

# FUTURE

# **M**odeling and **S**imulation in **H**ealthcare **F**uture **D**irections

*MOVES Institute Research Summit*  
Naval Postgraduate School  
Monterey, Ca  
13 July, 2010

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and



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| Report Documentation Page                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                    |                                     |                                                                  | Form Approved<br>OMB No. 0704-0188                  |                                    |
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# Simulation

## Definition

(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.

# Simulation

## Definition

(Proposed)

Representation of

‘real world’ objects, processes and ideas

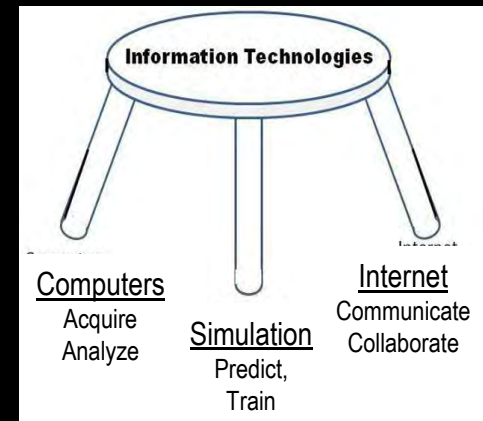
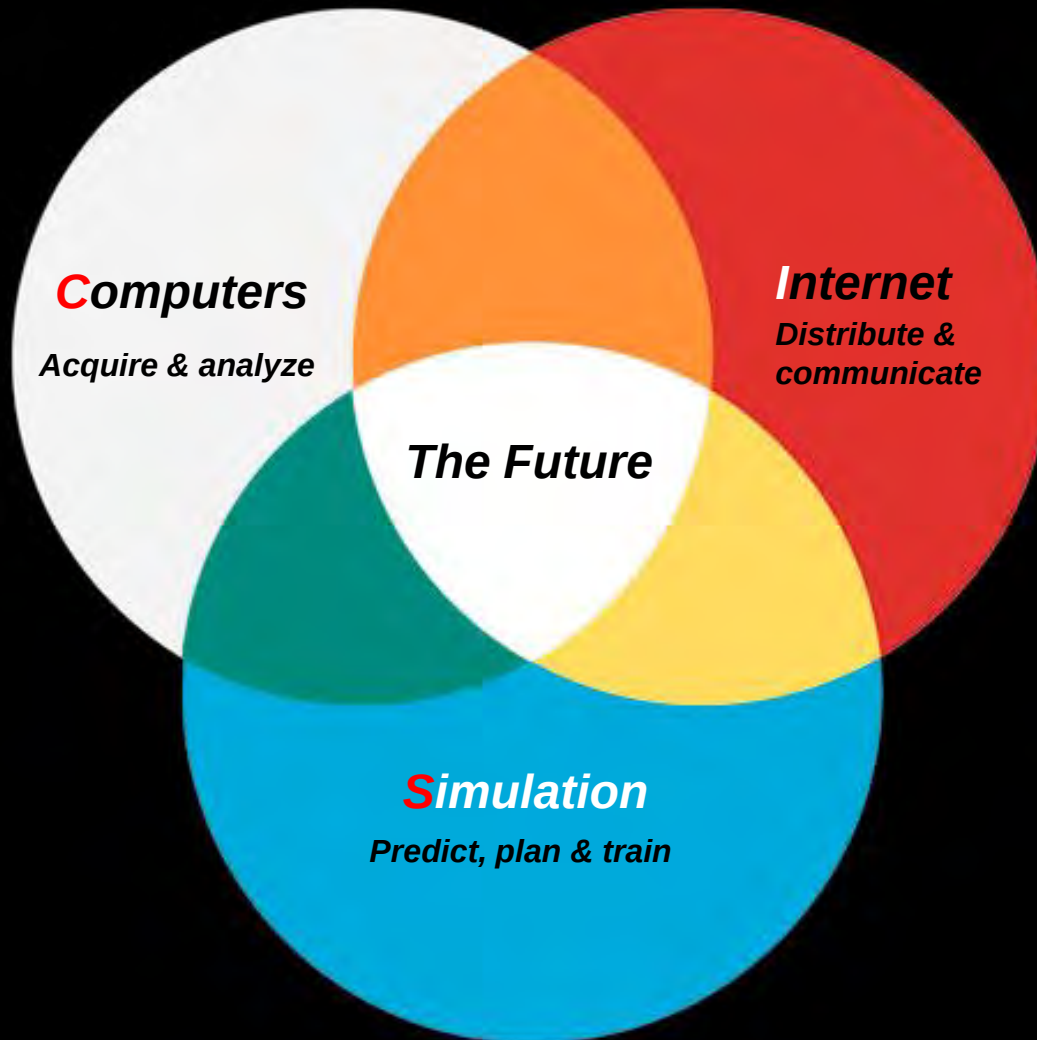
by an

‘intangible world’ of information

all have equal “weight” in the information world

# Simulation

## Third Leg of the Information Age



# **The Scientific Method is Dead**

**Evidence Based Medicine is . . .**

**The Scientific Method as  
Applied to Medicine**

**The Evidence IS the Science**

In order to accept evidence-based medicine

. . . we must accept the current method in Science

# Scientific Method . . .

. . . is **DEAD?**

Not necessarily but . . .

