Modeling and Simulation in Healthcare and Surgery

Surgical Grand Rounds
University of Colorado Medical Center
Denver, CO
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Presenter Financial Disclosure Slide

Richard M. Satava, MD FACS

Financial Support:	None (… but still hoping !)
Consulting:	Karl Storz
ISIS Support	Stryker SimuLab US Surgical
Investment	InTouch Technologies, Inc

* There will be no discussion of products from these companies

*S*imulation

*D*efinition

(Oxford English Dictionary)

1. Tendency to assume a form resembling that of something else; unconscious imitation.

2. A false assumption or display, a surface resemblance or imitation, *of* something.

3. The technique of imitating the behavior of some situation or process (whether economic, military, mechanical, etc.) by means of a suitably analogous situation or apparatus, esp. for the purpose of study or personnel training.

*S*imulation

*D*efinition

(Proposed)

Representation of

‘real world’ objects, processes and ideas

by an

‘intangible world’ of information

all have equal “weight” in the information world

*H*ealthcare *E*ducation
*N*ew *I*nformation *A*ge *P*rinciples

1. Teach how to find information, not to memorize
2. Information needs to be ubiquitous and distributed
3. "Information wants to be free" (no cost – Kevin Kelly, *Wired* magazine)
4. Evidence-based practice is essential, but must be balanced with creativity
5. Quantify performance (Competency – based to unambiguous metrics)
6. Simulate before practice (Digital Libraries)

Classic Education and Examination

What is the *REVOLUTION* in Surgical Education?

Training for New Technical Skills

Halstedian Model: See One, Do One, Teach One

MEDICAL EDUCATION

The Revolution

is

...Now

Roughly 100 year cycles

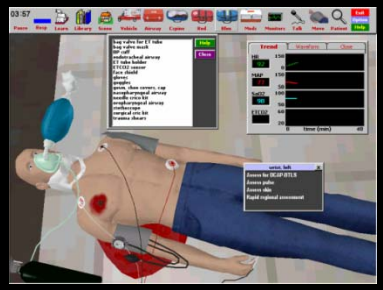
(1908 – Flexner Report)

Paradigm Shift

It's all about . . .

Improved Patient Care

Manikin



Virtual Reality

through

Advanced Medical Education

The 6 Competencies

2003 Consensus by the AGCME & ABMS

- Knowledge
- Patient Care
- Interpersonal and communication skills
- Professionalism
- Practice-based learning and improvement
- Systems-based practice

Two Components of the Revolution Using Modeling and Simulation

- Objective Training of Technical Skills
  - Simulators (technology)
  - Curriculum (training method)

- Assessment of Cognitive and Technical Skills
  - Objective metrics
  - Criterion-based tools

Skills Training

The New Mandates

Effective

1 July 2008 — All residency programs must have a skills training (simulation) center
RRC*

1 July 2009 — All surgical residents must pass FLS**
ABS — in order to apply for board certificate

* Residency Review Committee (RRC) — Accreditation Council of Graduate Medical Education Approved by American Board of Medical Specialties

** Fundamentals of Laparoscopic Surgery

It's not the Simulator

It's the Curriculum

Actually, it is the license or certificate

Uses for the *Curriculum**

Training	Initial fundamental training (residency, etc)
	New procedure
	Pre deployment (military)
Re-training*	Maintenance of certification
	Admin leave (pregnancy, sabbatical, illness, admin training)
	Redeloyment (military)

* Retraining curriculum needs to be substantively different from initial training - essentially a refresher of known skills

The 4 "Customers"

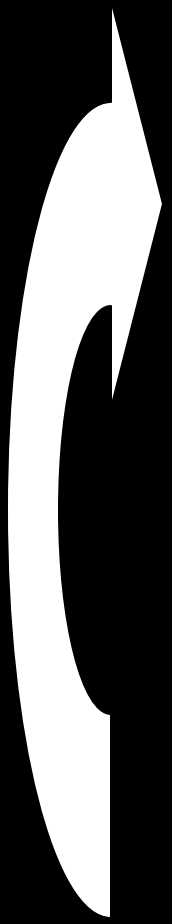
WHO USES A CURRICULUM ?

Customer	Role	Purpose
Department Chair	Planner	Develop a program
Faculty	Consumer	Teach the learner
Student	User	Learn to be competent
Licensing Authority	Certifier	Certify* competence

* Hospitals DO NOT use curricula, they use CERTIFICATES that prove their doctors/nurses are competent

