Emerging Trends in Medical Simulation:

Identifying the Needs of the Medical Community and Methods to Address Them

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Dale Alverson
Mark Scerbo
Mark Bowyer

http://simcen.usuhs.mil/mmvr2005

Preamble

- Workshop CDs
- Workshop website
  http://simcen.usuhs.mil/mmvr2005
- Presentations and forum for discussion

"Hey you! Wake up when I'm talking."

Schedule

- Technology and Medical Simulation
- A Clinical Perspective
- Human Factors and Medical Simulation
- Advanced Distributed Learning
- Open discussion and conclusion

Speakers

- Alan Liu
  - Project Scientist (Medical Simulation), National Capital Area Medical Simulation Center
- Mark Bowyer
  - Surgical Director of the National Capital Area Medical Simulation Center
- Mark Scerbo
  - Graduate Program Director, Human Factors Psychology doctoral program Old Dominion University
- Dale Alverson
  - Medical Director, Center for Telehealth and Cybermedicine Research, Health Sciences Center, University of New Mexico

Technology and Medical Simulation

Outline

- Motivation
- Trends
  - Survey of the State of the Art (past and present)
- What's ahead
- What's missing
  - And where we need to be

Why Simulation?

- More complex procedures
- Shorter patient interaction time
- Reduce medical errors

Source: National Institute of Advanced Industrial Science and Technology, Japan

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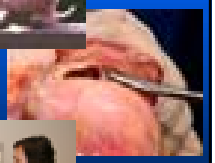
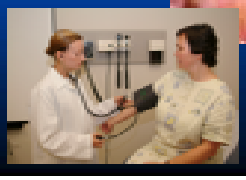
Current Practice

- Animals
  - Incorrect anatomy
- Cadavers
  - Incorrect physiology
- Patients
  - Risk to patient safety
- Each other
  - Can be painful





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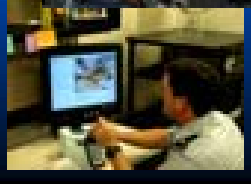
Medical Simulators

- Computer-based "Virtual" patient
- Ability to mimic some tissue properties
- Some physiological response
- Dexterous and cognitive skills training



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The Expectation Gap

- Better visuals
- Accurate tissue models
- Haptics
- Procedure specific hardware
- Specific tasks
- Minimally invasive procedures
- Cost (pricey)

Gap

- Integration with curriculum
- More cases
- More procedures
- Procedure independent hardware
- Wider audience
  - Paramedic, first responder
- Cost (cheap)

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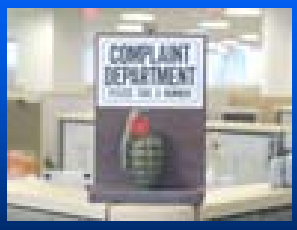
Why?

- Communications
  - How do you quantify "doesn't feel right?"
- Different expectations
- Human factors
- Team dynamics
- Understanding the learning process



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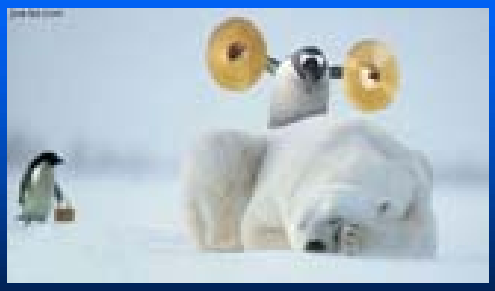
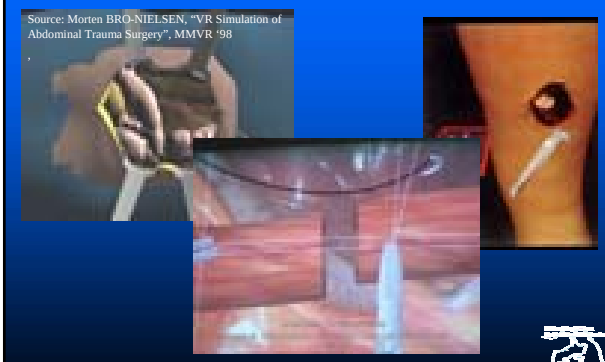