Not all science is explainable using the scientific method

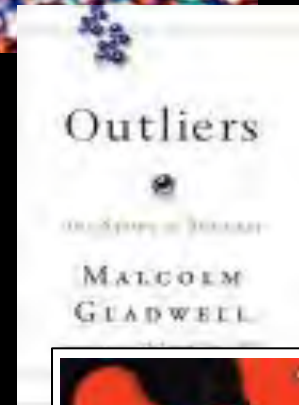
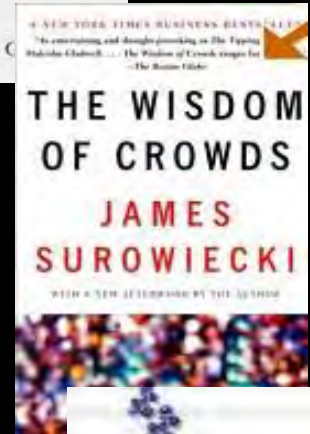
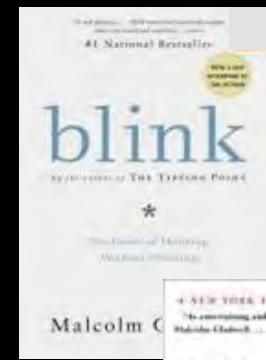
|                      |             |             |
|----------------------|-------------|-------------|
| Where is the role of | Imagination | Intuition   |
|                      | Innovation  | Creativity  |
|                      | Serendipity | Inspiration |

**FURTHER PROOF:** Current evidence is inadequate for

|                   |           |        |
|-------------------|-----------|--------|
| Event horizons    | Cognition | Genome |
| Quantum mechanics | Memes     | Etc    |

New discoveries evolve from

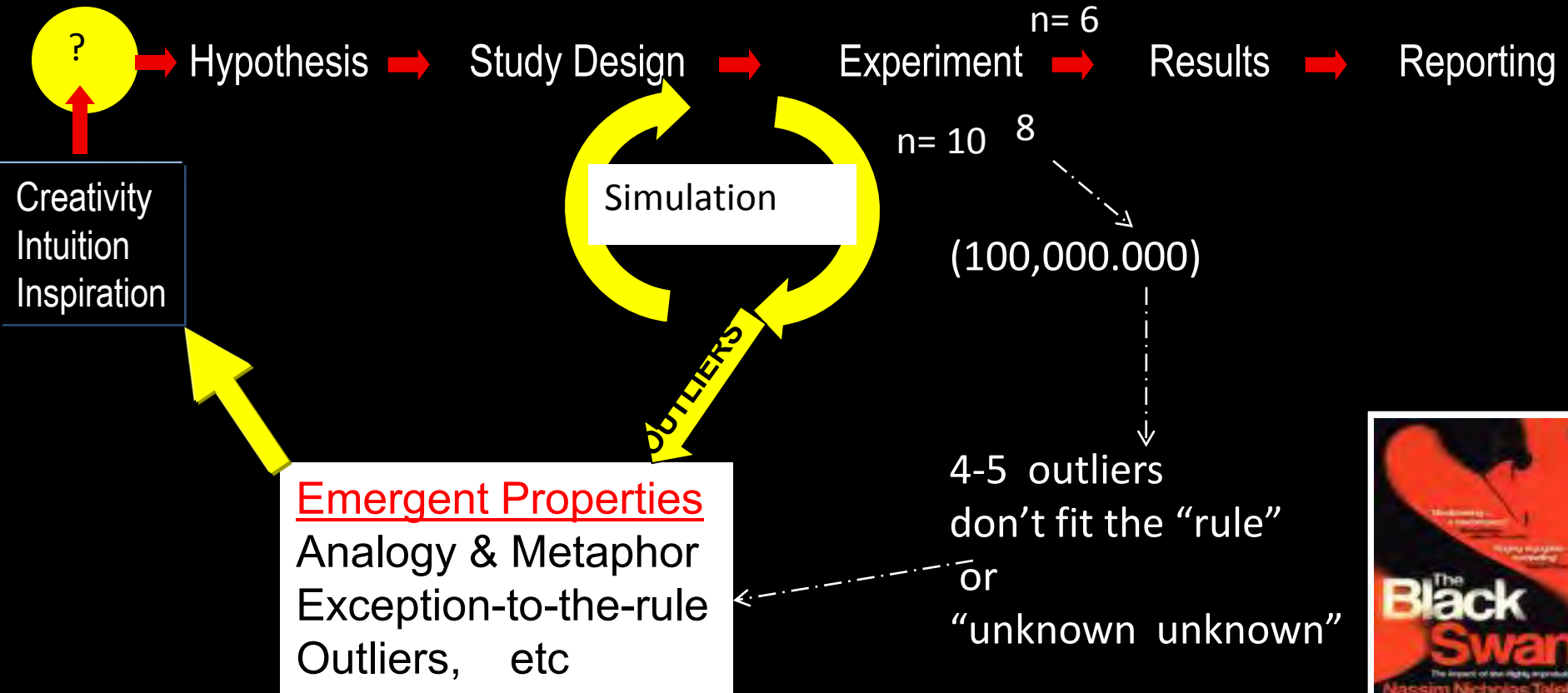
**Emergent Properties**



# How has the Scientific Method changed ?

Hypothesis → Study Design → Experiment <sup>n=8</sup> → Results → Reporting

Simulation



# **M**odeling and **S**imulation **H**ealthcare **A**pplications

1. Education and training (technical and cognitive skills, distributed learning)
2. Healthcare systems (processes and optimization)
3. Fiscal responsibility (financial planning)
4. Clinical practice (procedural planning, surgical rehearsal, warm-up)
5. Patient administration (Quality improvement and patient safety)
6. Hospital network integration (System of Systems Engineering - SoSE)

# Healthcare Education

## New Information Age Principles

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)
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)**

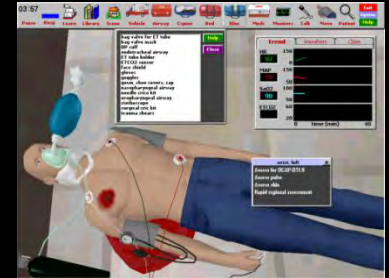
# Paradigm Shift

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
  - Criterion-based tools
  - Objective metrics

# Skills Training

## The New Mandates

Effective

1 July 2008  
RRC\*

All residency programs must have  
a skills training (simulation) center

1 July 2009  
ABS

All surgical residents must pass FLS\*\*  
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)

Redeployment (military)

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

# Standardized Curriculum

Suggested template

- 
- Goals of the Curriculum  
(include consensus on metrics and initial instructions)
  - Anatomy or Tasks (if basic skills)
  - Steps of the Procedures or skills tasks
  - **Errors** (define and describe how to avoid)

## TEST

- Skills Training (on simulator, to benchmark metrics)
- Outcomes assessment\* (and results reporting)