Standardized Curriculum

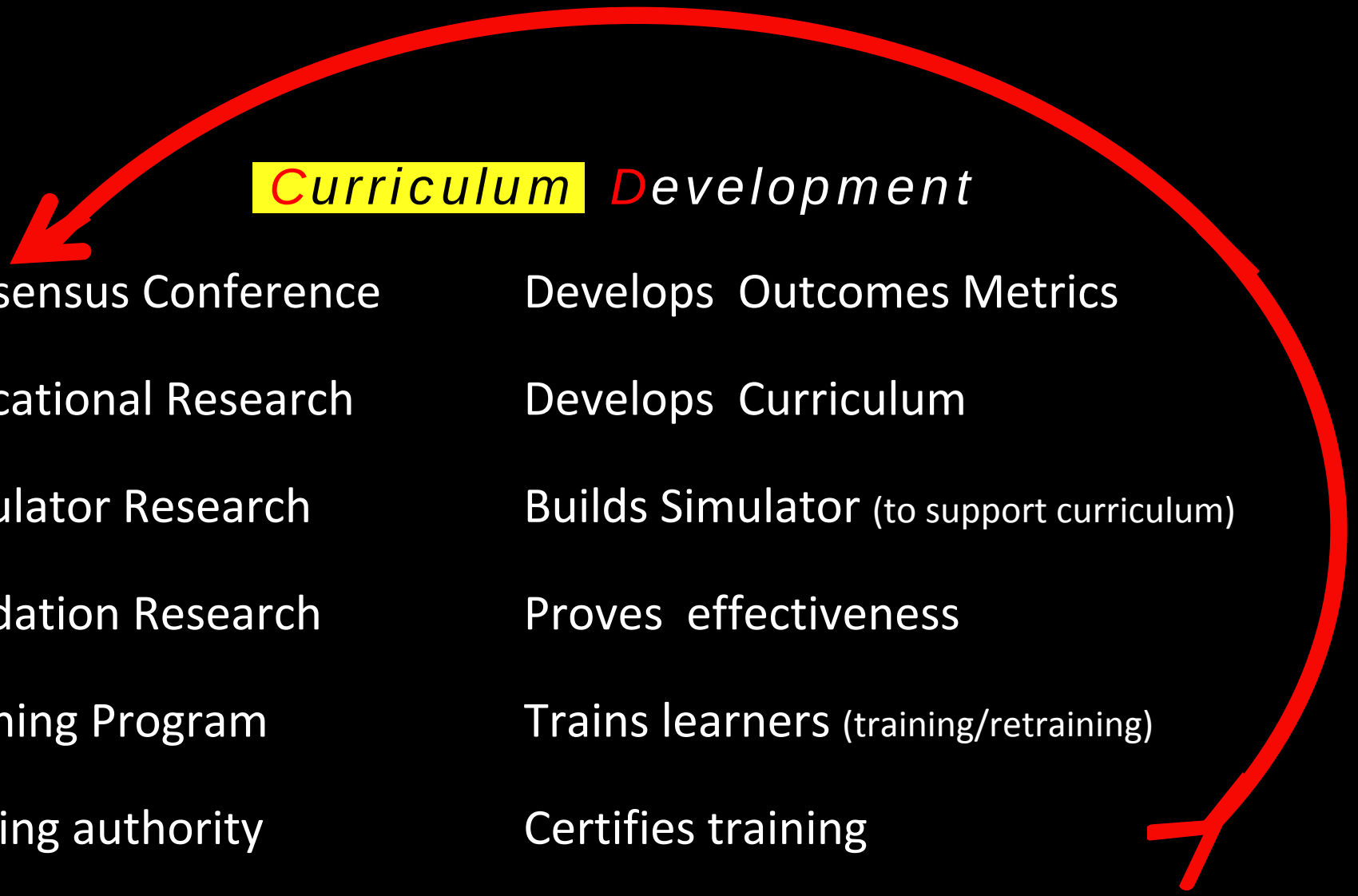
Suggested template



- Goals of the Simulation
- Anatomy
- Steps of the Procedures
- Errors

  TEST
- Skills Training
- Outcomes

Process to Develop a Curriculum



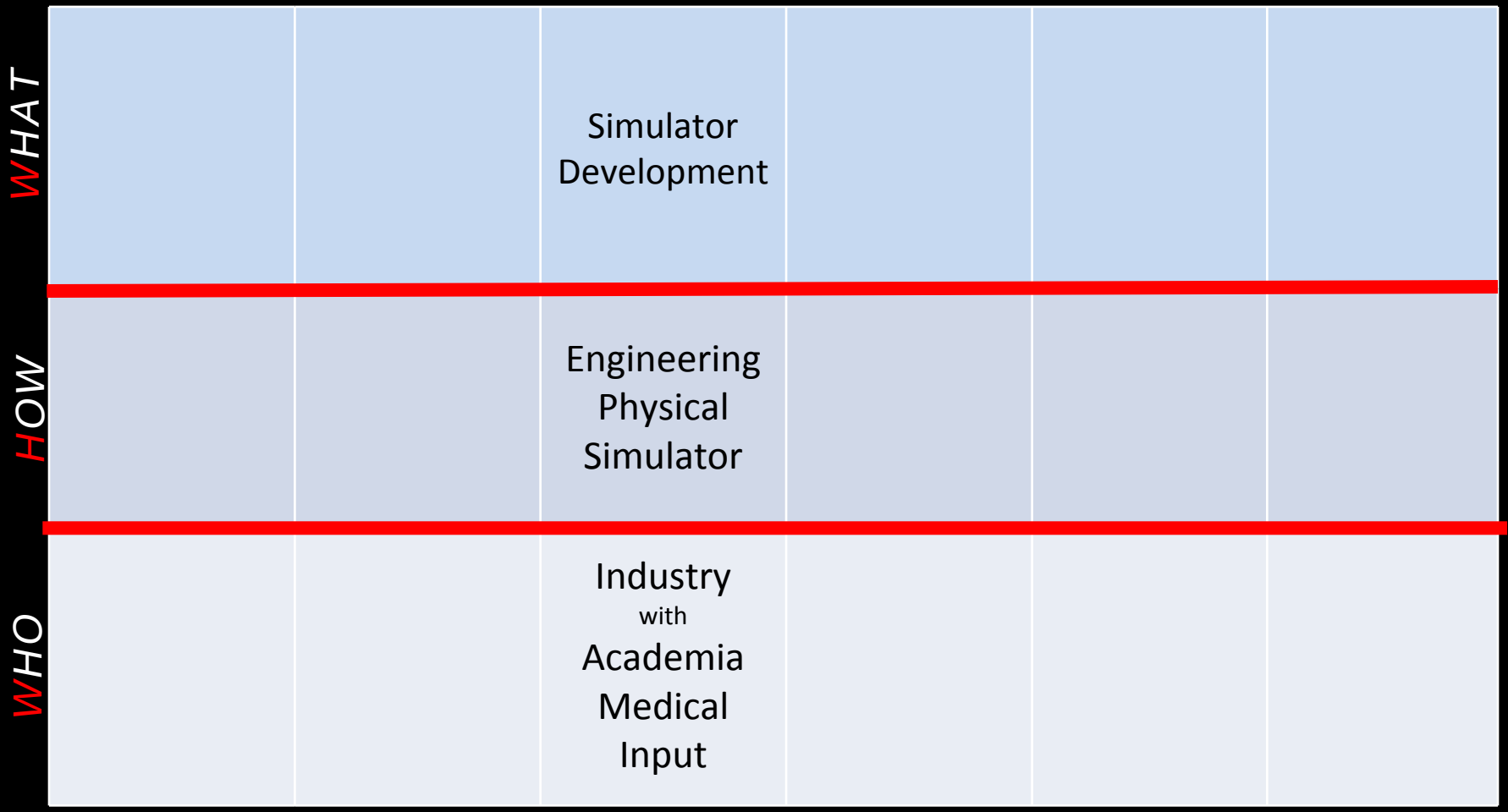
Curriculum Development

Consensus Conference	Develops Outcomes Metrics
Educational Research	Develops Curriculum
Simulator Research	Builds Simulator (to support curriculum)
Validation Research	Proves effectiveness
Training Program	Trains learners (training/retraining)
Testing authority	Certifies training
Certifying authority	Certifies competency (and decides mandates)

What Has Been Learned

Curriculum Development

1987 – 2003 Simulator Phase



What Has Been Learned

Curriculum Development

2003 - 2008 Curriculum Phase

WHAT	Curriculum Development	Simulator Development	Validation Studies		
HOW	Standard Curriculum Template	Engineering Physical Simulator	Standard Validation Template		
WHO	SAGES ACS Societies Academia	Industry with Academia Medical Input	ACS SAGES, Participating Societies		

What Has Been Learned

Curriculum Development

2008 - 2010 High-stakes Testing Phase

WHAT	Curriculum Development	Simulator Development	Validation Studies	High stakes Testing Survey Training Certification	
HOW	Standard Curriculum Template	Engineering Physical Simulator	Standard Validation Template	Current Procedures	
WHO	SAGES ACS Societies Academia	Industry with Academia Medical Input	ACS SAGES, Participating Societies	FLS SAGES/ACS	

The Metrics Drives the Process

Curriculum Development

2010 - ? Certification Phase

Outcomes & Metrics	Curriculum Development	Simulator Development	Validation Studies	Implement: Survey Training Certification	Issue Certification
Consensus Conference	Standard Curriculum Template	Engineering Physical Simulator	Standard Validation Template	Current Procedures	Issue Mandates And Certificates
ABS SAGES ACS Specialty Societies	SAGES ACS Societies Academia	Industry with Academia Medical Input	ACS SAGES, Participating Societies	FLS SAGES/ACS	ABS certifier

