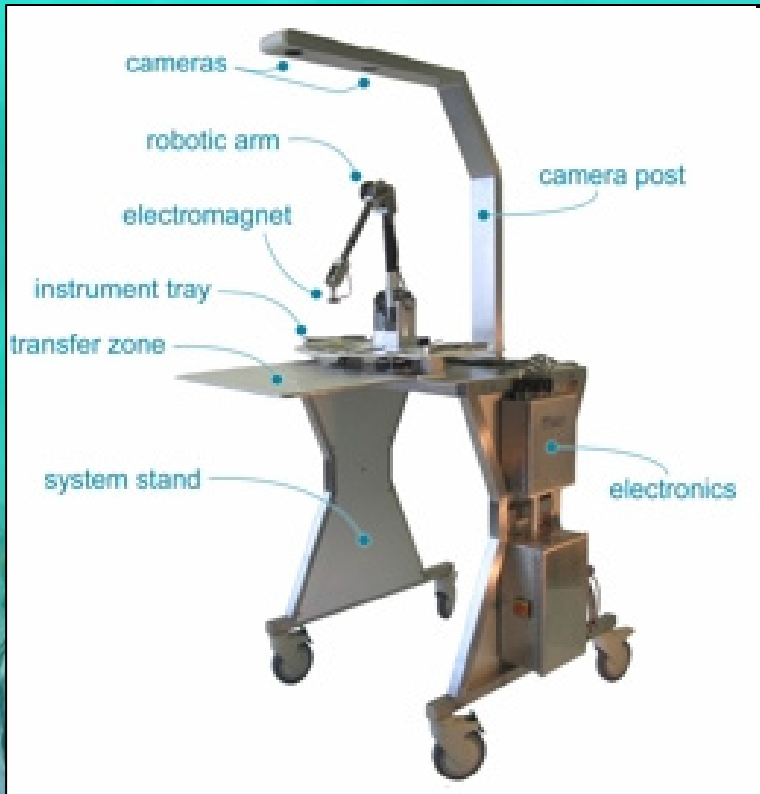




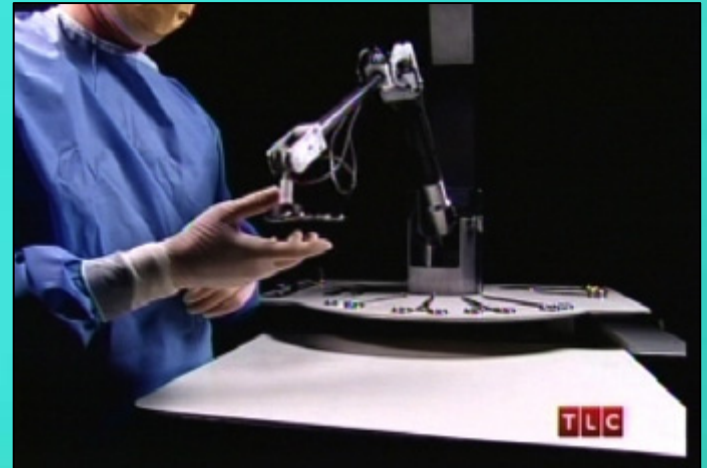
Penelope

- 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

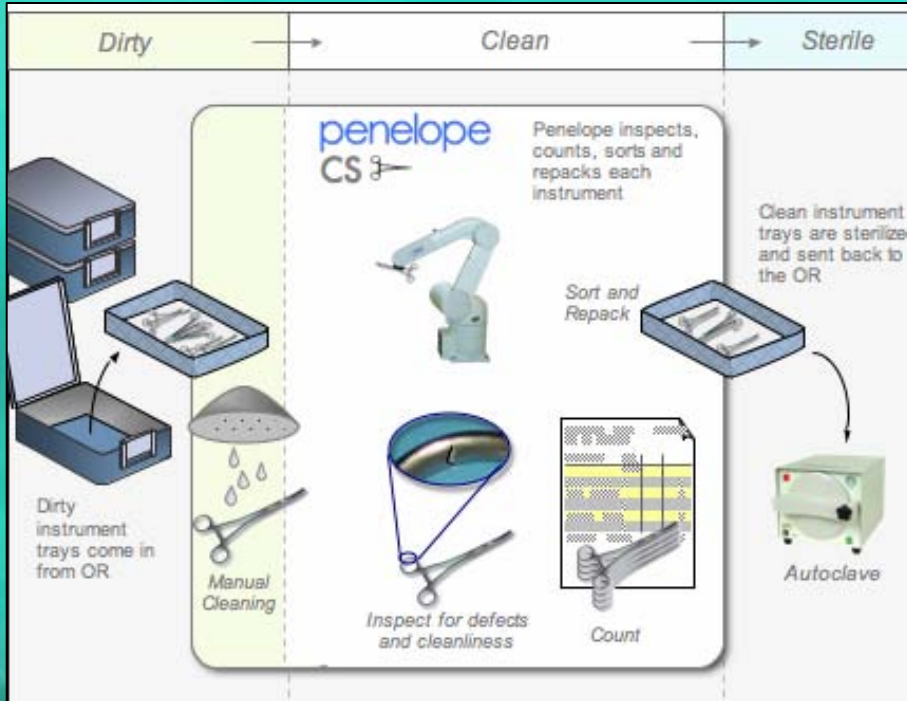
Penelope



Penelope



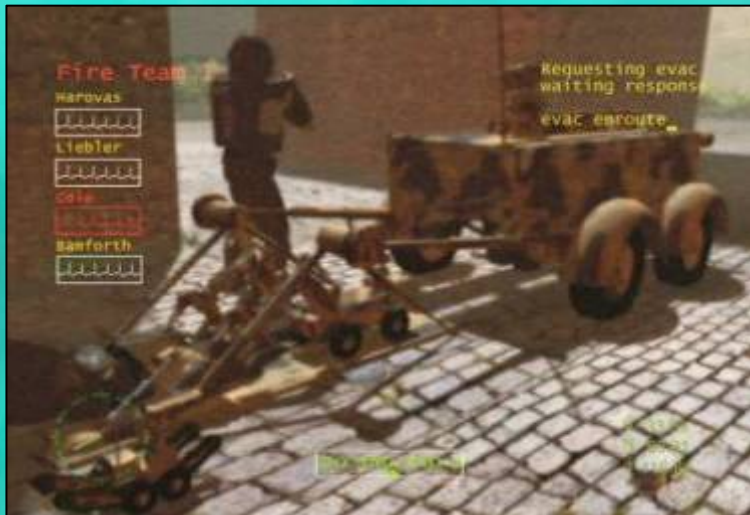
Penelope CS



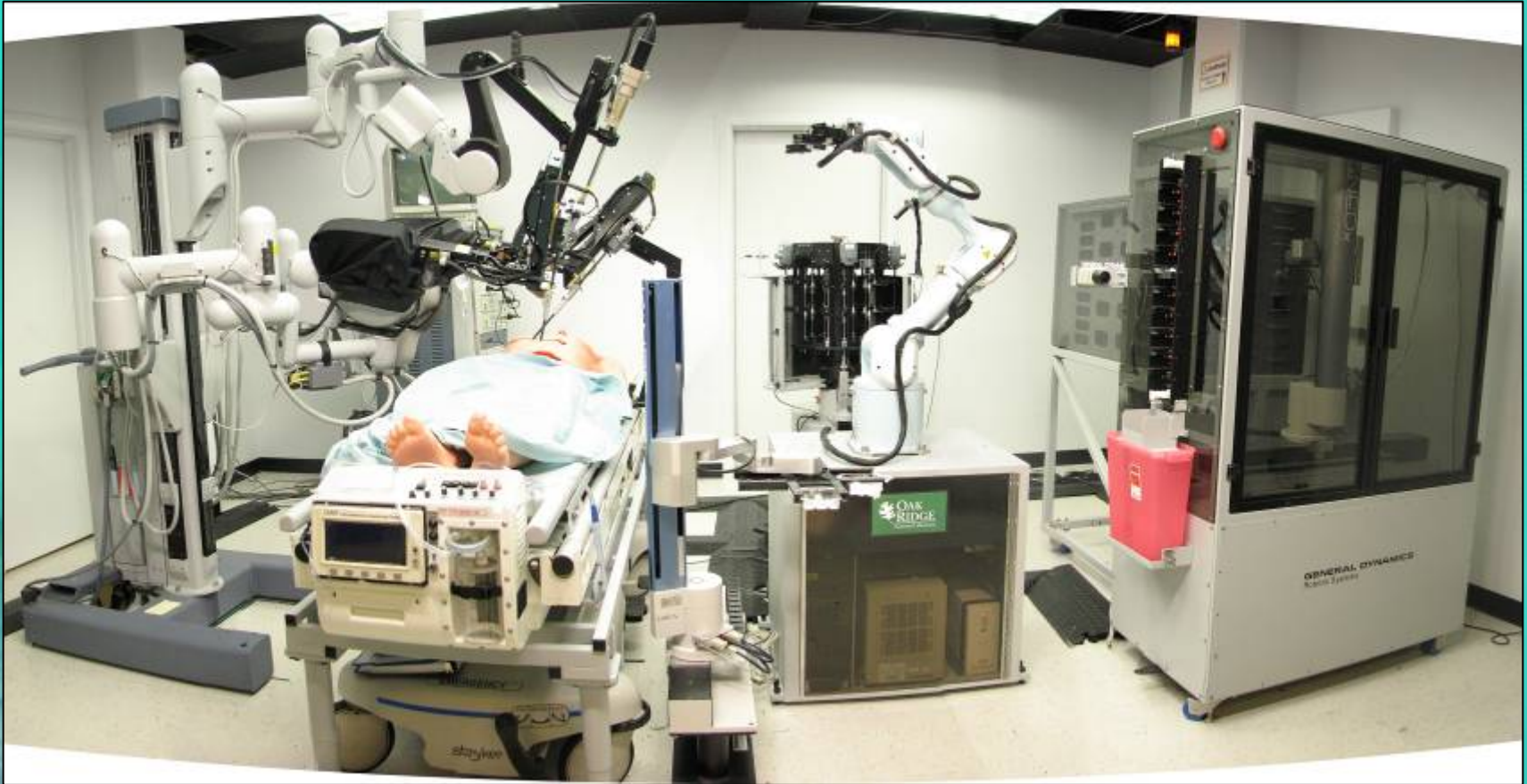
TraumaPod Project

- 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.

DARPA TraumaPod Project



DARPA TraumaPod Project



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

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

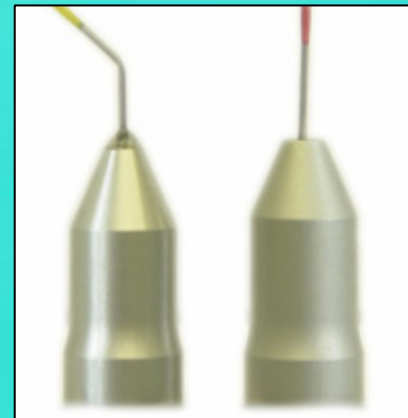
Anybody here know how to play Microsoft's Flight Simulator?