\* After validation by experts who take the curriculum and finish the Outcomes Assessment, the experts' mean scores become the Benchmark metrics

# 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

# 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

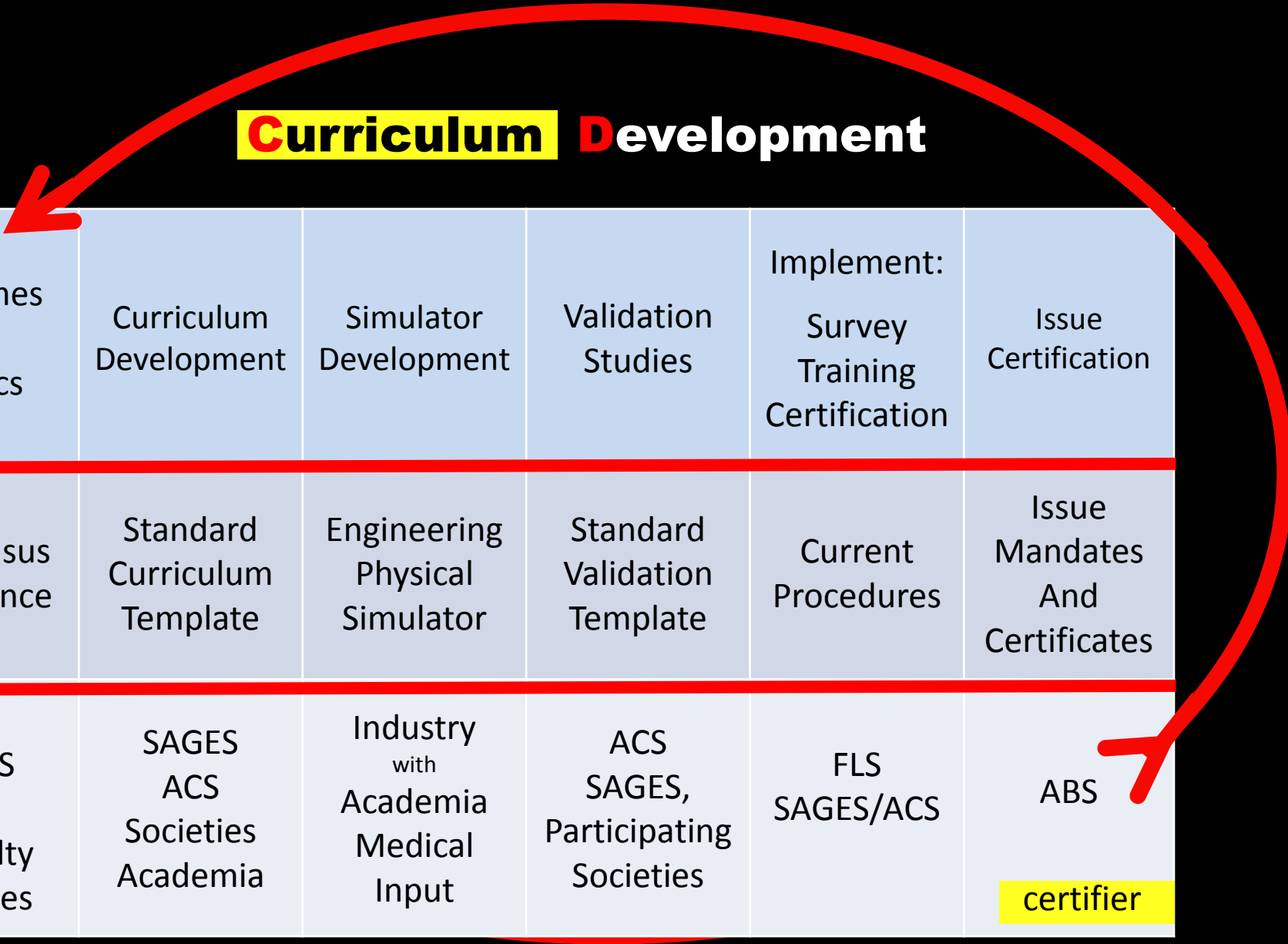
Certifies training

Certifying authority

Certifies competency (and decides mandates)

# The Metrics Drives the Process

## Curriculum Development



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

# **A**nother **C**oncern

**o**ppportunity

Maintenance of Certification ...

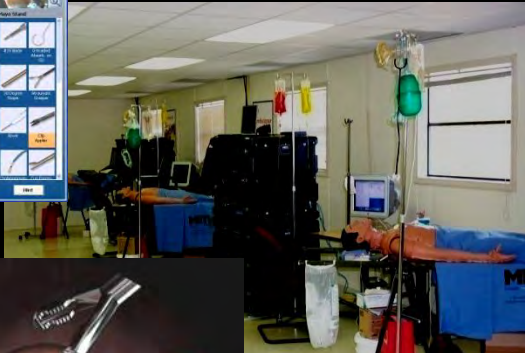
... will be more frequent

**S**kills **T**raining via **I**nternet

# Technology

## Current areas of simulation

Models, tissue, animals



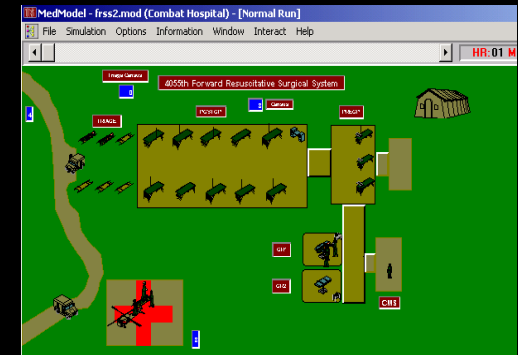
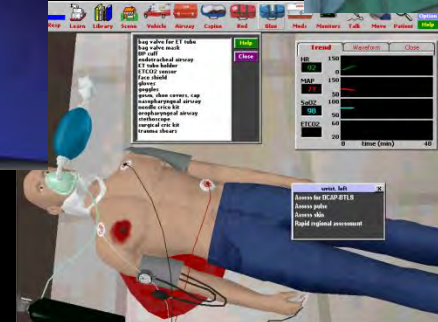
VR