Another ~~Concern~~ Opportunity

Maintenance of Certification …

… will be more frequent

Skills Training via Internet

Applying

Objective Metrics

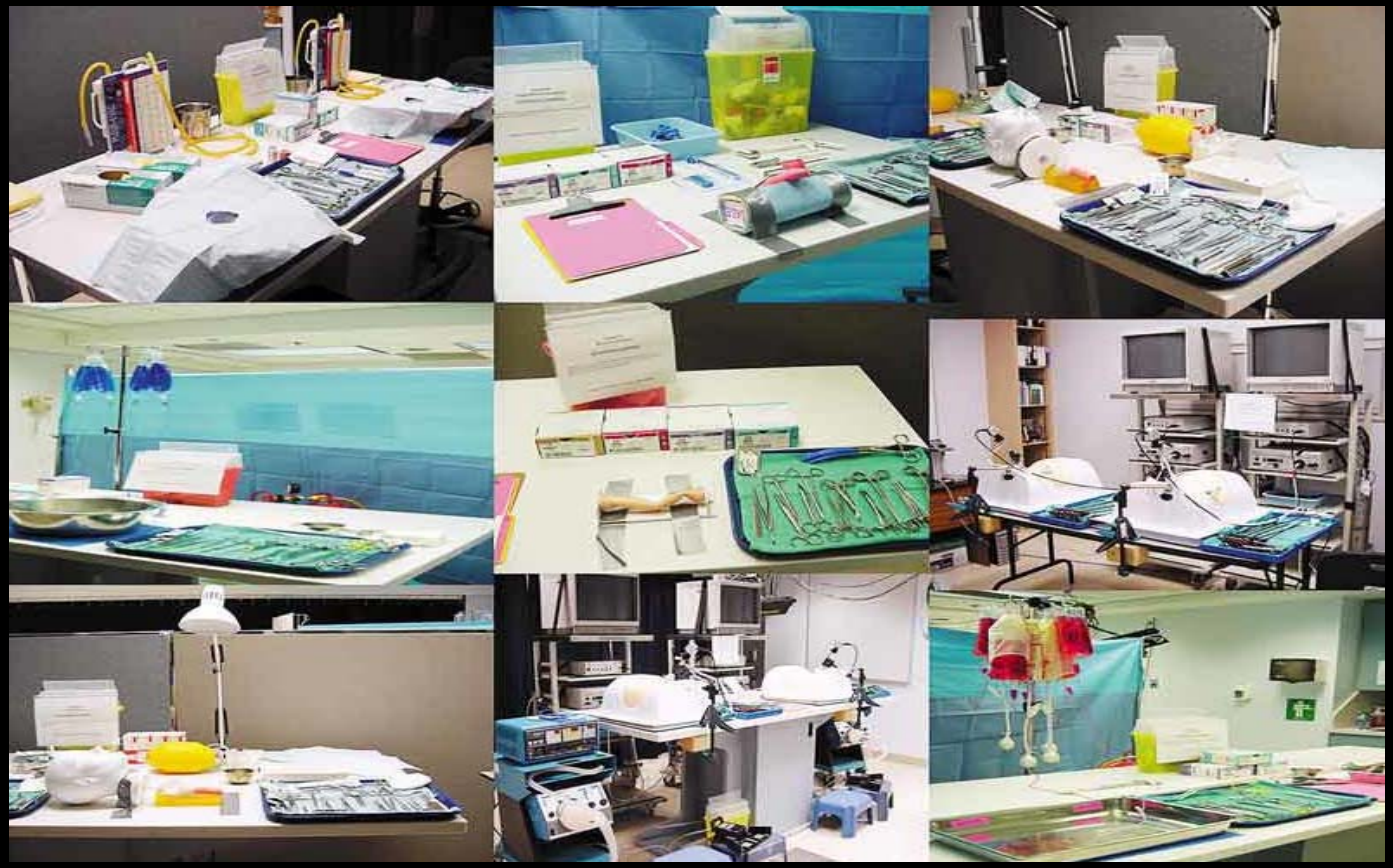
and

Simulation Technology

Methodology

OSATS

Objective Structured Assessment of Technical Skills



Richard Reznick, Univ of Toronto - 1998

Objective Methodology

OSCE

Objective Structured Clinical Exam

Patient Actors

Expert observers

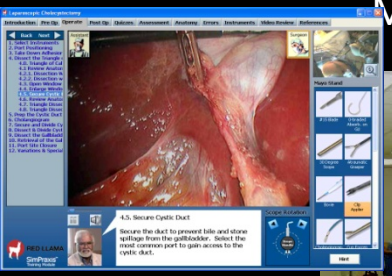
Technology
Current areas of simulation

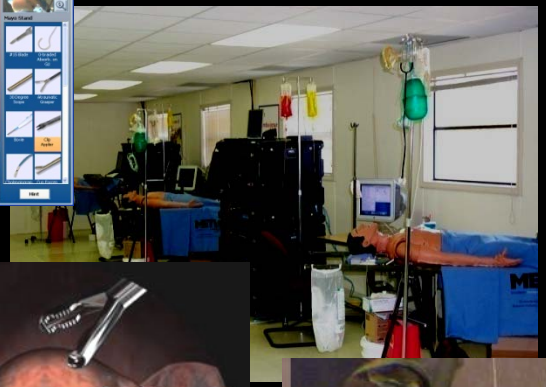
Models, tissue, animals

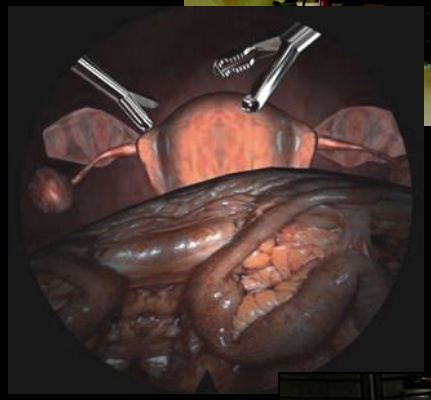
VR

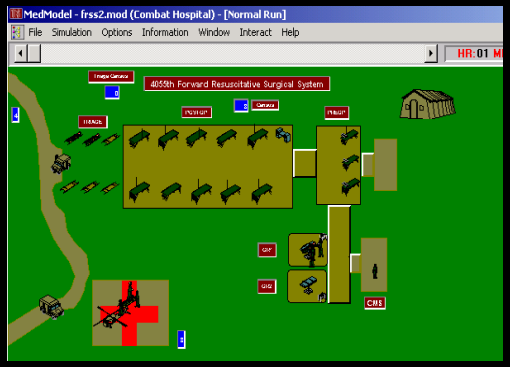
Manikin

CAI







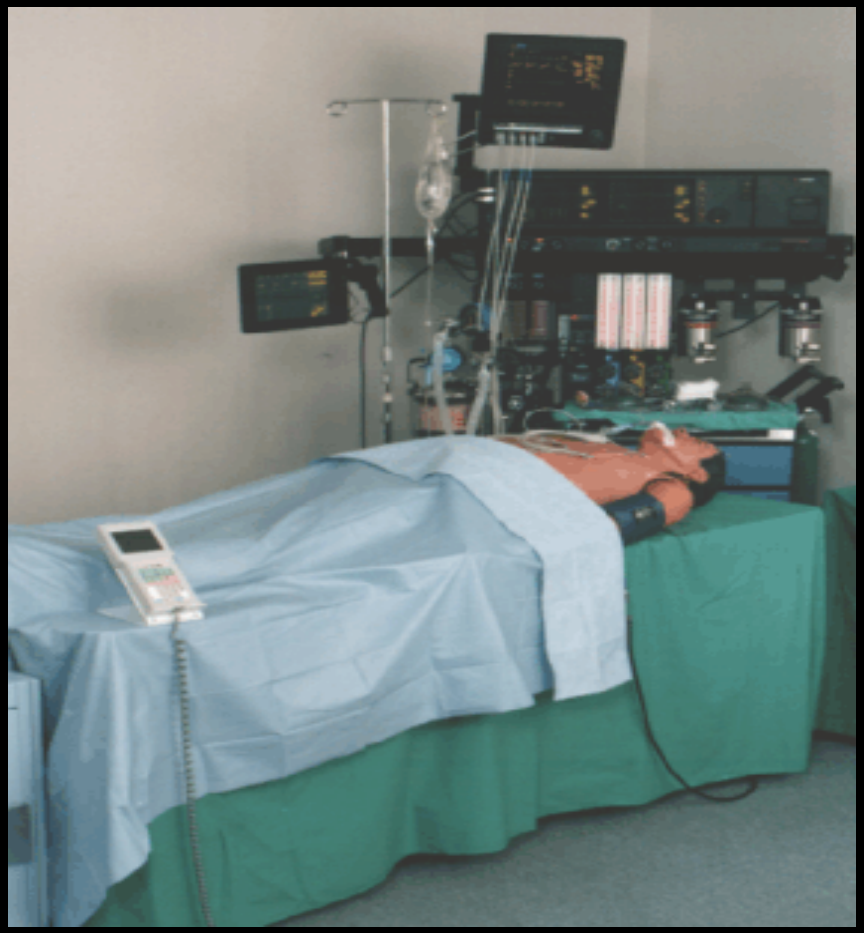


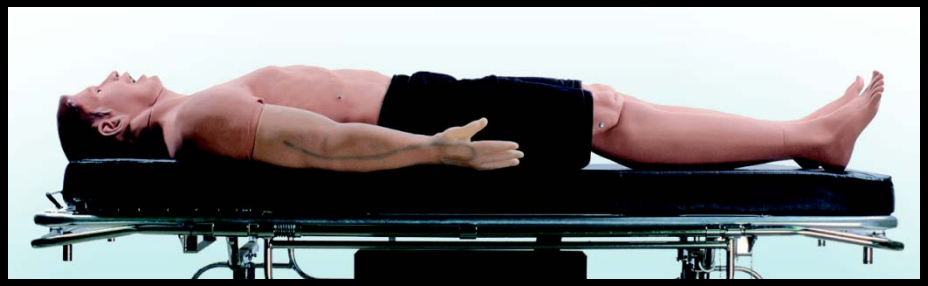
Virtual **Live** **Constructive**

*M*annequin-based *S*imulator

Individual Training and Team Training

Realistic physiologic response





