Embracing Game Technology for Medical Education

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Growing Issue in Medical Education

- Medical procedures are becoming more numerous and more complex – medical knowledge has “hypertrophied” (Cooke, et al, New England J Med, 2006)

- Training residents to a common level of knowledge and competence is already impossible (conversations with Satava, 2008)
“The Perfect Storm”
(Murphy, J of Critical Care, 2007)

- Risk to patient health. (McDougall, 2007)
- Cost is a barrier to training. (Bridges, 1999)
- Availability of training opportunities. (Birden, 2007; Davis, 1999)
- Access to training. (Dunkin, 2007; Spitzer, 1997)
- Limited working hours. (Satava, 2004)
- Ethics of practicing on patients. (Satava, 2004; Murphy, 2007)
- Expectations around computer technologies. (Murphy, 2007)
- Insurance coverage of educational actions. (Satava, 2004)
- Volume of unique procedures. (Reznick & MacRae, 2006)
- Complexity of modern surgery. (McDougall, 2007)
- Quality of VR technology. (Murphy, 2007)
- Professional Acceptance. (Ziv, 2003)
- Learning from Mistakes. (Ziv, 2005)
- Proficiency-based Medicine. (Murray, 2005)
The Next Step in Training

Human
Mannequin
Simulator

Animal

Box Trainer

VR/Game Tech
“Nothing endures but change” – Heraclitus, 5th Century BC
Game Technology:
the more successful son of VR

Hermann

Albert
Powerful Motivations

- Motive 1: Lower Cost
- Motive 2: Better Access to Symptoms/Cases
- Motive 3: Reduced Training Time
- Motive 4: Reduced Errors

Similar for Military, Industrial, and Medical Training
Motive 1: Lower Cost

- Teaching students in the OR requires a longer surgery time. (Bridges & Diamond, 1999)
  - Accumulates to 186 hours over a 4 year residency
- The facilities and personnel could be applied to additional revenue generating procedures. (Bridges & Diamond, 1999)
  - Estimate the cost of using the operating room at $257.40 per hour.
  - Adds $47,970 to the cost of medical education.

- Conflicting OR Cost Estimates
  - Cost of the operating room is $1,500 per hour (Frost & Sullivan, 2004)
  - Swedish operating room costs $1,000 per hour (Hyltander, 2003)
  - Rule of Thumb “$250 per 15 minutes” (Satava, 2008)

- Residency Cost may be $186,363 to $279,545
## M1: Return on Investment

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Fixed Cost</th>
<th>Recurring Over Residency (4 Years)</th>
<th>After Residency (5th Year)</th>
<th>Total over 5 Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment</td>
<td>AccuTouch Simulator</td>
<td>(72,000)</td>
<td>(18,664)</td>
<td>0</td>
<td>(90,664)</td>
</tr>
<tr>
<td>Time Savings</td>
<td>Instructor time</td>
<td></td>
<td></td>
<td>23,040</td>
<td>23,040</td>
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<tr>
<td></td>
<td>Additional Procedures</td>
<td></td>
<td>0</td>
<td>114,400</td>
<td>114,400</td>
</tr>
<tr>
<td>Reduction in Errors</td>
<td>Complications</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cancellations</td>
<td></td>
<td></td>
<td>13,600</td>
<td>0</td>
<td>13,600</td>
</tr>
<tr>
<td>Faster Time to Competence</td>
<td>Residents generating revenue</td>
<td></td>
<td>78,000</td>
<td>0</td>
<td>78,000</td>
</tr>
<tr>
<td>Equipment Breakage</td>
<td>Reduction due to better training</td>
<td></td>
<td>5,428</td>
<td>5,428</td>
<td>10,856</td>
</tr>
<tr>
<td>Other Financial Benefits</td>
<td>Reduction in alternative training</td>
<td></td>
<td>4,400</td>
<td>0</td>
<td>4,400</td>
</tr>
<tr>
<td></td>
<td>Revenue from selling time on simulator</td>
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<td>93,000</td>
<td>0</td>
<td>93,000</td>
</tr>
<tr>
<td>Total Cost/Benefit</td>
<td></td>
<td>(72,000)</td>
<td>198,804</td>
<td>119,828</td>
<td>246,632</td>
</tr>
</tbody>
</table>

Derived from Frost & Sullivan 2004
“The traditional Halstedian apprenticeship model of ‘see one, do one, teach one’ is no longer adequate to train surgeons, since good laparoscopic skills cannot be developed by merely watching an expert.

Laparoscopic proficiency is only realized after sufficient practice in the minimally invasive environment. To this end, a variety of approaches have been developed to teach laparoscopic skills outside of the operating room; these methods include practicing on animal models or artificial tissues, training boxes, and virtual reality simulators.” (Pearson et al, 2002)

In laparoscopy, “see one” does not contribute to the learning process. Learning begins with “do one” (Jordan et al, 2001; Gallagher et al, 2001b; Madan & Frantzides, 2007).
Proficiency is reached after 10 to 30 surgeries. Under current teaching methods these occur on animals and live patients. VR systems allow these to be moved off of patients (Grantcharov et al, 2003b and 2004; MacFadyen et al, 1998).

Repeated practice of procedures, standardized tasks, and objective measurements are all lacking or limited in traditional OR-based training (Grantcharov et al, 2003b and 2004).

In laparoscopy, observation does little to convey the skills that must be mastered. Only actual practice has been effective at this (Jordan et al, 2001; Gallagher et al, 2001b; Madan & Frantzides, 2007).
Motive 3: Reduced Time

- VR systems can differentiate experienced from inexperienced subjects based on their performance scores (Adamsen et al, 2005).

- MIST-VR simulator can determine which students would never achieve proficiency in laparoscopy and should be dropped from a training program (Gallagher et al, 2004).

- Non-VR trained students are nine times more likely to fail to make progress in their performance than those who use VR in their training (Seymour, 2002).

- Students trained in VR are 29% faster at performing laparoscopic surgeries (Enochsson et al, 2004; and Seymour, 2002).
“There is no excuse for the surgeon to learn on the patient.” (William J. Mayo, 1927).

Laparoscopic surgery has an error rate three times higher than open surgery. Error rate has not decreased over eight years of data. (Huang et al, 2005).

VR systems can improve performance because surgeons become familiar with the appearance of organs and tissue in a 2D environment (Huang et al, 2005).

Students trained in VR make up to five times fewer mistakes (Enochsson et al, 2004; and Seymour, 2002).
There is more evidence that training with computer graphics, VR, and game technology improves medical education than there is for all of military training.

- We spend billions of dollars on this technology for the military.
- We bet soldiers’ lives on it.
- There is more evidence that it works in medicine.


"Investigating the Disruptive Effect of Computer Game Technologies on Medical Education and Training"

Roger Smith, August 2008