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



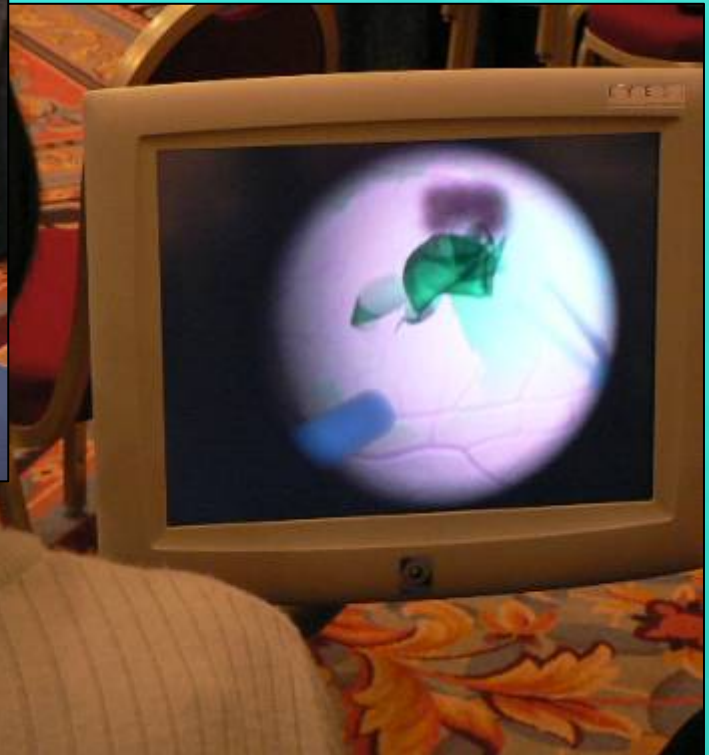
EYESi Simulator



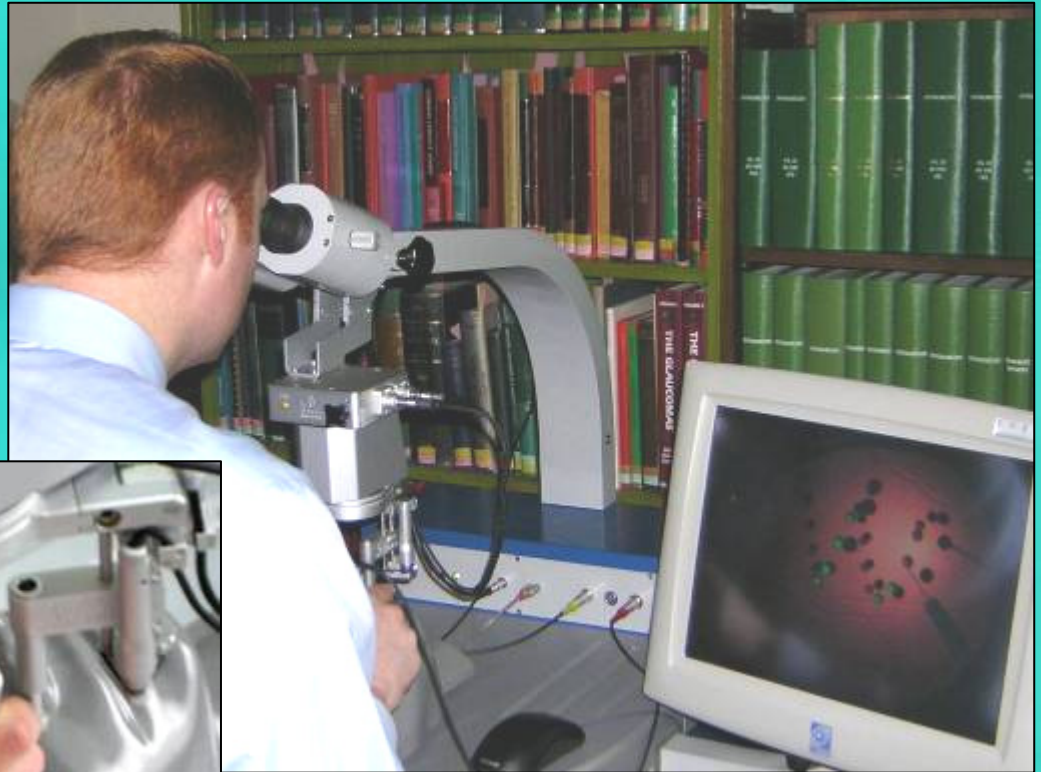
EYESi Simulator



EYESi Simulator



EYESi Simulator



EYESi Simulator

Back Logout demo

Beginner's Course - Task 1 Navigation Training (level 1)

Instructions Medical Control Instruments

General

Used needles and light sources. They are inserted directly by moving the tip of the needle into one of the bubbles and holding the tip as steady as you can within the bubble. Once the bubble changed to color you can proceed to the next. The smaller a bubble gets the harder it is to keep the instrument within its boundary. You will have to use the focus on the microscope (needed to adjust focus when working in different depths. Try to get a feeling for the space within the eye.

Configuration

Nineeen bubbles are arranged in a helix. The bubbles in the lower part of the helix will have a quite large distance to the retina, so that you can practice explore the available focus.

Tip: Use the light source to generate a shadow of the instrument on the window bubble. The shadow enables additional depth cues and helps to navigate inside the eye.

Screenshot



Start Simulation

Back Logout demo

Vitreoractor Training Module v0.9 - Task 1 Vitreoractor Training (level 1)

	Value	Points/Penalty