Trends in Technology

- Visual feedback
- Tissue models
- Instrument simulation
  - Tactile and Haptic feedback
- Hardware
- Procedure focus
- Team-based training

Visual Feedback

Source: Morten BRO-NIELSEN, "VR Simulation of Abdominal Trauma Surgery", MMVR '98



Simulating Surgical Instruments

Surgical Effects

- Cutting
- Bleeding
- Smoke

Daniel Bielser, Computer Graphics Lab, ETH Zürich

Source: Forschungszentrum Karlsruhe

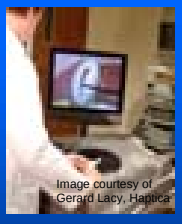
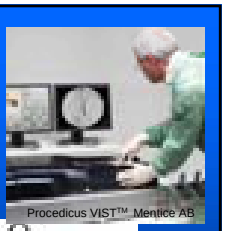


Image courtesy of Gerard Lacy, Haptica



Procedicus VIST™, Mentice AB

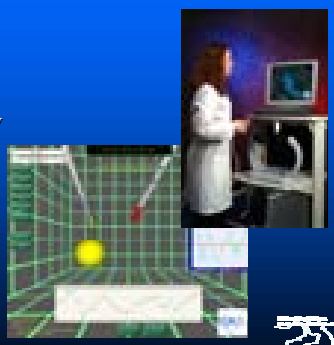
VRMagic GmbH

Simbionix

Xitact S.A.

Verefi Technologies

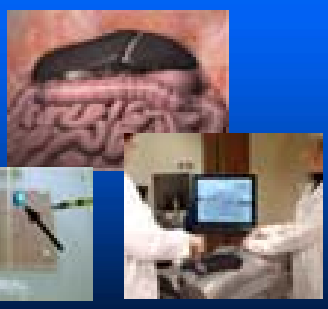
- EndoTower
- SmartTutor
  - Adaptive difficulty level
  - Listen to talk on Saturday



Images courtesy of Randy Haluck, Verefi Technologies

ProMIS (Haptica)

- Optically tracked
- Can use actual instruments
- Real and virtual exercises
- Validated



Images courtesy of Gerard Lacy, Haptica Ltd.

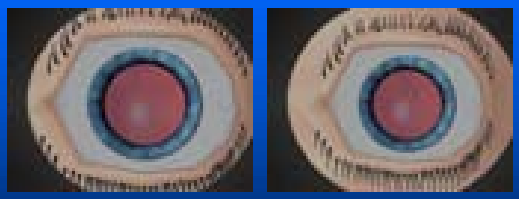
Lapsim (Surgical Science)

- Basic laparoscopic skills
  - Navigation, Cutting, Suturing
- Intermediate skills
  - Dissection
  - Lower intestine manipulation

EYESI (VRMagic)

- Intraocular surgery training
- Basic skills
  - Instrument and object manipulation
- Tool operation
  - Microscope
  - Vitrectomy unit

Continuous Curvilinear Capsulorhexis Simulator



Acknowledgements:
Roger Webster[1-3], Randy Haluck[1,2], Aaron Benson[1], Rod Shenk[1,3]

1 Verefi Technologies Inc., Hershey, PA USA 17033

2 Department of Surgery, Penn State University College of Medicine, Milton S. Hershey Medical Center, Hershey, PA USA 17033

3 Department of Computer Science, Caputo Hall, Millersville University, Millersville, PA. USA 17551

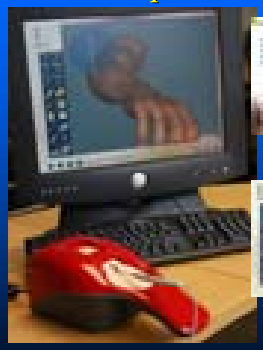
Epidural Injection Simulator

(prototype for any needle procedure)