First Mannequin VR Simulator – David Gaba 1984

Courtesy MedSim, Inc - 1991

Human Patient Simulator 2005

Courtesy METI, Inc Sarasota, FL 2006

Team Training

Nurses

Residents

In-situ Care

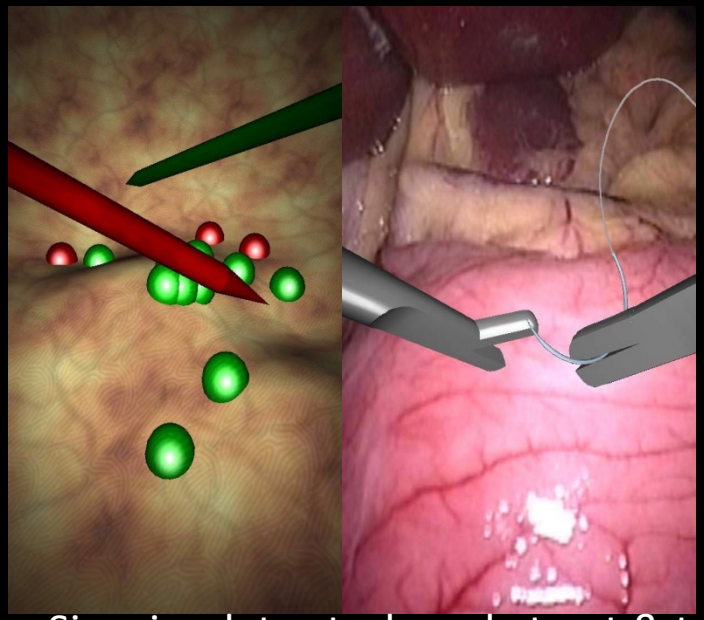
Real Emergency Room

Continuity of Care

ER → Hand-off → OR → Hand-off → ICU

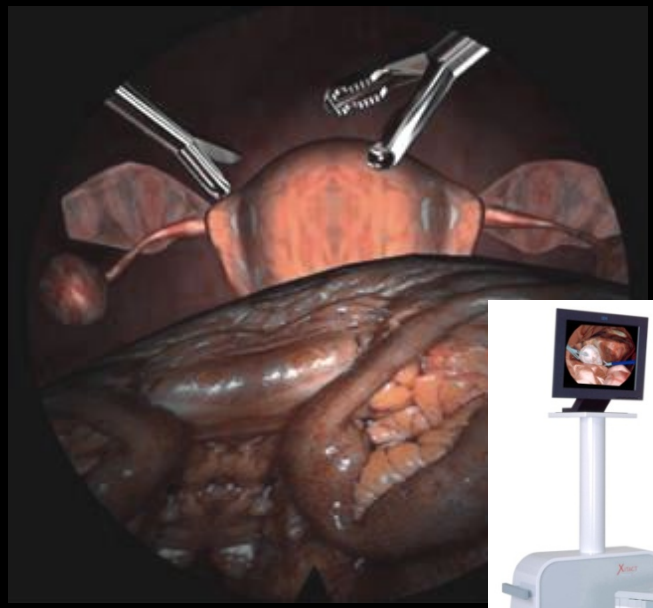
*T*ask and *P*rocedure *S*imulators

Surgical Simulators



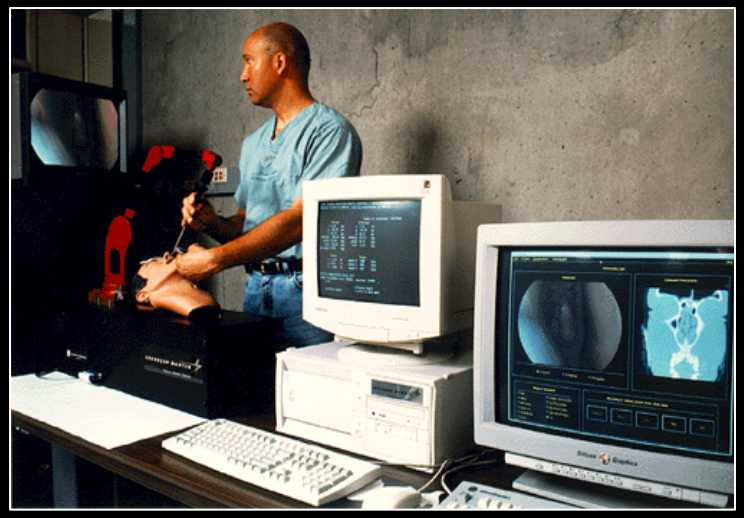
LapSim simulator tasks - abstract & texture mapped
Courtesy Andres Hytland, Sugical Science,
Gothenburg, Sweden, 2000

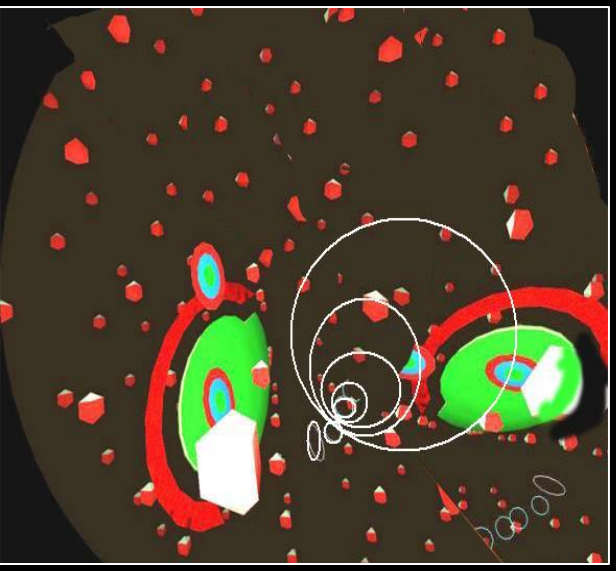
Laparoscopic hysterectomy
Courtesy Michael vanLent, ICT, Los Angeles, CA

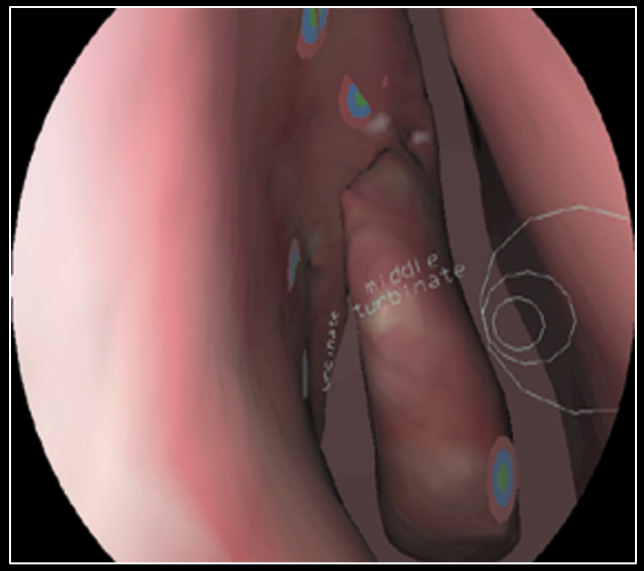


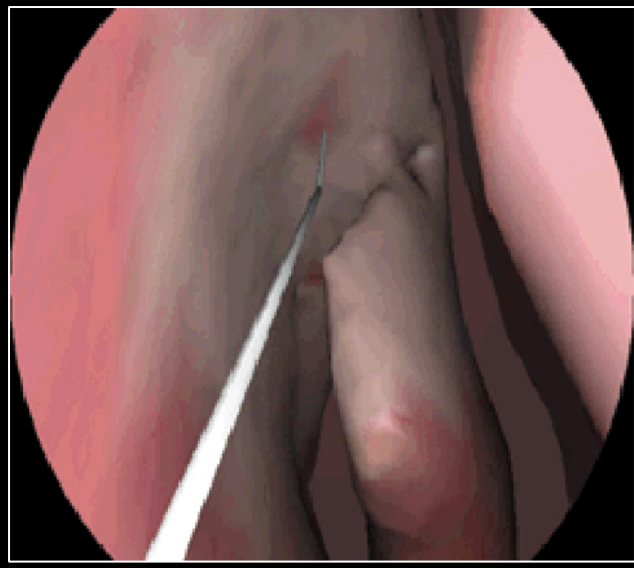
Laparoscopic Simulator with tactile feedback
Courtesy Murielle Launay, **Xitact**, Lausanne Switzerland