Remaining Balls	9 (20)	100
Time	5:02	100
Retina Injury	0%	-40
Critical Eye Pressure		0
Lens Contact		-12
Light Intoxication		-5

Task Score

0

OK Show History

Back Logout demo Head VRT CAT

Navigation Training Module - Task 1 Navigation Training (Level 1)

Program Status Instruments Microscope Eye Deformation

Zoom: 1.000 x
Biom lens height: 0.02

Microscope Footpedal

XY Position

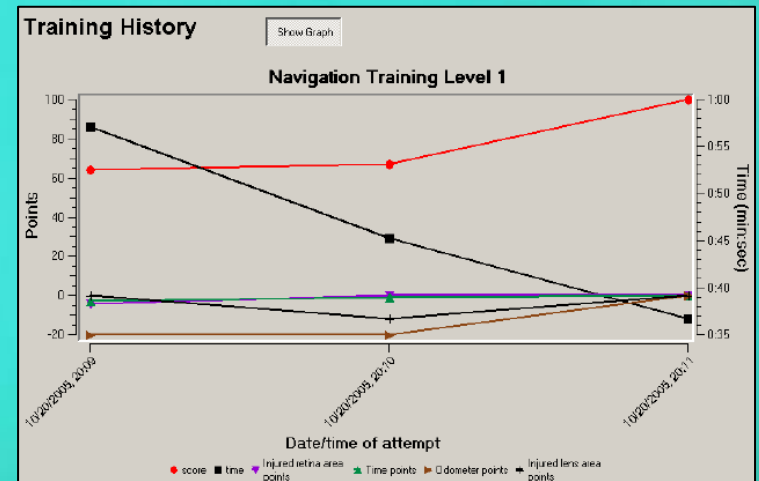
Biom up Focus Up Zoom In Biom down

Auxiliary optics on/off Focus Down Zoom Out

Auxiliary optics: None, Biom 50 D, Biom 120 D, Contact optics macula, Contact optics widefield, SDI

Use Alternative Settings

Evaluation About Simulation



EYESi Simulator

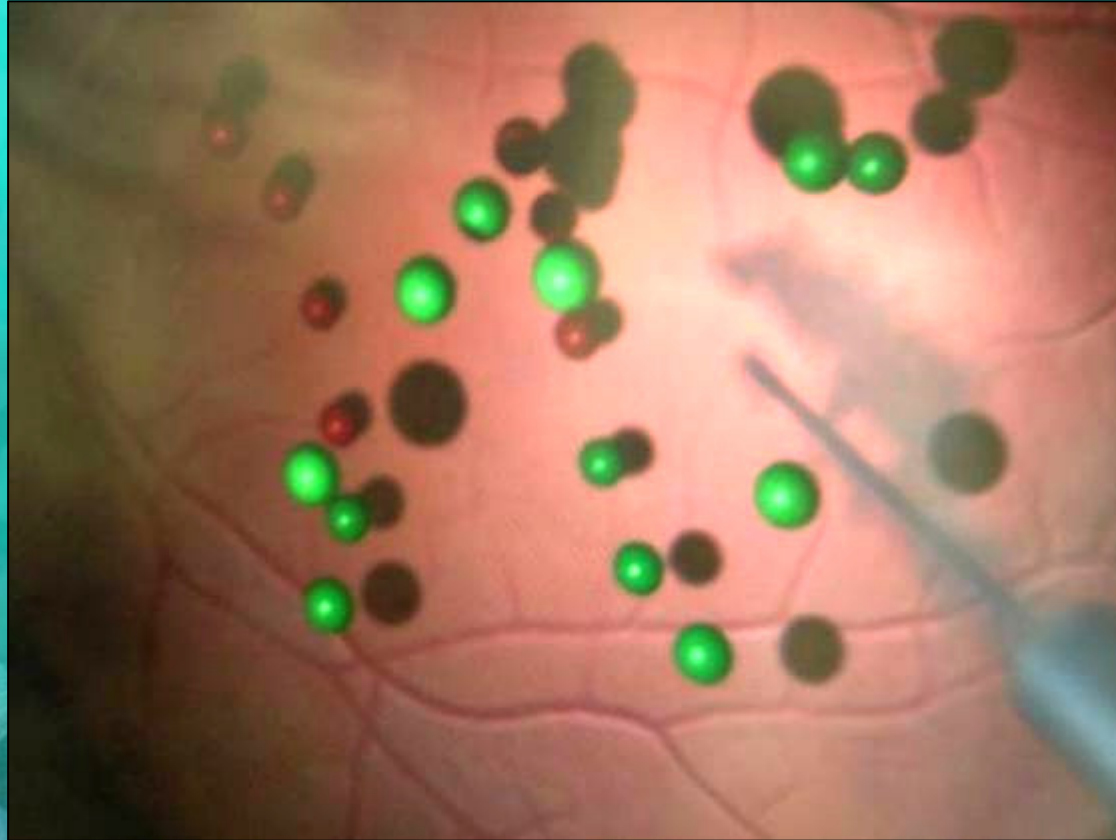
The screenshot displays the 'Aspiration Preset' window. At the top, it shows 'aspiration: peristaltic' and a scale from 0 to 500. The main window has a 'Vacuum (mmHg)' display set to 20, with 'DOWN' and 'UP' buttons. Below this is a 'Flow Rate (cc/min)' display set to 22, also with 'DOWN' and 'UP' buttons. On the right side, there are buttons for 'Linear Flow', 'Linear Vac', 'Mode', 'Fast', 'Vac rise', and 'Venting'. At the bottom, there are 'US RATE: Continuous' and 'reset' buttons. The background shows various instrument icons like DIATH, U/S, I/A, SCISS, and VIT, along with a 'GEMINI' logo and a 'Program demo' indicator.