Haptic Interface inside the Mannequin provides touch feedback

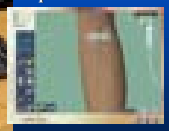
Slide Courtesy of M.A. Srinivasan, MIT

Simquest Virtual IV Trainer



Procedural Training Sequence

Anatomic Viewer



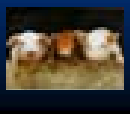
Virtual IV Simulation

Procedural Assessment

Images courtesy of Bob Waddington, Simquest International

Trends

- Focus on minimally invasive procedures
- Specialized hardware
- Better visual realism
- Haptic feedback
  - More of the same
- Tactile feedback?
- Validation



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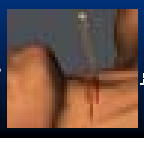
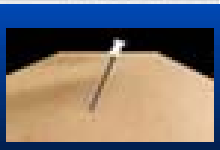


What's Missing?

How much is enough?

- How much realism is really necessary?
  - And when does it become eye-candy?
- Maybe its much less than you think [BATTEAU04]
- What you need vs. what you want.



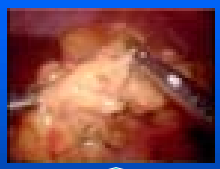
Open Surgery

Trauma is the major cause of death in the under-45 age group and the third leading cause of death in all populations

- Yelle JD, Trask A. Trauma: an overview. In: Rippe JM, Irvin RS, Alpert JS, et al, eds. Intensive Care Medicine. Boston: Little, Brown; 1996:1900-1904

Open Surgery Simulators

- Minimally Invasive Surgery
  - Limited field of view (2D mostly)
  - Limited interaction
  - Surgical manipulators
- Open Surgery
  - Wide open field of view (any angle)
  - Interact with a wide variety of instruments and methods
  - HARD



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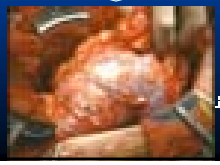
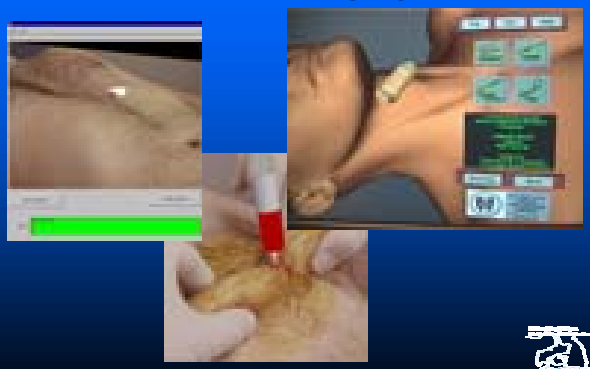


Think Low Hanging Fruit



A Common Framework

- Software
  - Open standards
    - » See PANEL: INTEROPERABILITY STANDARDS FOR MEDICAL MODELING AND SIMULATION: The Need, Challenges and Opportunities
  - CAML (CIMIT)
  - GiPSi (Case Western)
- Hardware
  - Modular platform
  - VRDemo

Images courtesy of Randy Haluck, Verefi Technologies

Team Training

- One surgeon, one patient paradigm
  - What about the rest of the team?
- Medical treatment is a team effort
  - Trauma
  - Mass-casualty management
- The need for a team trainer
  - Distributed

- A winged cockroach jumped into the woman's mouth as she was cleaning her home
- She tried to scoop the bug out with a fork
- She swallowed the fork
- The surgeon removed the fork with laparoscopic surgery
- The cockroach was already digested.

Source: www.joe-ks.com

References

- [COSTA94] Costa KD, McCulloch AD. "Relationship between regional geometry and mechanics in a three dimensional finite element model of the left ventricle." ASME Winter Annual Meeting, Chicago, Nov. 6-11, ASME Advances in Bioengineering, BED-vol. 28: 5-6, 1994.
- [BATTEAU04] Batteau, A. Liu, J.B. A. Maintz, Y. Bhasin, M. Bowyer, "A Study on the Perception of Haptics in Surgical Simulation", L… LNICS v. 3078, 2004.