Fully Integrated Curriculum









ENT Sinusoscopy Simulator

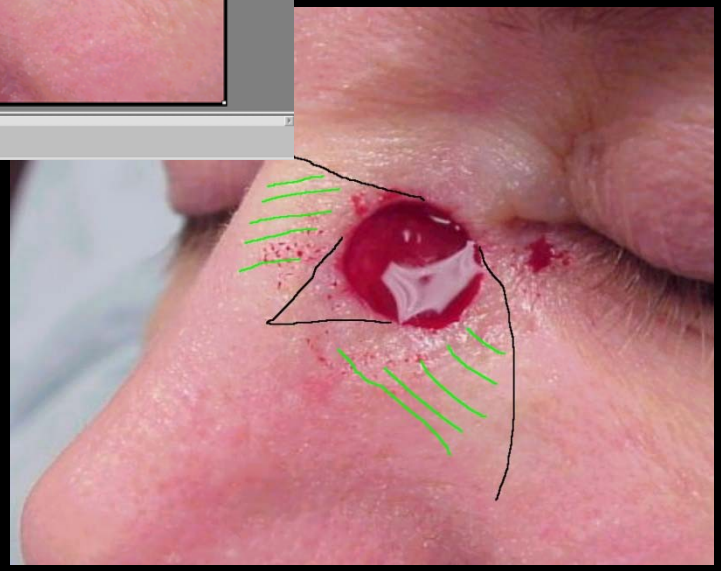
Lockheed Martin 1999

Technology
Current advances in simulation

Courtesy Donald Stredney PhD, Ohio State University, 2008

Pre-operative Planning
Surgical Rehearsal
Simulators

Computer-based
wound planning



Virtual Reality Suturing Simulator

Courtesy Daniel Berg,MD, Suzanne Weghorst and Peter Oppenheimer, HIT Lab, U Washington, 2005

Future Directions

What is new in Technology?

Skills Laboratory

Virtual Patients

OSCE

Patient Actors

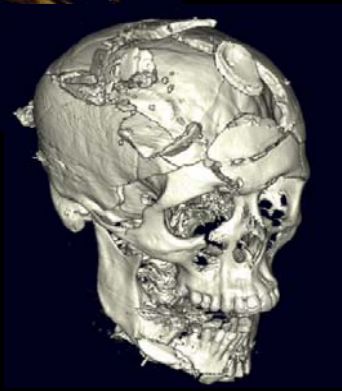
Future

Virtual Patients

Includes HSBC

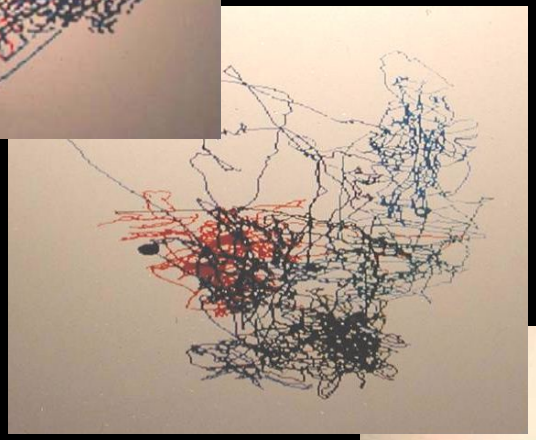
Courtesy John Textor, Digital Domain, 2009

Virtual Cadaver

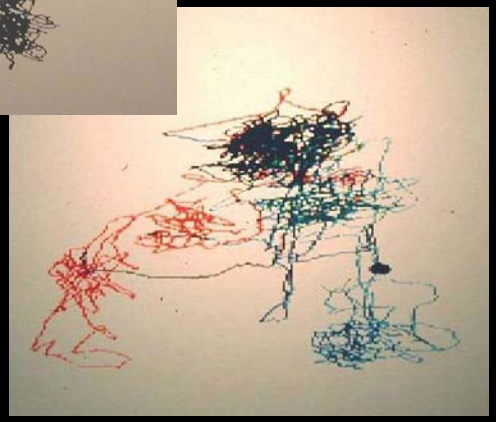


Quantitative Measures

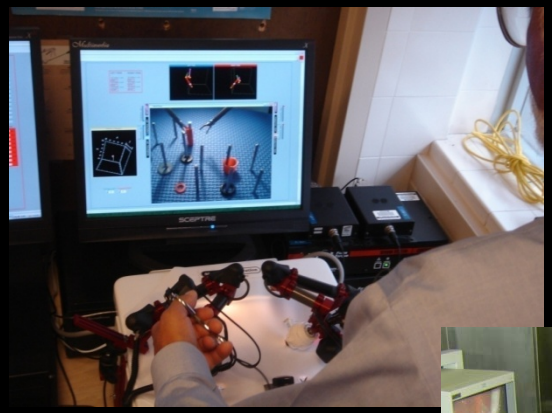
Novice



Intermediate

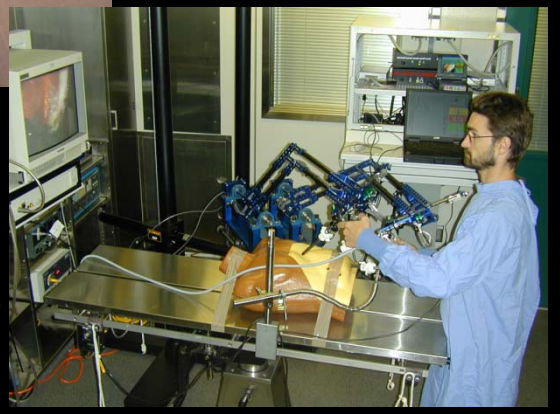


Expert



"Red Dragon"

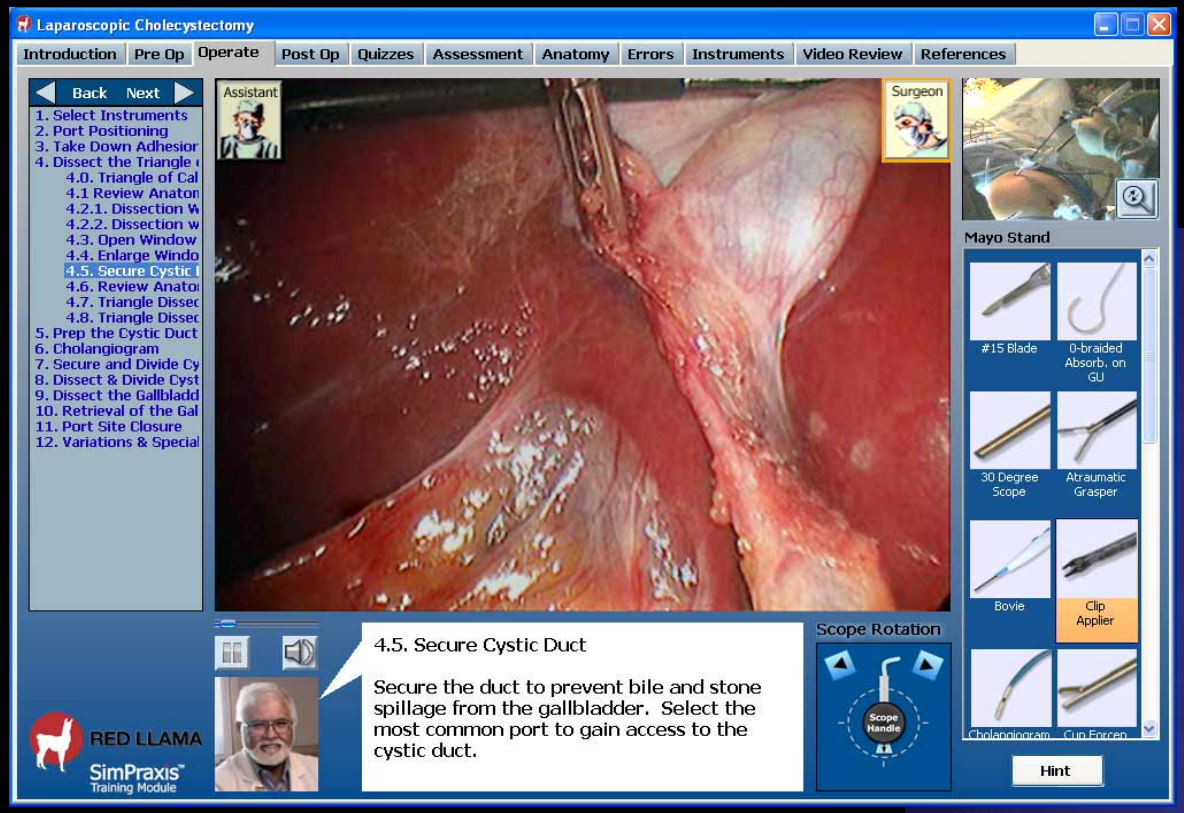
Passive recording devices



"Blue Dragon"