This screenshot shows a control panel with five digital displays and corresponding up/down buttons. The displays show the following values: 30, 000, 000, 80, and 50. The first display is labeled 'mmHg', the second 'mmHg', the third '%', the fourth 'Illum 1', and the fifth 'Illum 2'. A 'Close' button is located at the bottom right. At the bottom of the panel, it reads 'Alcon Accurus adapter for Ophthalmosurgical Simulator EYESi, VRmag c GmbH'.

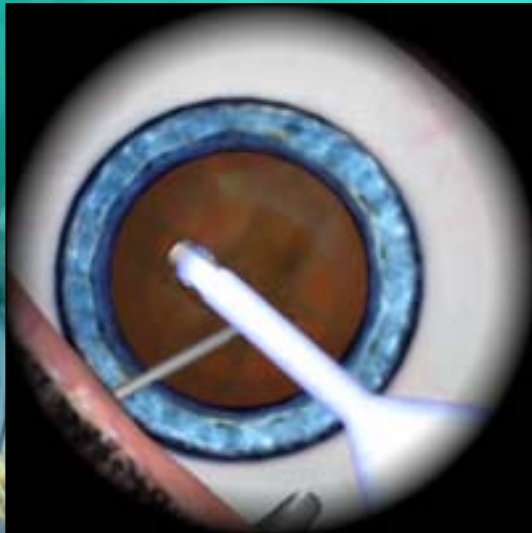
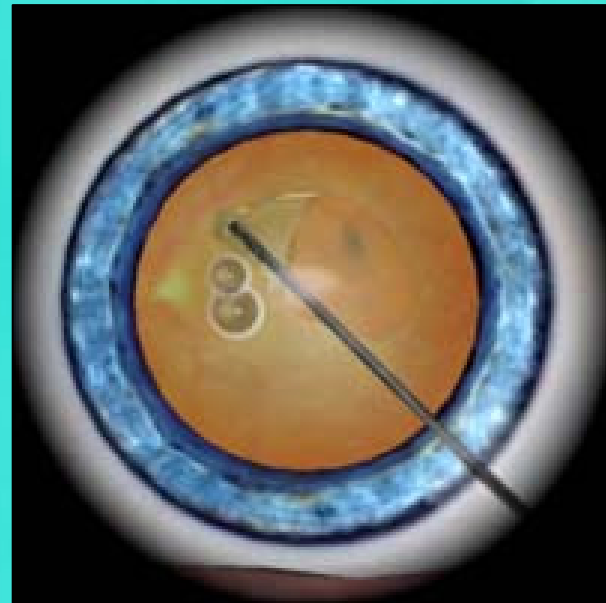
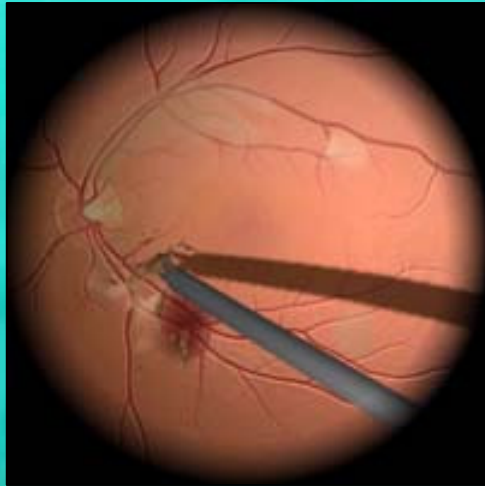
The screenshot shows the 'Infusion Control' panel. It features two columns of instrument icons: 'Infusion Job 1' (Lamp 1, Lamp 2) and 'Infusion Job 2' (Candle Pick, Forceps, Endoscopic Forceps, Vector). Below these are 'Configure' buttons. In the center, there is a diagram of an infusion bottle and a scale. At the bottom, there is a 'Configure' button. The top of the panel has tabs for 'Program Status', 'Instruments', 'Microscope', and 'Eye Distraction'.

This screenshot shows the 'Memory 1' control panel. At the top, it displays 'clara' and 'Posterior Memory'. The main section is titled 'VIT: Proportional Vacuum' and includes a 'Vacuum' display set to 0, with a 'Max Limit' of 300 mmHg. Below this is an 'Accurus Cut Rate' display set to 0, with a 'Set Point' of 0 cpm. At the bottom, there are buttons for 'PropVac', '2 Pedals', and 'Dual'. A row of icons at the very bottom includes 'VIT', 'Frag', 'Scissors', 'Extrude', 'VFC', and 'Exit'. At the bottom of the panel, it reads 'Alcon Accurus adapter for Ophthalmosurgical Simulator EYESi, VRmag c GmbH'.

EYESi Simulator



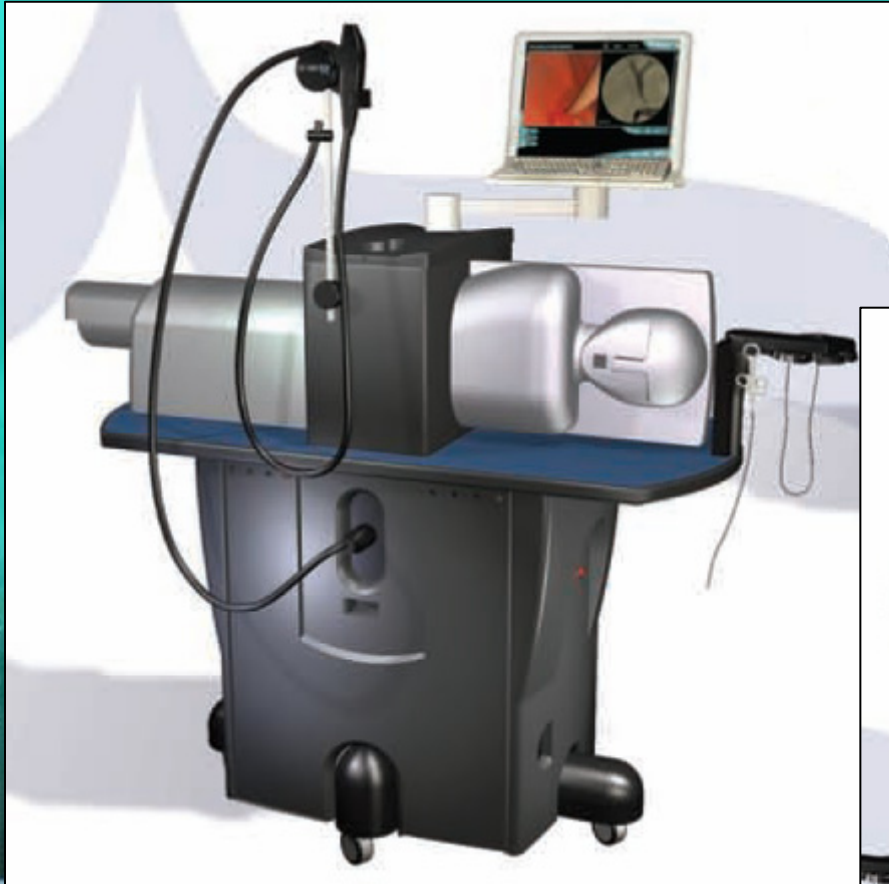
EYESi Simulator



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, endourology, percutaneous access, gastro intestinal and angiography procedures
- Simulators designed for training and assessment
- Metrics for skill assessment
- Cost between \$50,000 & \$100,000

