Motion capture technologies supporting medical interventions

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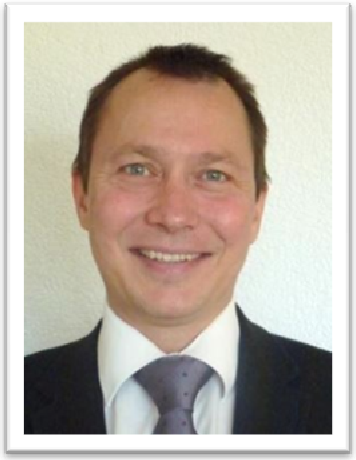
Thomas Stüdeli



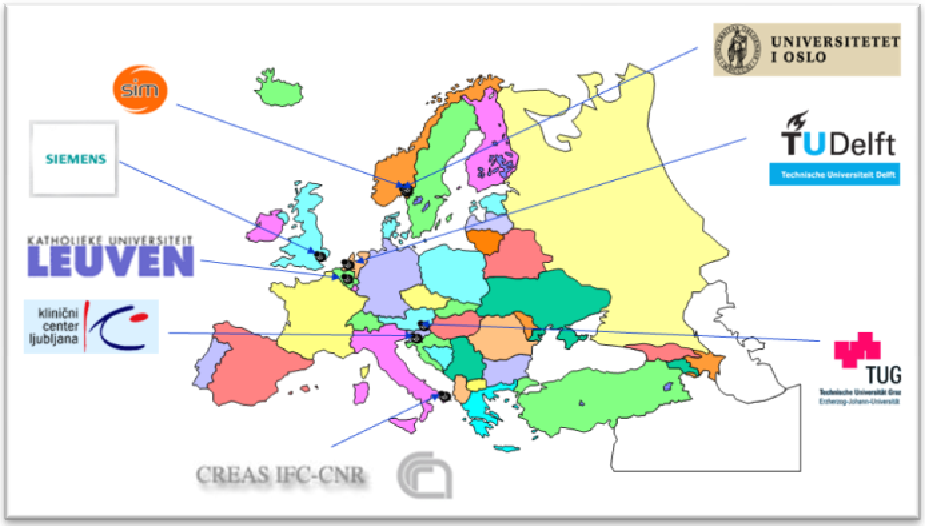
www.hf-engineering.ch

Education

- MSc in Environmental Scienece, ETH Zürich, Switzerland (1991-1998)
- MAS in Work & Health, ETH Zürich & University Lausenne (1999-2001)
- PhD in Visual Ergonomics, ETH Zürich, Switzerland (2002-2005)
- ***Post-Doc in Industrial Design & Human Factors Engineering for Medical Technology, TU Delft, The Netherlands (2006-2009)***

Zertification

- Europeam Ergonomist Eur.Erg. (12/2003, 12/2008)
- Occupational Hygienist SOHA-IOHA (01/2004, 12/2009, 2012/12)



www.ariser.info

Agenda

- Why ergonomics for medical interventions?
- Tracking in the operation theater and the radiology suit…
- Some lessons learned.

Work Environment (1)
Classical Operation Theater

- Micro-universe of flexible “workplaces”
- Individual AND team work
- High time pressure AND high demands
- Action tasks AND monitoring / control tasks
- Highly complex AND highly regulated

“Entering an Operation Theater, it’s like going 100 years back in Ergonomics”

Richard Goossens, Prof. in Physical Ergonomics and leader of Healthcare Program at TU Delft, the Netherlands (10.8.2009 IEA congress Beijing)

(1) New technology for medical intervention

- Mandatory processes on **risk engineering** (IEC 60601-1-6), **usability engineering** (IEC 62366), and **risk management** (ISO 14971)

- Booming Medical Device Industry needs to learn the potential behind usability and risk engineering processes!

[KARL STORZ OR1™]

[da Vinci Surgical System]

(2) New tools for medical intervention

[Sensei® Robotic Catheter System HansenMedical]

[KARL STORZ OR1™]

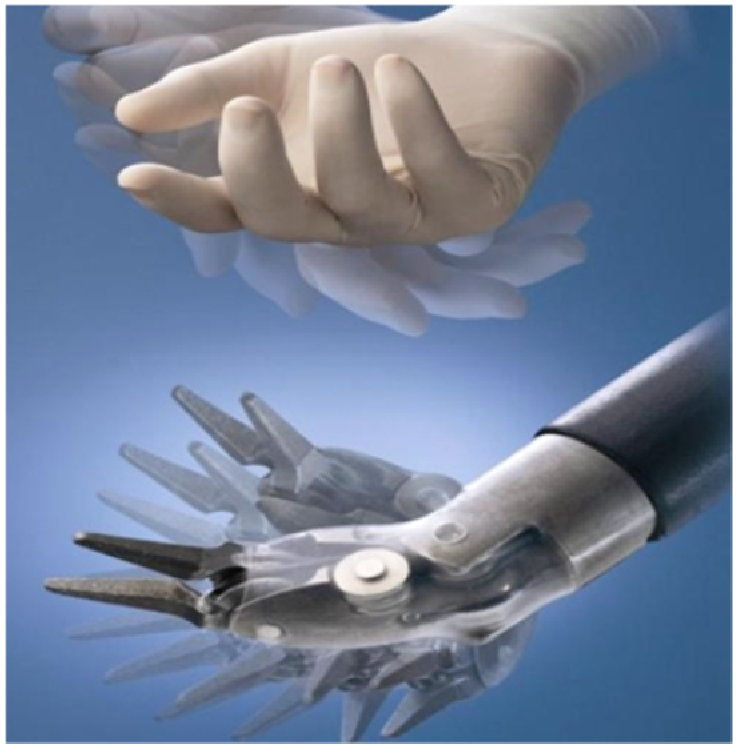
[da Vinci Surgical System]