Manikin



CAI



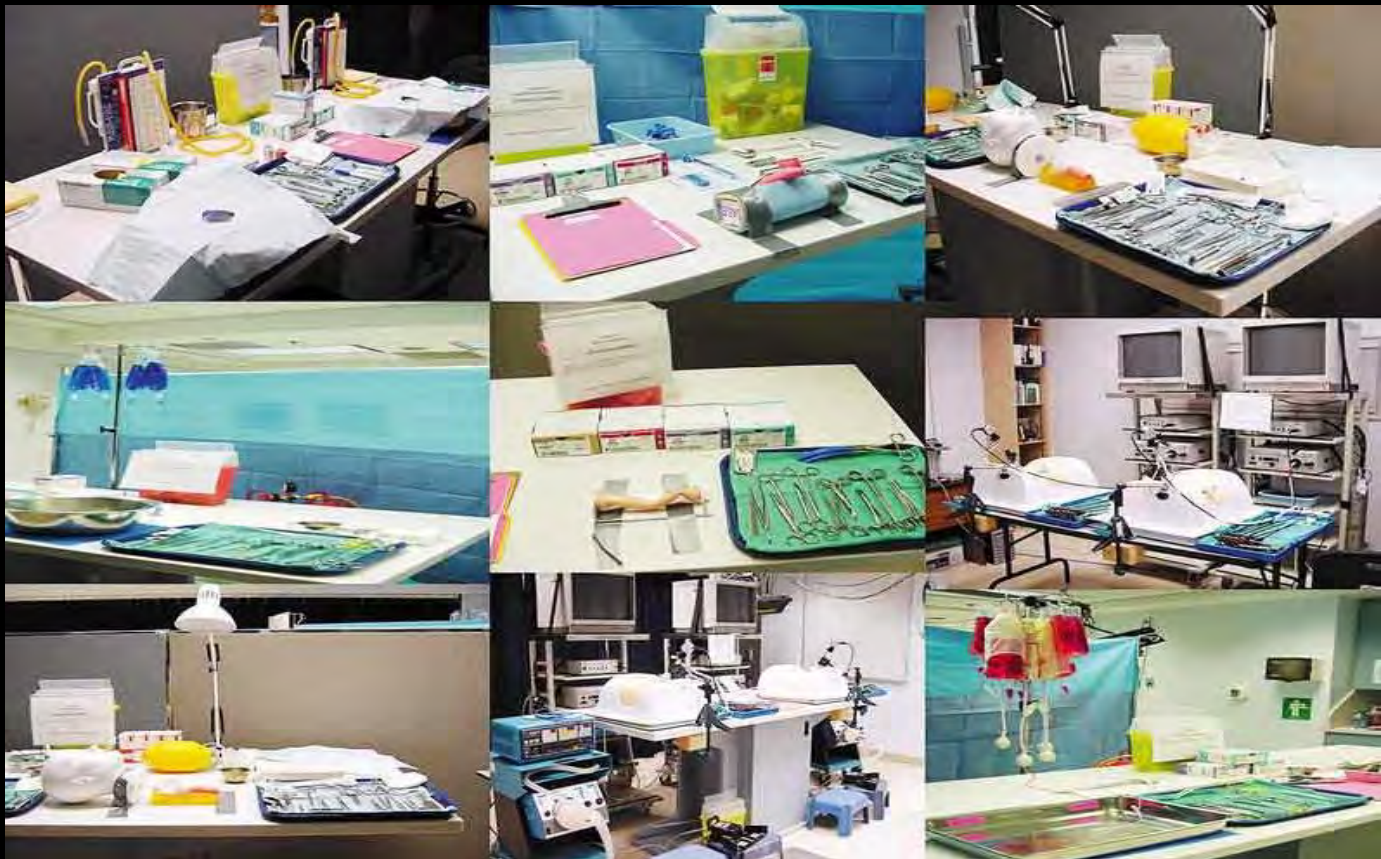
Virtual

Live

Constructive

# OSATS Methodology

**Objective Structured Assessment of Technical Skills**



# Team Training



**Nurses**



**Residents**



# In-situ Care



Real Emergency Room

# Continuity of Care



**ER**

Hand-off



**OR**

Hand-off



**ICU**

**Future**

**Directions**

A close-up photograph of an ostrich's face, showing its large, grey, textured beak and its large, brown eyes with dark pupils. The ostrich has dark, spiky feathers on its head and neck. In the background, there is a grassy field and a body of water under a bright sky. A speech bubble is positioned in the upper right corner of the image.