GI Mentor



ANGIO Mentor



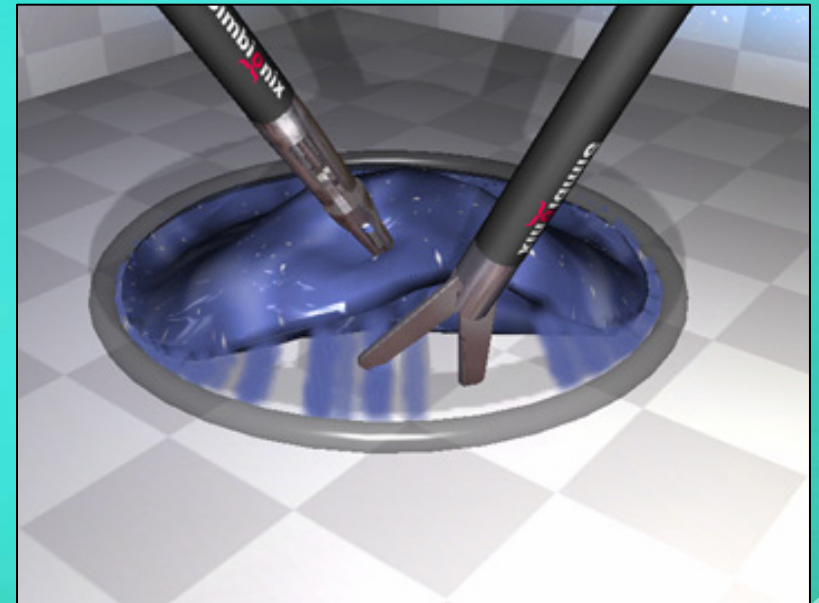
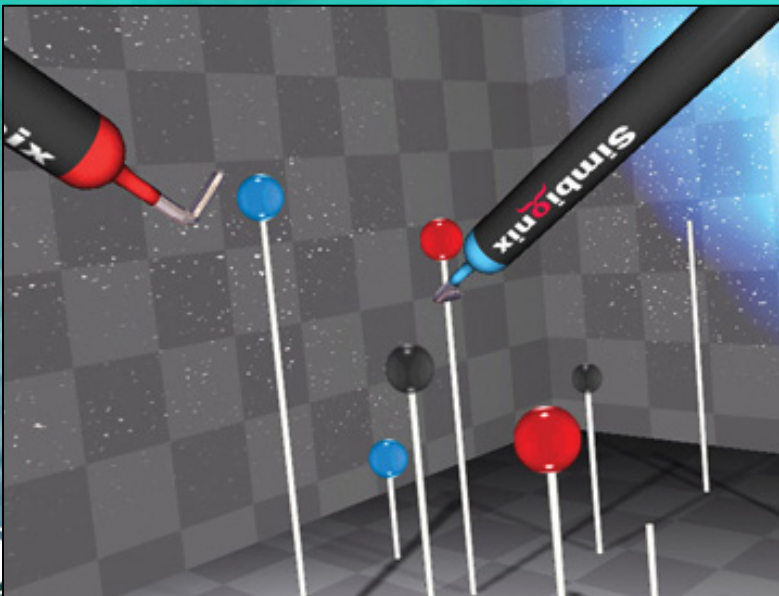
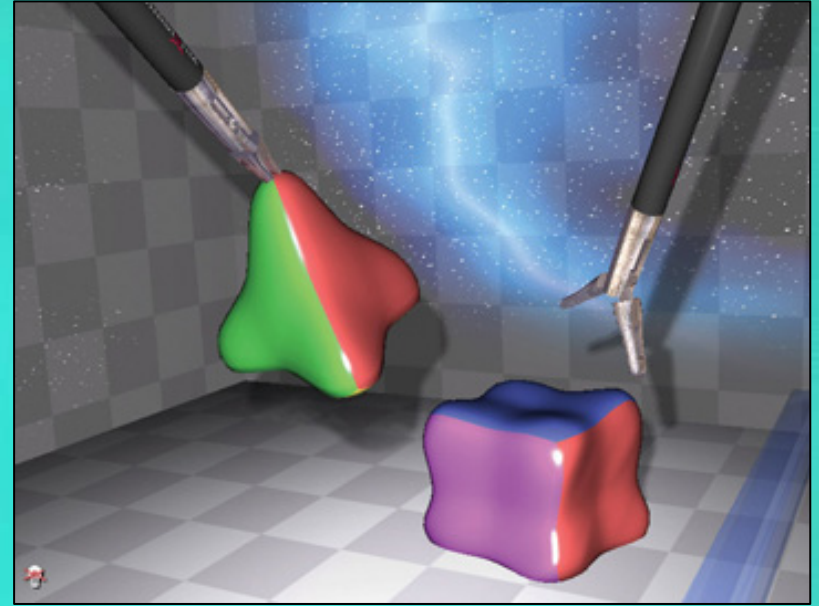
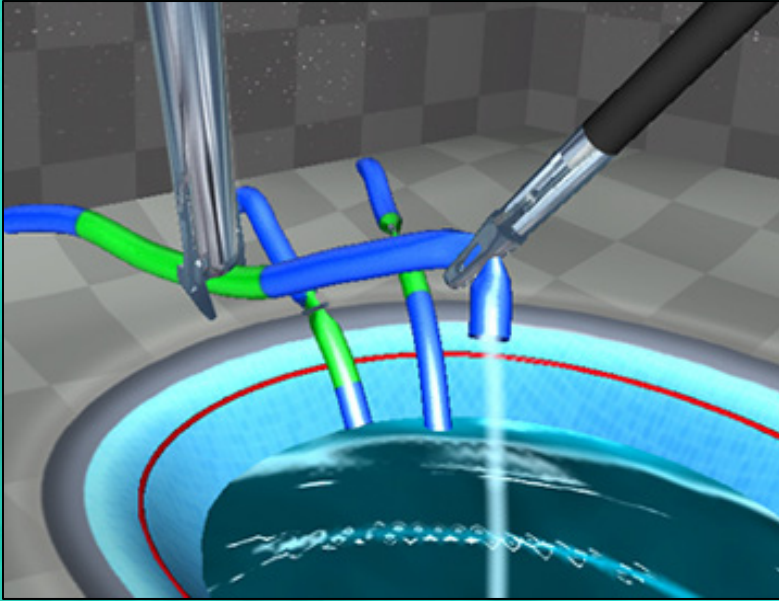
URO Mentor