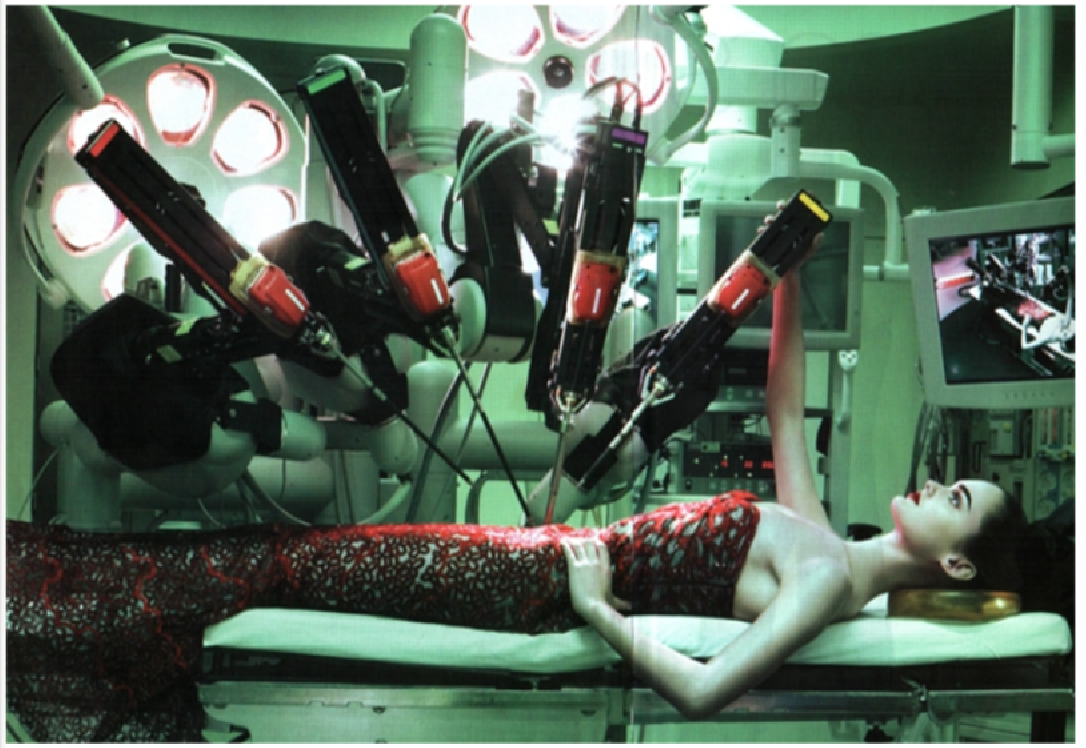
(3) New medical interventions
– less invasive, faster, …

Intervention Radiology, a.o.

- Angiography
- Balloon angioplasty/stent
- Cholecystostomy
- Drain insertions
- Endovascular aneurysm repair
- Embolization, Chemoembolization, Radioembolization
- Thrombolysis
- Biopsy (percutaneous or transjugular)
- Radiofrequency ablation (RF/RFA)
- Cryoablation
- Central venous catheter placement of intravenous devices (IVs)
- Inferior vena cava filter (IVC filters)
- Vertebroplasty
- Nephrostomy placement
- Radiologically inserted gastrostomy (RIG)
- Dialysis access and related interventions
- Transjugular Intrahepatic Porto-systemic Shunt (TIPS)
- Endovenous laser treatment of varicose veins

From manual to robotic procedures…



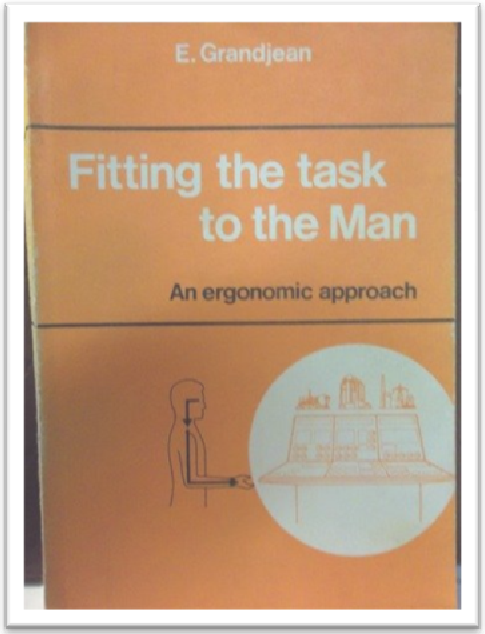


Work Environment (2)
From Operation Theater to …

Work Environment (2)
From Operation Theater to … the Intervention Radiology Suit

Agenda

- **Why ergonomics for medical interventions?**
  - New technology …
    - enables new interventions
    - changes type of workload
  - tracking technology is an important „assistant technology“ for task simplification