**What is new in  
Technology?**

**S**kills

**L**aboratory

# OSCE



**Patient Actors**



**Virtual Patients**



# Virtual Cadaver



# Hand-off:

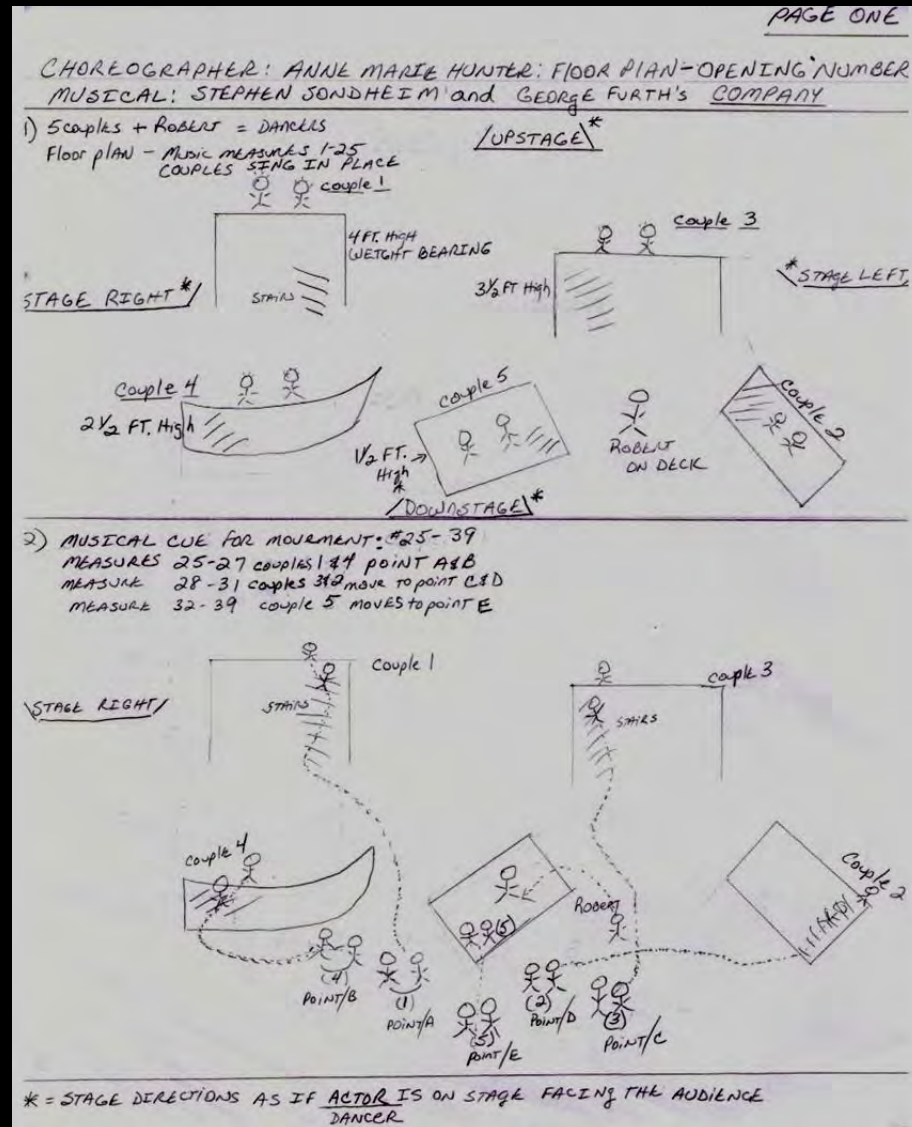
# Virtual Hospital Continuity Care

Combat Trauma Training  
Chain of Evacuation - (MSTC)  
Madigan Army Hospital, Ft. Lewis, WA

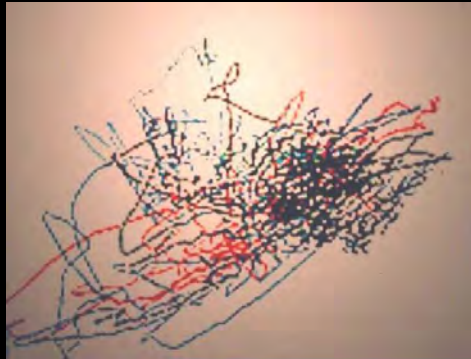
Civilian Hospital Training  
Chain of Safety - Riverside Sim Center  
Columbus Ohio



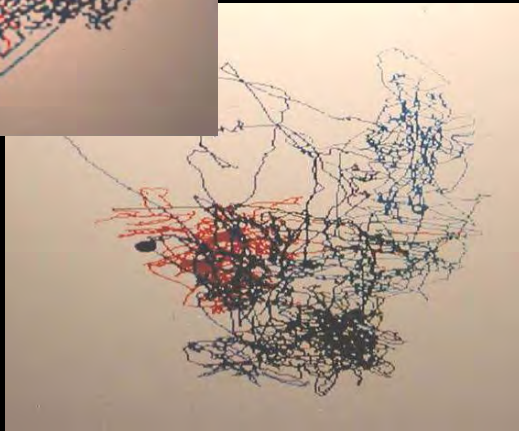
# Choreography



# Quantitative Measures



Novice



Intermediate



Expert



"Red Dragon"

Passive  
recording  
devices



"Blue Dragon"

# Cognitive vs Psychomotor

**Laparoscopic Cholecystectomy**

Introduction Pre Op Operate Post Op Quizzes Assessment Anatomy Errors Instruments Video Review References

Back Next

1. Select Instruments
2. Port Positioning
3. Take Down Adhesior
4. Dissect the Triangle of Cal
  - 4.0. Triangle of Cal
  - 4.1 Review Anaton
  - 4.2.1. Dissection W
  - 4.2.2. Dissection w
  - 4.3. Open Window
  - 4.4. Enlarge Windo
  - 4.5. Secure Cystic I
  - 4.6. Review Anato
  - 4.7. Triangle Dissec
  - 4.8. Triangle Dissec
5. Prep the Cystic Duct
6. Cholangiogram
7. Secure and Divide Cy
8. Dissect & Divide Cyst
9. Dissect the Gallbladd
10. Retrieval of the Gal
11. Port Site Closure
12. Variations & Special

Assistant

Surgeon

Mayo Stand

- #15 Blade
- 0-braided Absorb. on GU
- 30 Degree Scope
- Atraumatic Grasper
- Bovie
- Clip Applier
- Cholangiogram
- Clin. Forcen

Scope Rotation

4.5. Secure Cystic Duct

Secure the duct to prevent bile and stone spillage from the gallbladder. Select the most common port to gain access to the cystic duct.

RED LLAMA SimPraxis Training Module

Hint



# Cognitive vs Psychomotor Inferring Judgment



Can we understand what you are thinking?