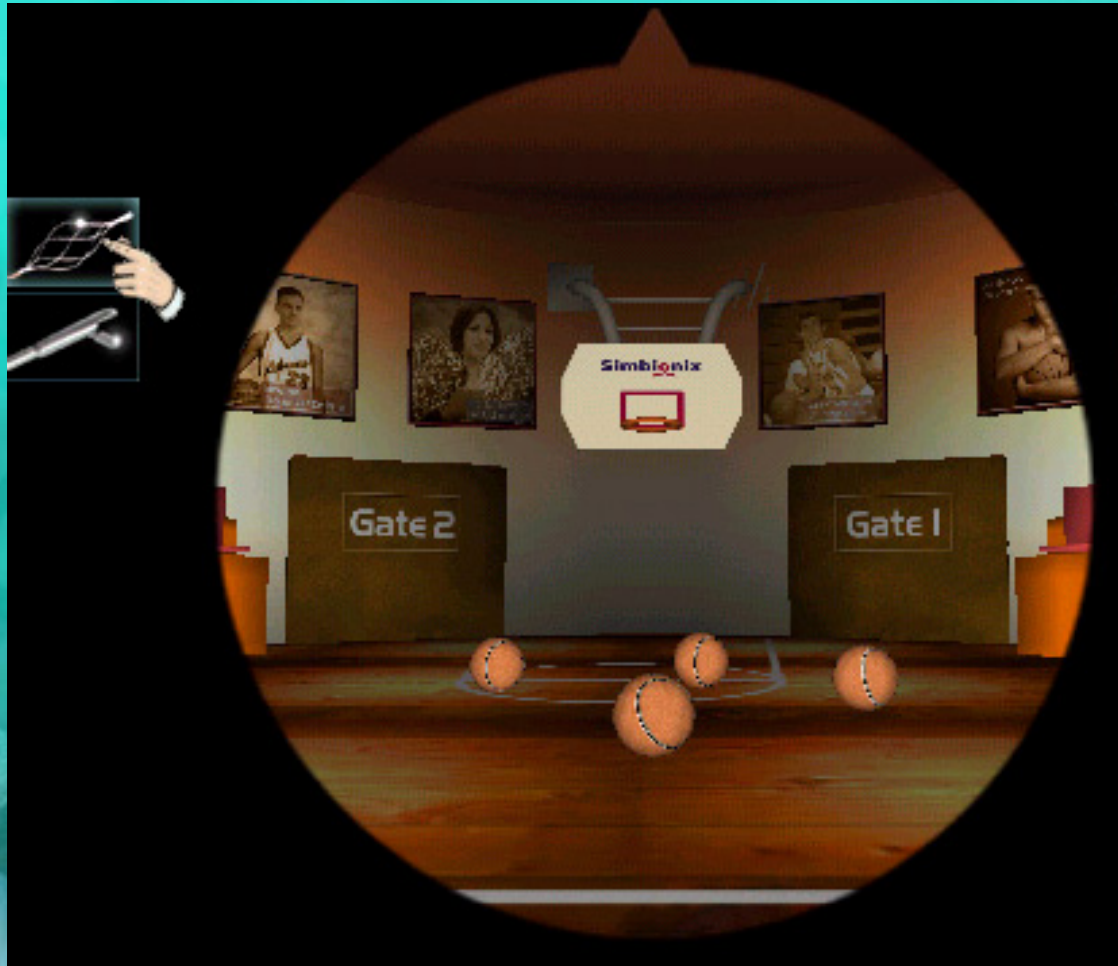
LAP Mentor



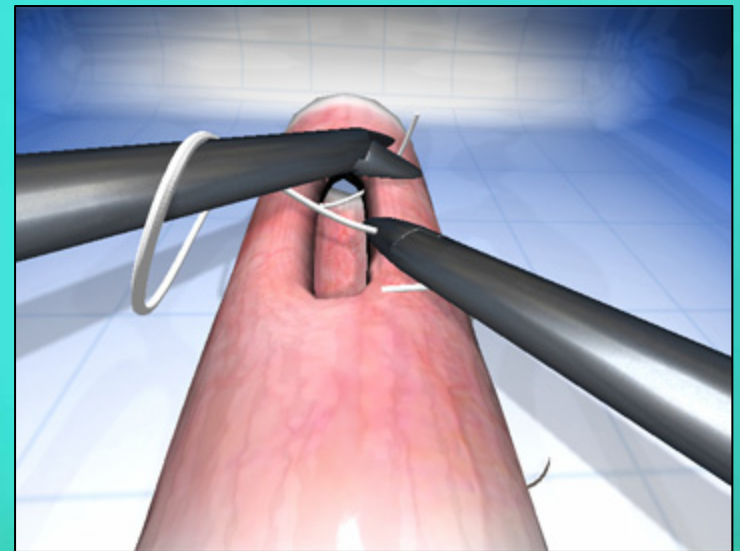
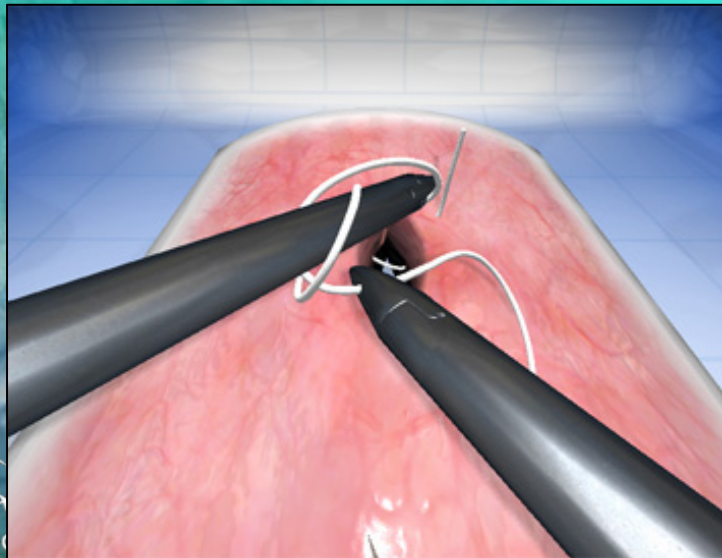
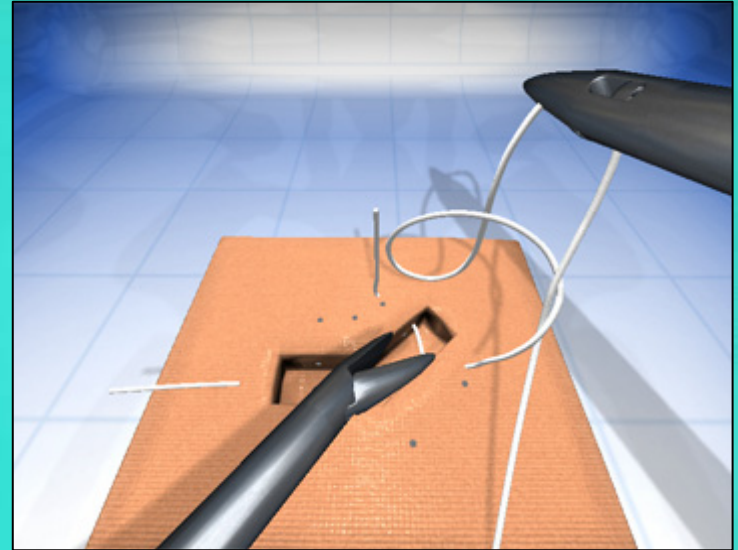
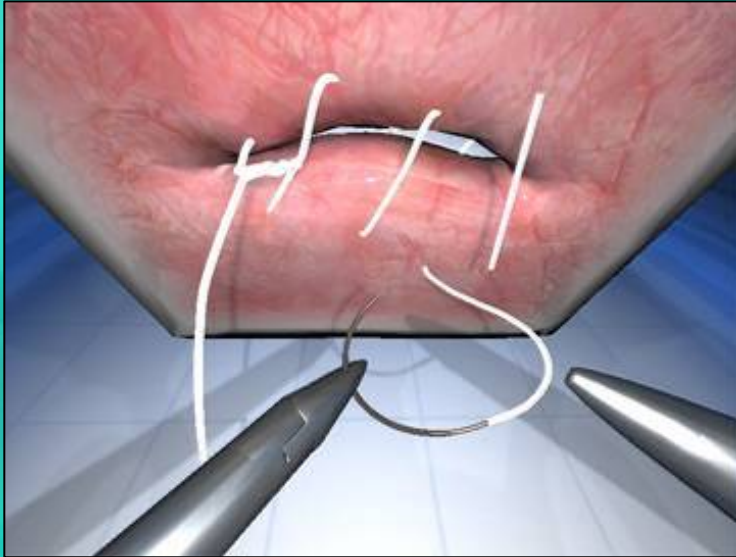
Dexterity Exercises