Courtesy Blake Hannaford, PhD, University of Washington, Seattle

Cognitive vs Psychomotor



Cognitive vs Psychomotor

Inferring Judgment

Can we understand what you are thinking?

Ara Darzi, Imperial College, London, 2005

Simulation in Social Networking

My Space

You Tube

Multi-user video games

Second Life

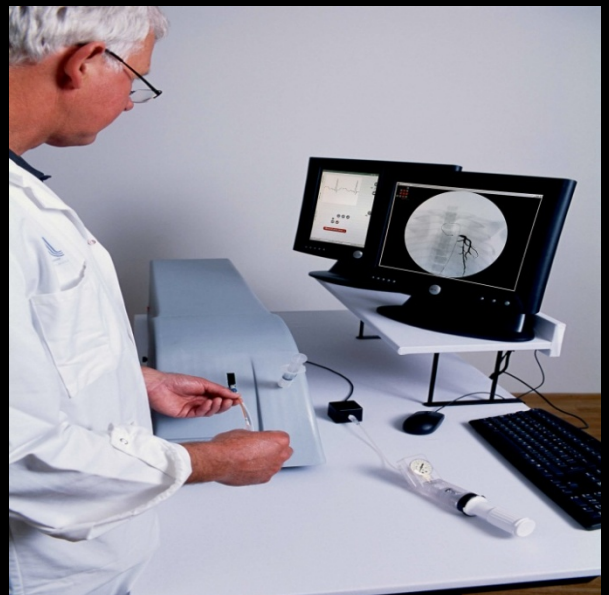
Second Life

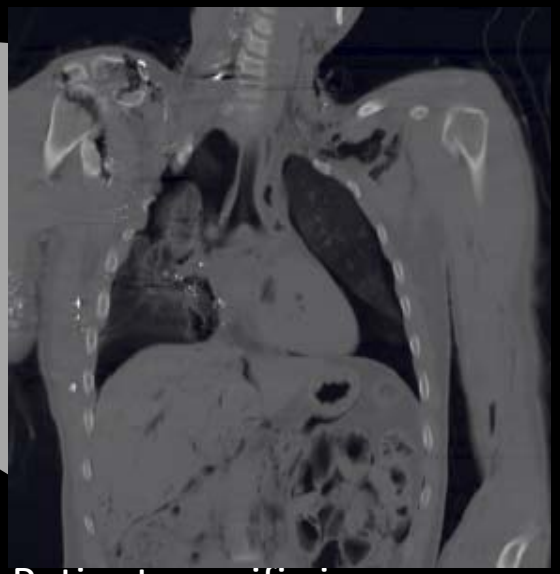
ISIS
Institute for Surgical & Interventional Simulation
University of Washington
Medipelago Visitor
Bio Kidd
ISIS