# **Simulation in Social Networking**

**My Space**

**You Tube**

**Multi-user video games**

**Second Life**



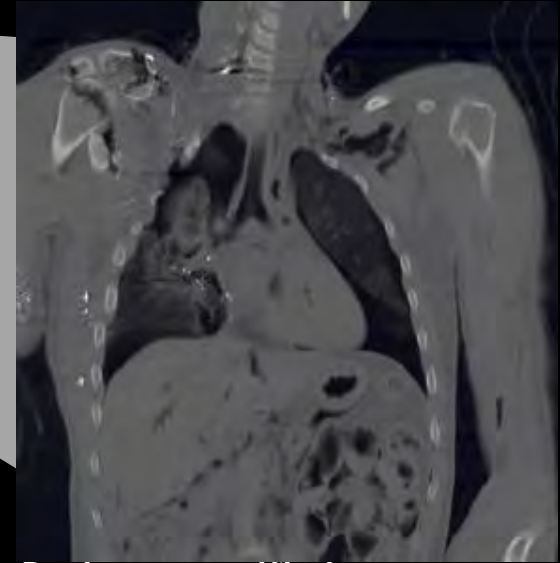
# Second Life



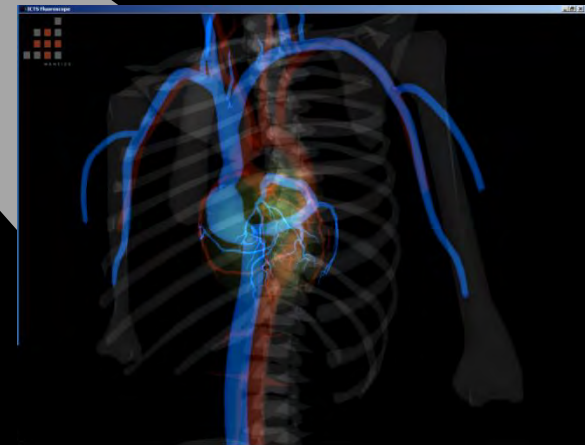
**C**linical

**A**pplication

# Surgical Rehearsal Endovascular Simulators

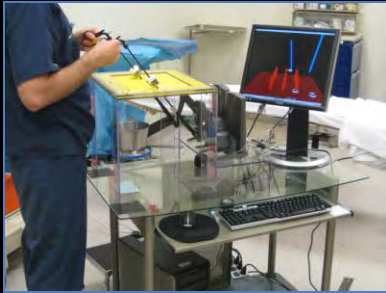


Patient specific image

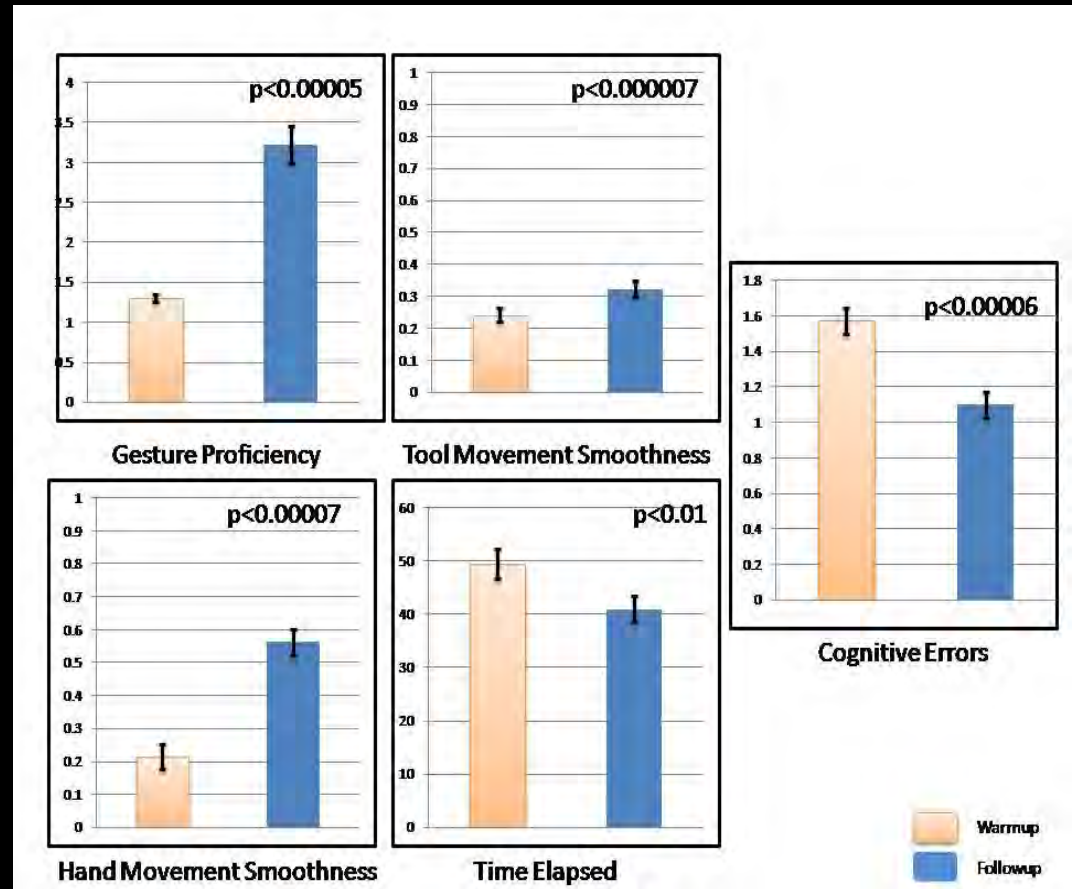
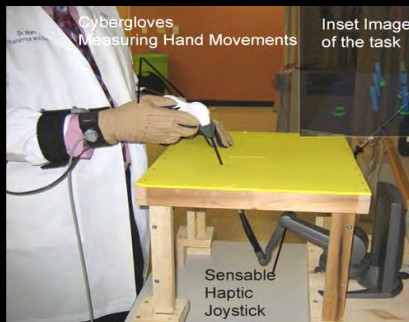
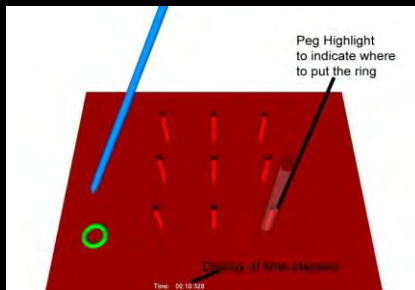


Graphic overlay

# Pre-operative Warm-up



Portable Simulator rolled into OR.