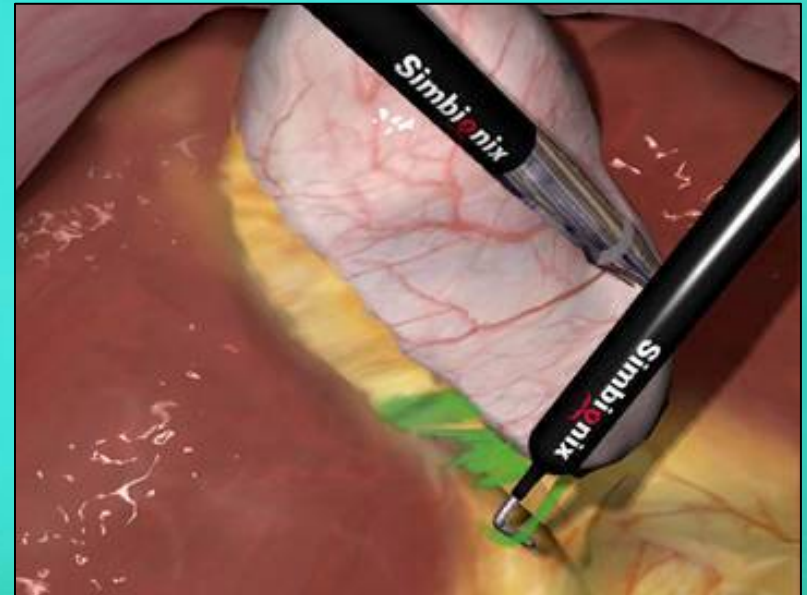
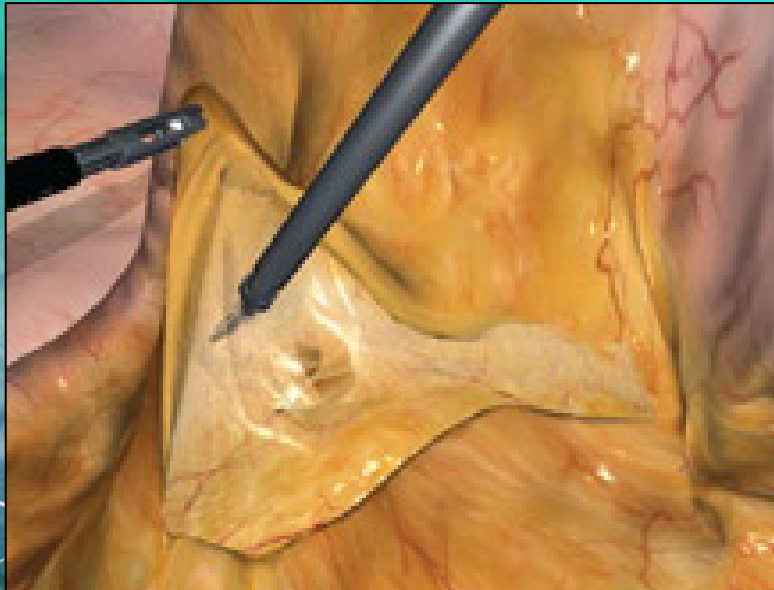
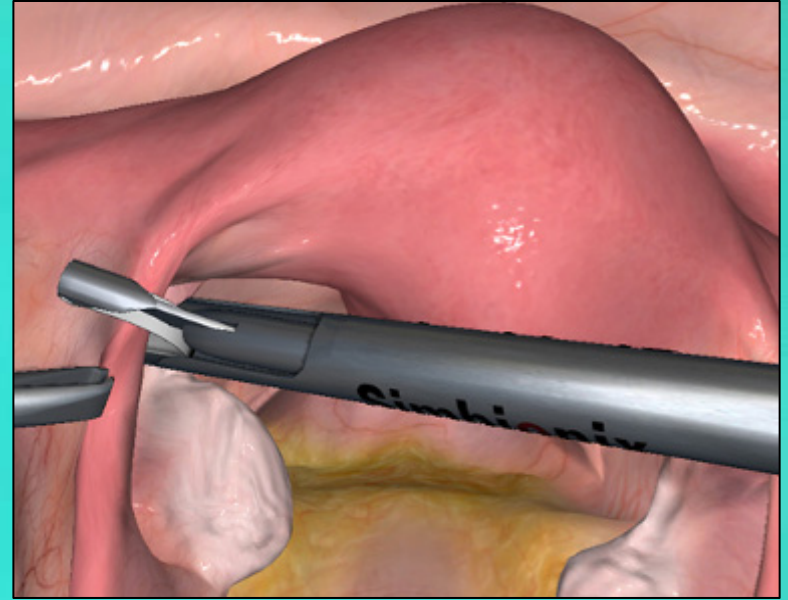
Dexterity Exercises



