Surgical Technology
Circa 1900

Spot the innovations in surgical visualization . . . .
Cognitive Ergonomics in the OR:
Development of Human Factors Tools for the Assessment of Surgical Technology
Surgical Technology
Circa 2000
Laparoscopic Surgery
Advantages for Patients, but for Surgeons . . .

- More training
- More physical strain
- Greater “mental strain”
Challenges

- Limited field of view
- Lack of depth cues
- Occlusion
- Reduced haptic cues
- Poor control-display correspondence
  - fulcrum effect
  - FOR (frame of reference) effects
Potential Solutions . . . . .
Weighing In . . . .

Cognitive Ergonomics

- Develop Metrics
- Perform Evaluations
- Develop Guidelines
Core Problems

- WHAT to measure
- HOW to measure “it”
- WHO to test
- WHEN to test them
WHAT TO MEASURE

- Performance Efficiency
- Satisfaction and Preference
- Mental Workload
- Psychological Stress
- Situation Awareness
Workload Assessment Methods

Subjective
- NASA-TLX
- MRQ

Secondary Task
- Visual Detection
- Interval Production

Physiological
- Eye Movements:
  - Blinks
  - Saccades
  - Pupil Size
General Strategy

- Manipulate task demand
- Collect candidate measures
- Determine which measures are most sensitive
- Fine-tune candidate measures
Lab Environments
Ring-to-Peg Task
Cannulation
Cobra Rope
Evaluated Computationally-Generated Global Views
Evaluated Postures for Performing Cholecystectomies

Medial Postures

Side Postures
Evaluated the 2D vs. 3D modes of the Da Vinci Servo
Subjective Measures

**NASA-TLX**
- Mental Demand
- Physical Demand
- Temporal Demand
- Effort
- Performance
- Frustration

**MRQ**
- Working Memory
- Spatial-Emergent
- Spatial-Concentrative
- Tactile-Figural

. . . . 17 scales in all.
Recommendations for Subjective Workload:

- NASA-TLX sensitive across diverse populations and tasks.
- Vocal administration is an acceptable alternative to written.
- MRQ is very sensitive and diagnostic in medical students.
Prospective Vs. Retrospective Use of the NASA-TLX

- Participants may be slightly better at anticipating physical compared to cognitive load.
- Participants are relatively poor at incorporating training outcomes in their judgments.
- Collecting prospective judgments does not contaminate retrospective reports.
“Blob” Secondary Task
Interval Production
Secondary Task

Methodological Recommendations

- Minimal training; No strategy instructions.
- Target intervals as low as 3 sec. are sensitive.
- Coefficient of Variance (CV) best performance measure
- 5 intervals needed for stable results
iProd: Interval Production Data Collection App
Eye tracking

- Number of Saccades
- (pupil size)
- (blink rate)
- (blink duration)
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