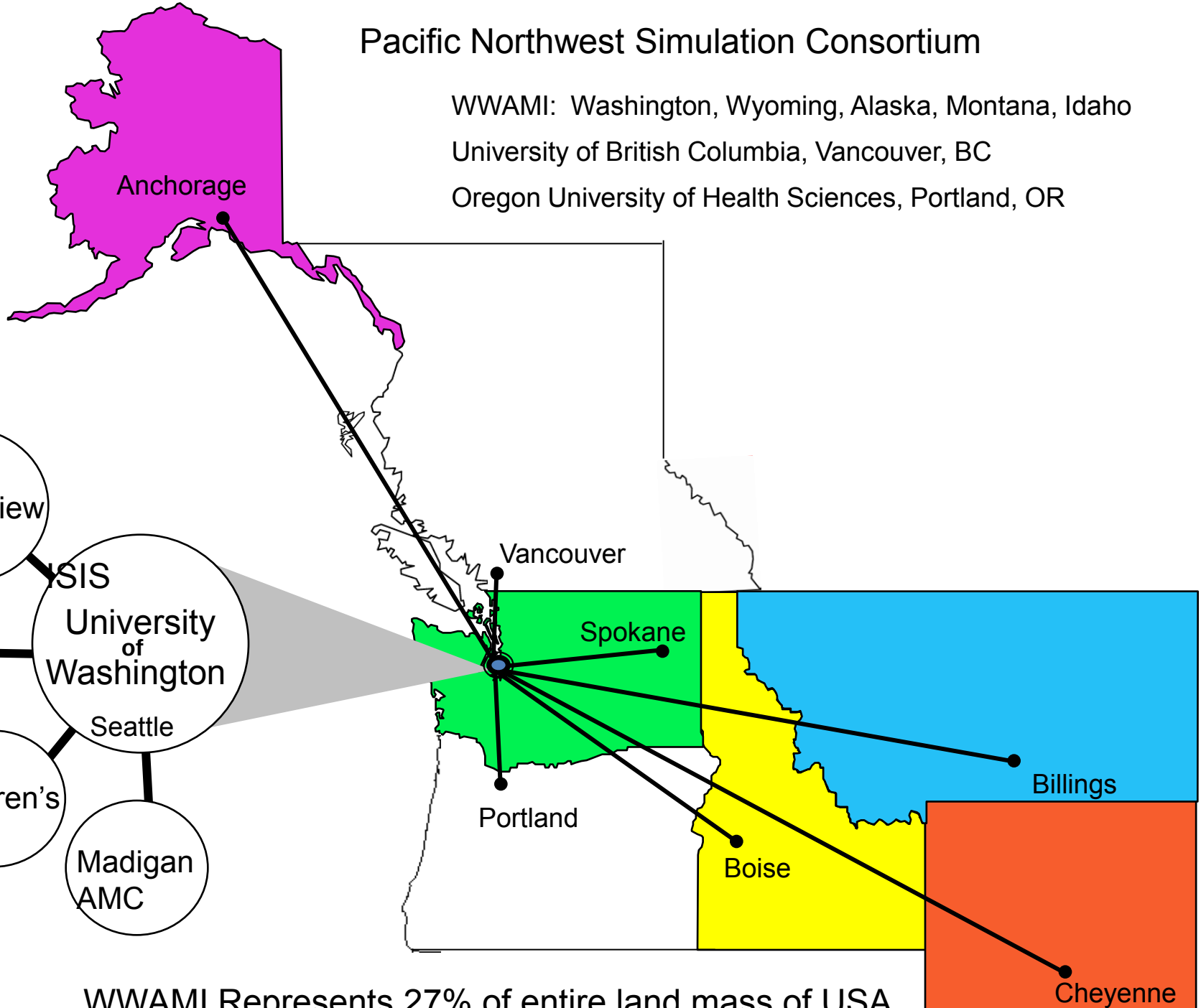


# Pacific Northwest Simulation Consortium

WWAMI: Washington, Wyoming, Alaska, Montana, Idaho

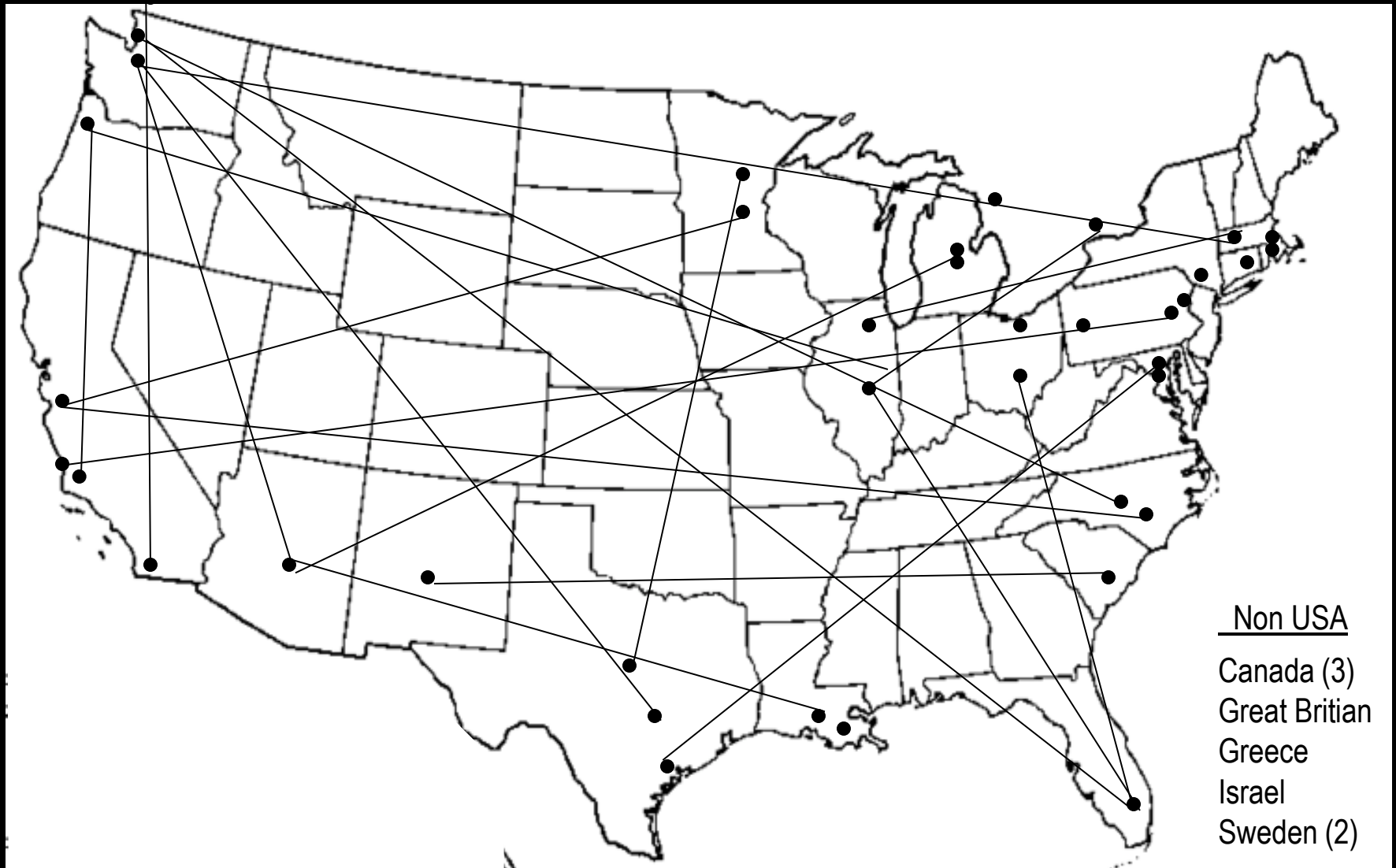
University of British Columbia, Vancouver, BC