nmc

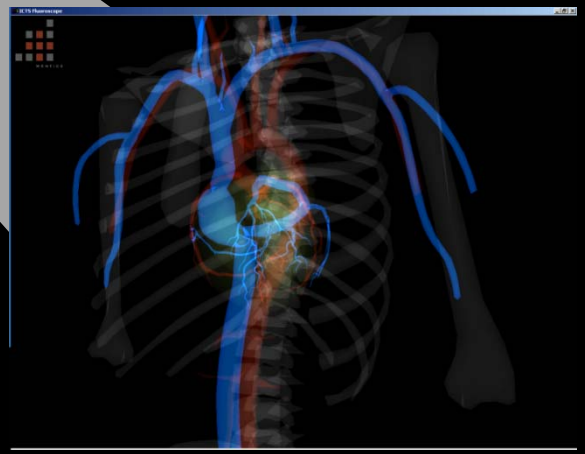
Clinical Application

Surgical Rehearsal
Endovascular Simulators





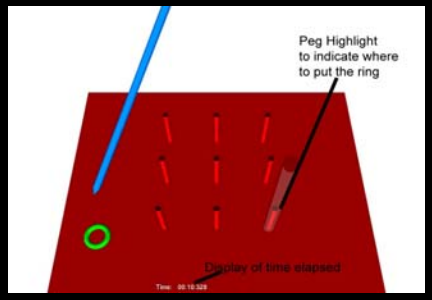
Patient specific image

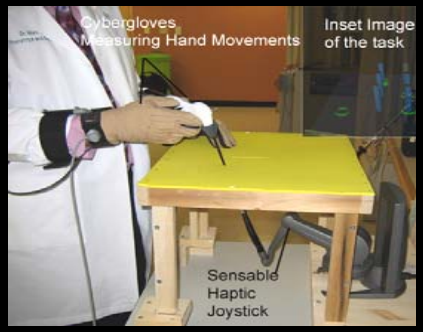


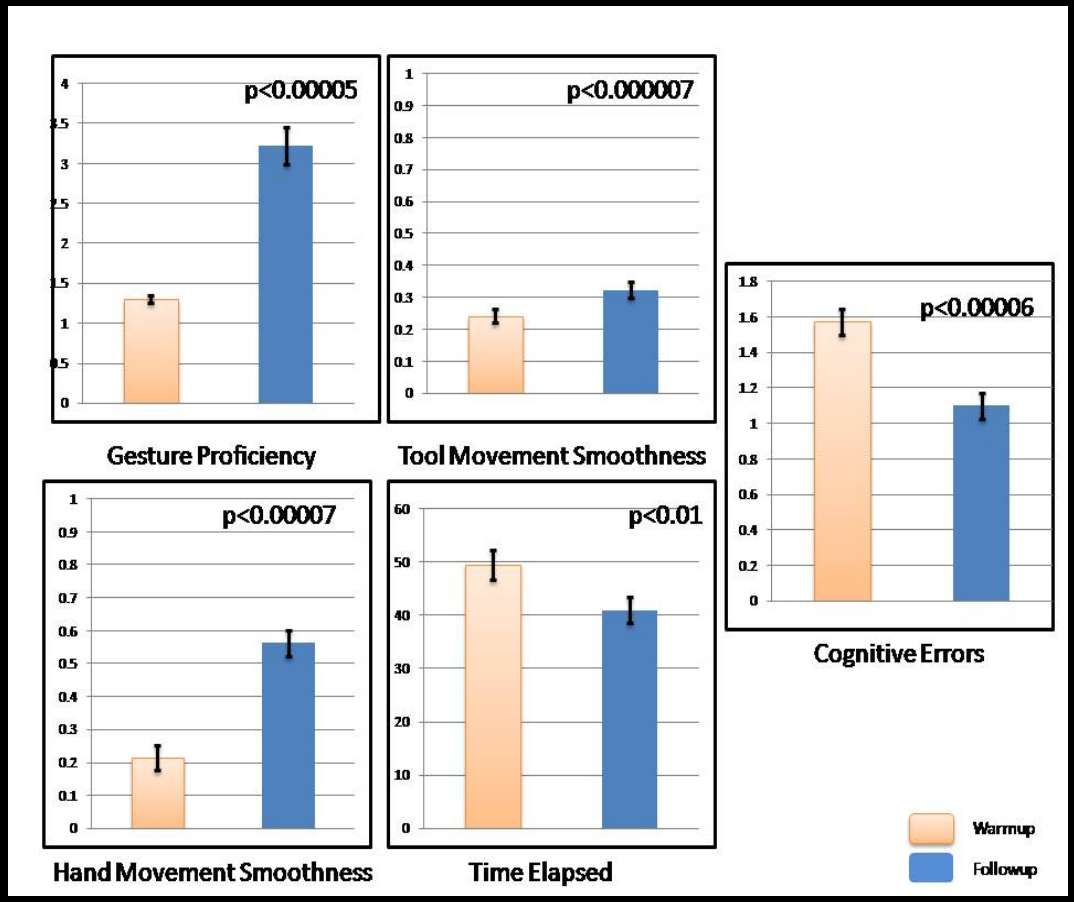
Graphic overlay

Pre-operative Warm-up

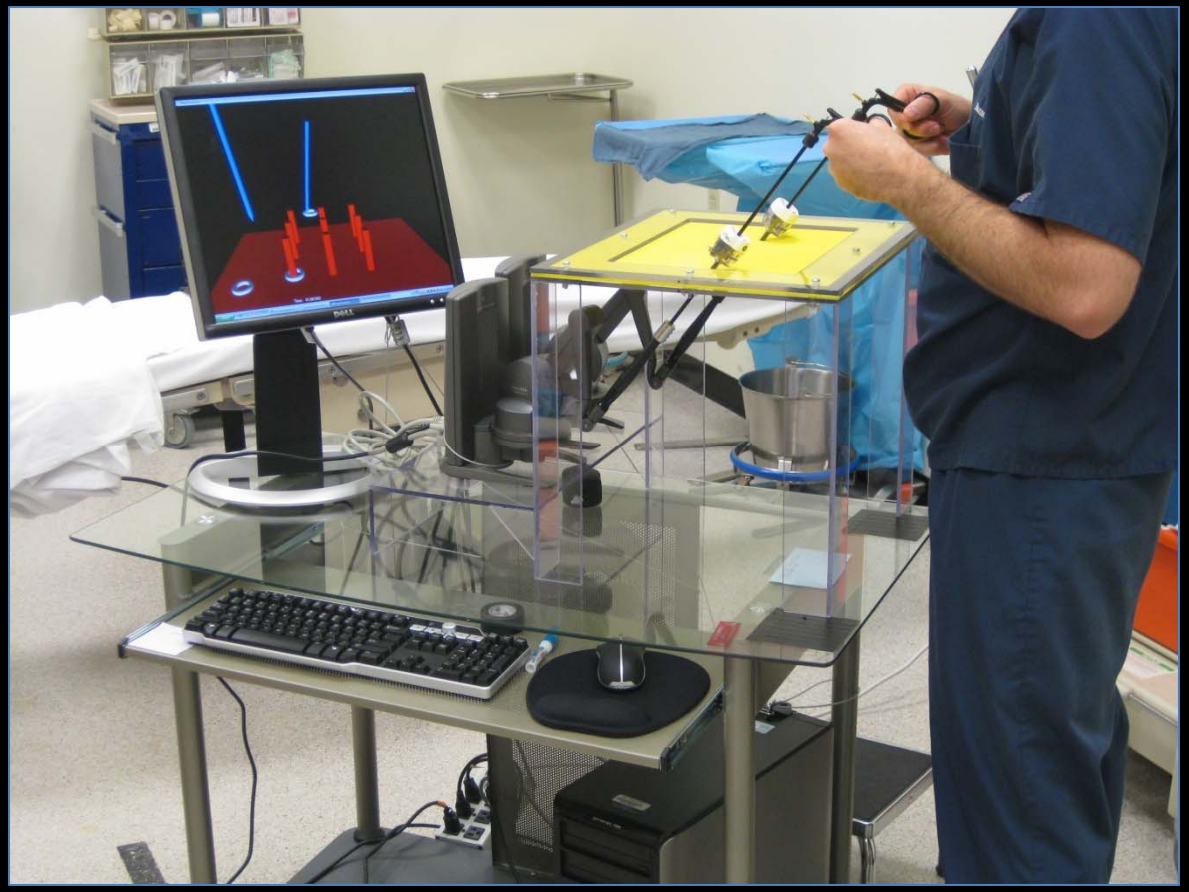
Portable Simulator rolled into OR.