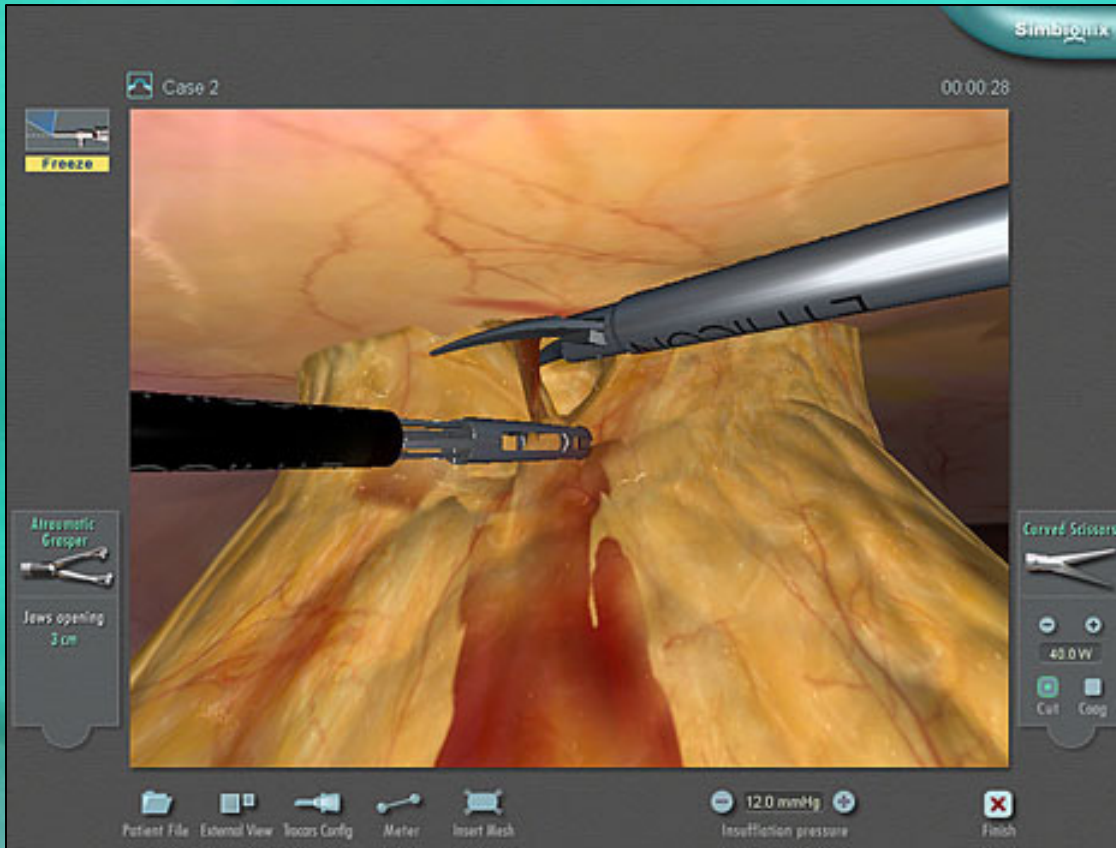
Basic Tasks Training



Procedure Training

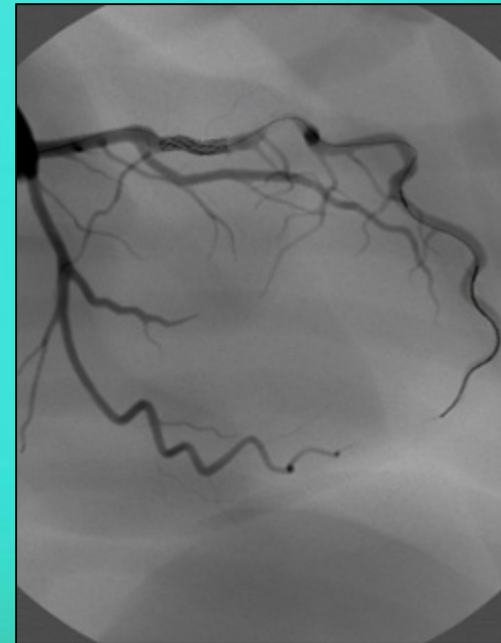
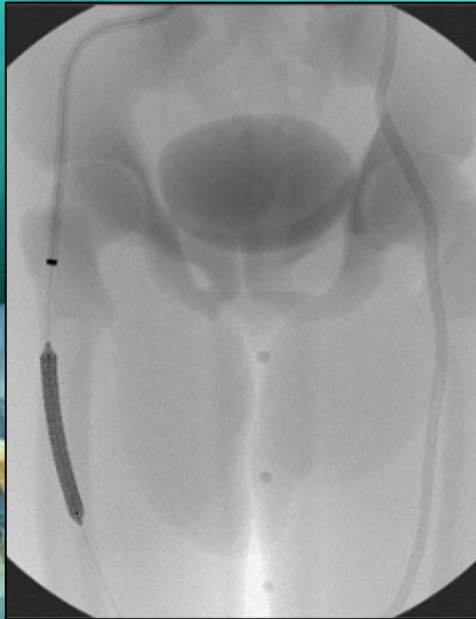
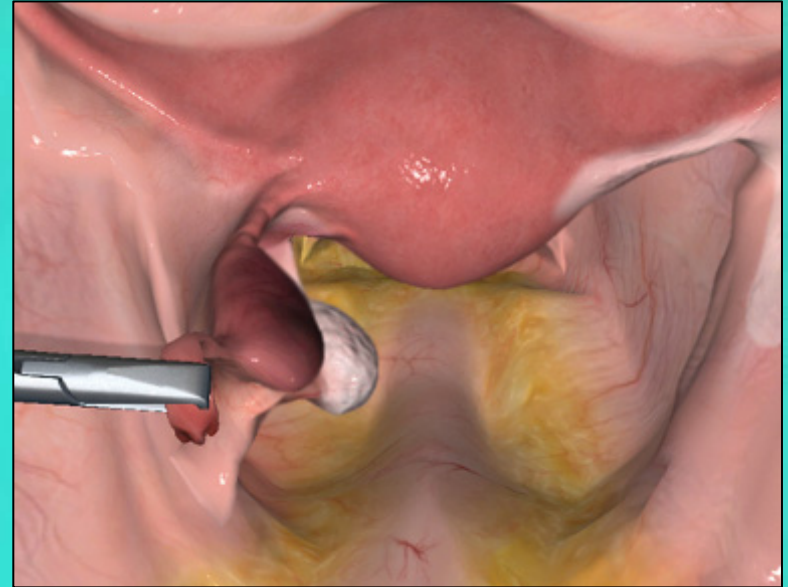
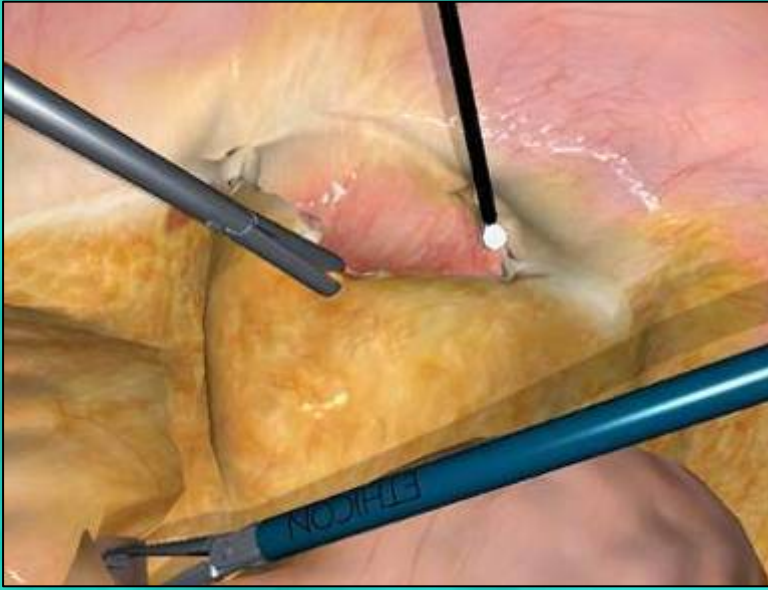


Procedure Training



Hemorrhage simulation

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



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>
 - Symbionix- Makers of the GI Mentor, ANGIO Mentor, LAP Mentor, URO Mentor
<http://www.symbionix.com>

Thank You

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