Oregon University of Health Sciences, Portland, OR



WWAMI Represents 27% of entire land mass of USA

# ACS-AEI Consortium



# Comprehensive Curriculum

Basic Skills

Simple Procedures

Advanced Procedures

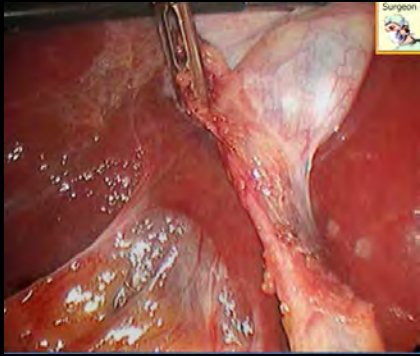
Team Training

Continuity of Care

Task  
Deconstruction

# Meeting Legal Requirements and Fiscal

## Animal, cadaver & actor replacements



# Technology Drivers

## Changing Training Requirements

| Future types of Simulation           | Where used           | Competency<br>(assumes all use Knowledge)          | Clinical Relevance<br>(assumes all serve Patient Safety) |
|--------------------------------------|----------------------|----------------------------------------------------|----------------------------------------------------------|
| In Situ Training                     | Team Training        | Systems –based<br>Communication<br>Professionalism | Risk management                                          |
| Hand off                             | Team                 | Communication<br>Professionalism                   | Patient safety                                           |
| Choreography                         | Team Training        | Communication<br>Technical Skills                  | Patient safety                                           |
| Pre-op Warm up                       | Clinical Application | Pt care<br>(Technical skills)                      | Patient safety<br>Risk management                        |
| Surgical Rehearsal                   | Clinical Application | Pt Care<br>(Technical Skills)                      | Risk management<br>Quality assurance                     |
| Cognitive vs Skills                  | Laboratory Training  | Knowledge<br>(Technical skills)                    | Credentialing                                            |
| Animal , cadaver & actor replacement | Laboratory Training  | All<br>Federal Law                                 | Ethical Issues<br>Cost reduction                         |

# Funding for Medical Simulation

|                  |                                  |
|------------------|----------------------------------|
| TATRC            | Congressional Special Interest   |
| DHP              | US Army Core Medical             |
| PEO-STRI         | US Army Logistics                |
| Veterans Affairs | CoE Medical Simulation - Orlando |
| AIMS             | DHHS (AHRQ) – Multi-agency       |

# Business Model ?

## 1. Drivers

- a. Mandates
- b. Cost Reduction
  - 1.) Cadaver Lab - av \$800,000 yr
  - 2.) Actor patients - \$250,000 – \$400,000/yr

## 2. **Digital Libraries** or synthetic tissue models

- a. Subscription vs up-front costs
- b. Virtual cadavers
- c. Virtual actors
- d. Synthetic vs virtual animals (humans)

## 3. Non-technical skills training

- a. Manikin and hybrid models, virtual actors
- b. Team training, hand-off, communication, professionalism

Will the simulation companies be able to survive?

# Enabling Technology

## High Performance Computing



and data storage

First hard disk drive in 1956... with **5 MB** of storage. In September 1956, IBM launched the 305 RAMAC, the first 'SUPER' computer with a hard disk drive (HDD). The HDD weighed **over one ton** and stored a 'whopping' **5 MB** of data.

# Future **S**imulation and **E**xamination ?



Courtesy : Ivo Broeders, Twente University,  
Delph Netherlands 2010

Is this the **REVOLUTION** in Surgical Education?

# The Scientific Method

... make evidence-based decisions

Hypothesis



Design



Experiment

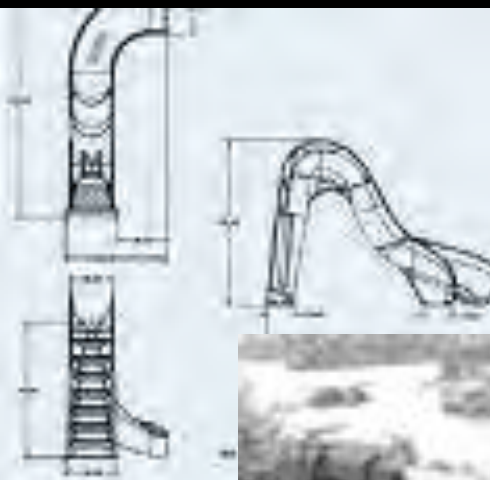


Results



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



# National Simulation Initiative

A Nexus of Medical Simulation in Orlando, FL