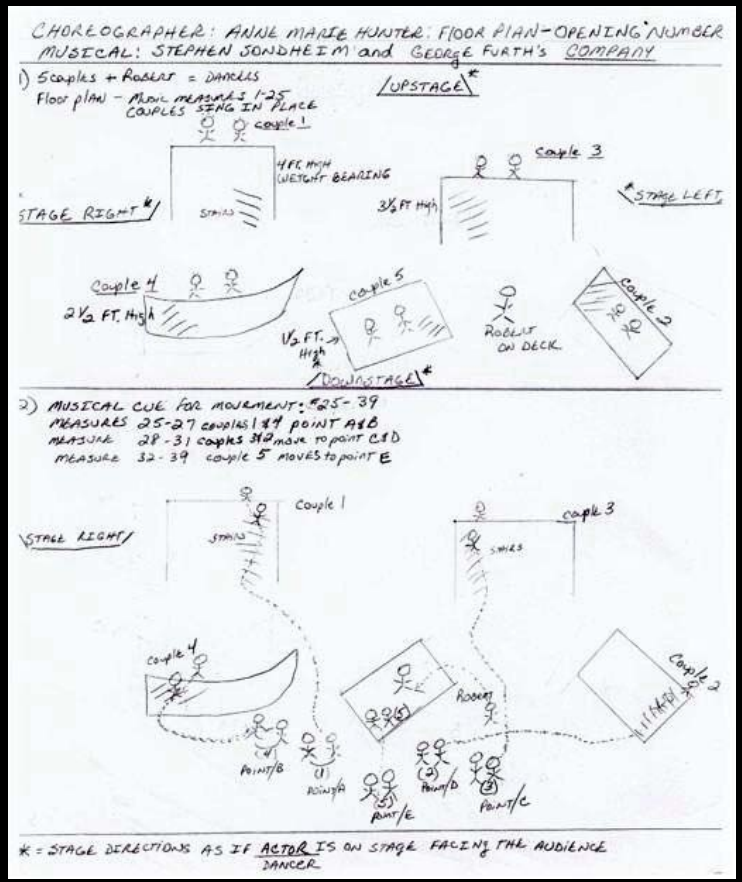


Pre-operative Warm-up

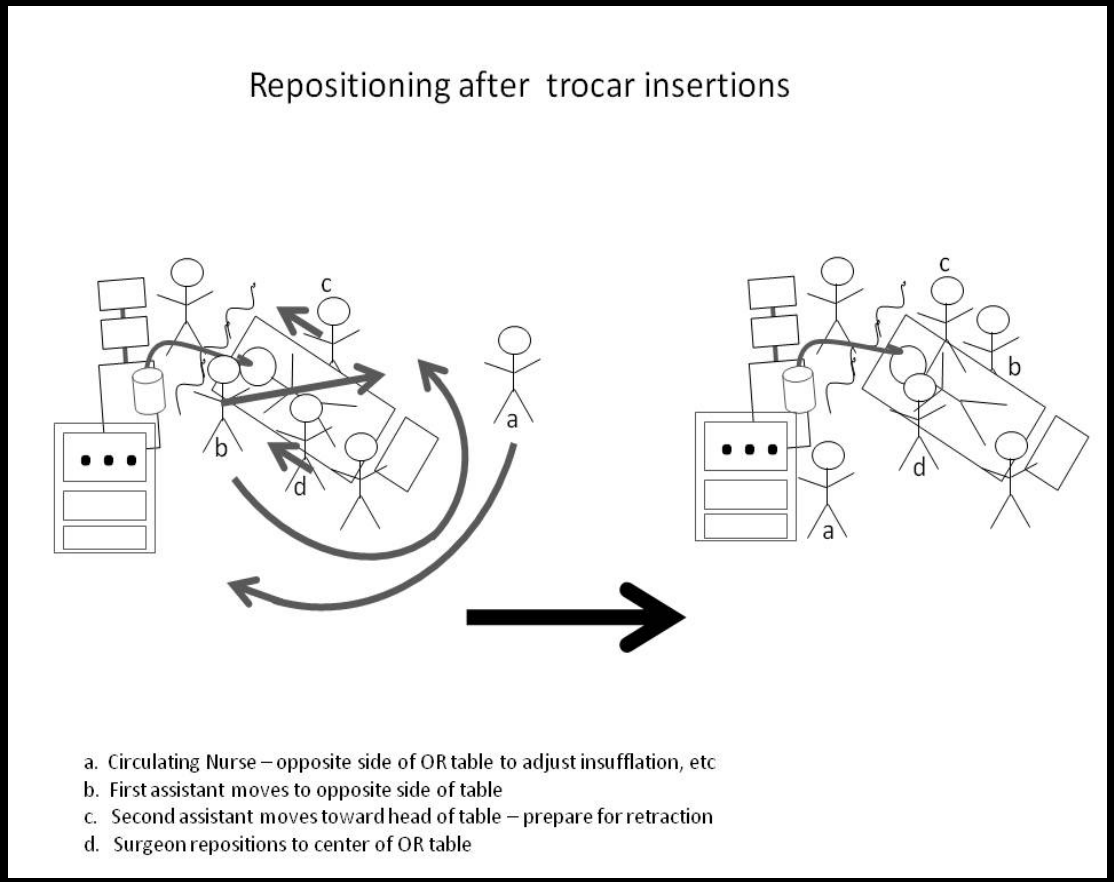


Portable Simulator rolled into the OR.

Choreography

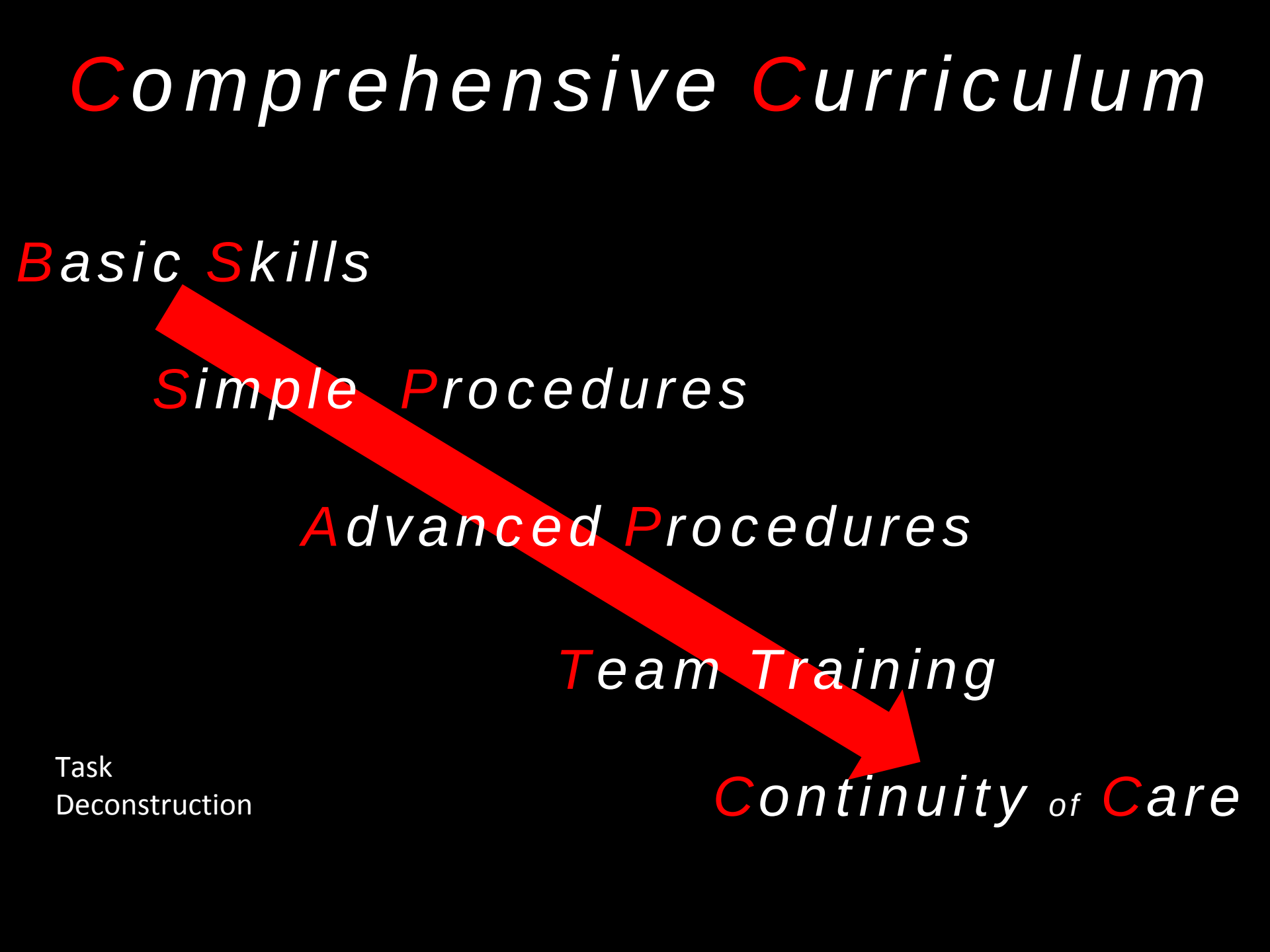


From the Musical "Company"
Courtesy Anne Marie Hunter, BFA 2010



Notional diagram of choreography for Laparoscopic Cholecystectomy
Courtesy Richard Satava, MD FACS, 2010

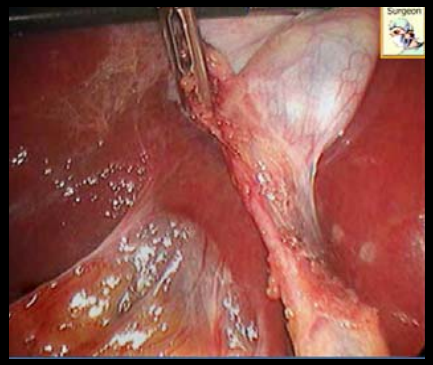
Comprehensive Curriculum

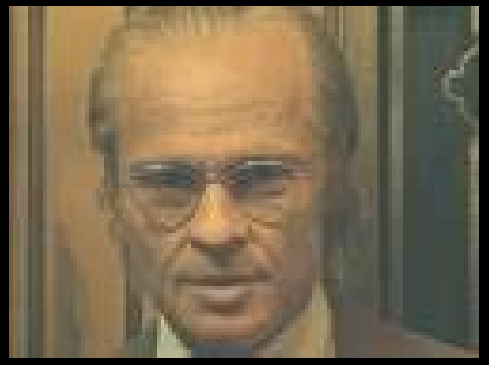


Meeting Legal Requirements

and Fiscal

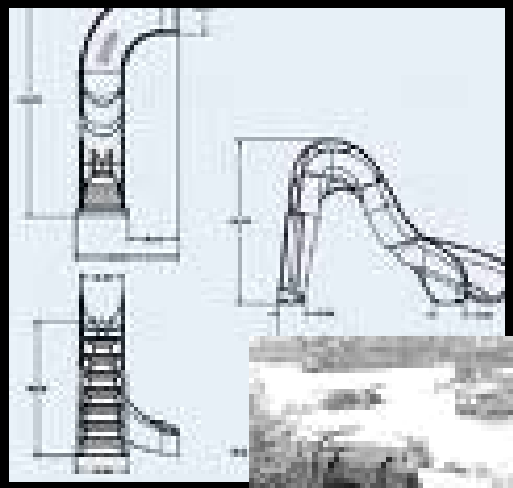
Animal, cadaver & actor replacements





The Scientific Method

... make evidence-based decisions



Hypothesis

Design

Experiment

Results

Report

In Science and Discovery,
there is always Risk . . .

Be careful of unintended consequences

Experience is the name everyone gives to their mistakes - Oscar Wilde

The only thing more dangerous
than trying too hard and failing …
… is not trying hard enough

and succeeding ! Michelangelo 1503