Agenda

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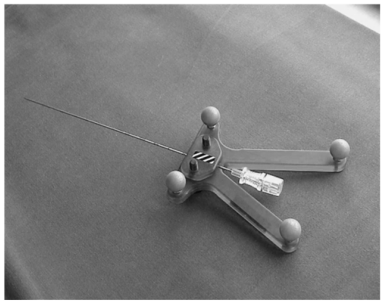
MRI guided bone biopsy, optical tracking

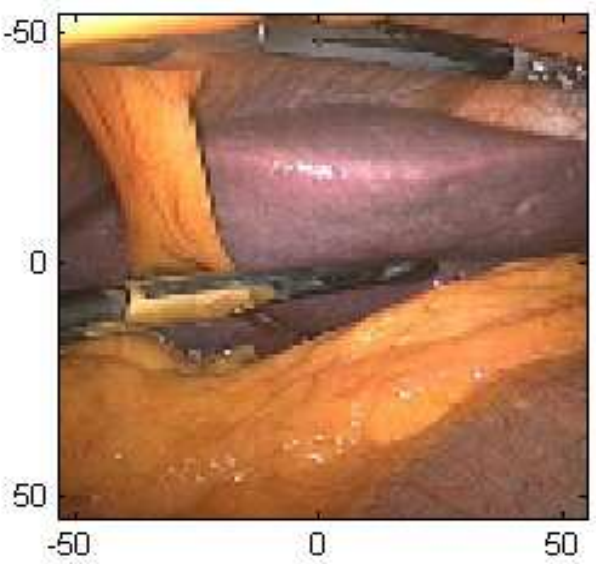


Project "Herkules", Oulu, Finland (approx. 1996-2002)

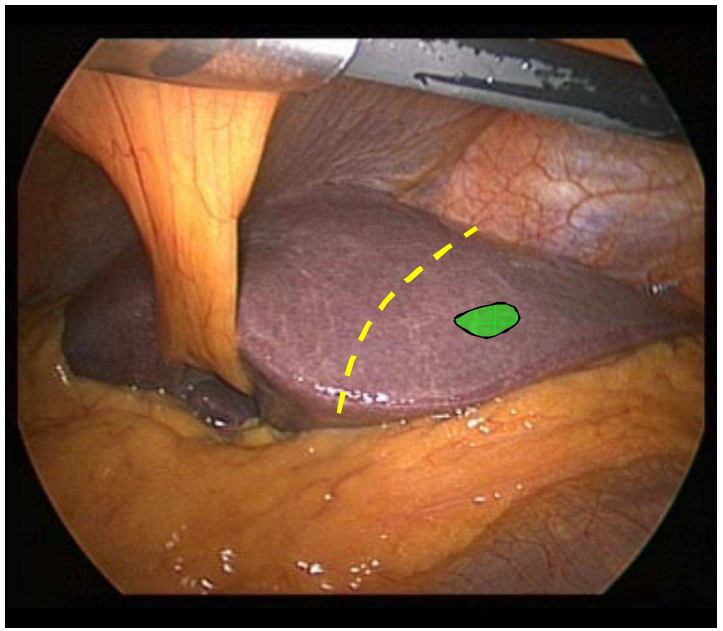
Electromagnetic Measurement System

http://www.ndigital.com/medical/applications.php

Augmented Reality in Surgery (ARIS*ER) - Laparoscopy



Lack of haptic feedback and limited orientation performance in laparoscopic images



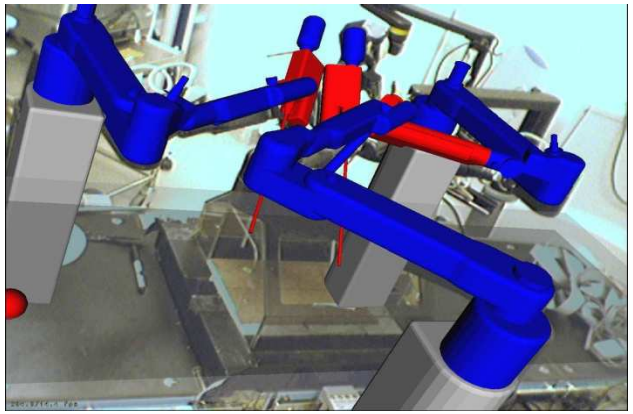
Augmented laparoscopic images (liver resection)

Tracking of laporoscope (optical or magnetical)
Tracking of liver countours (image processing)

Augmented Reality in Surgery (ARIS*ER) – Robotic surgery

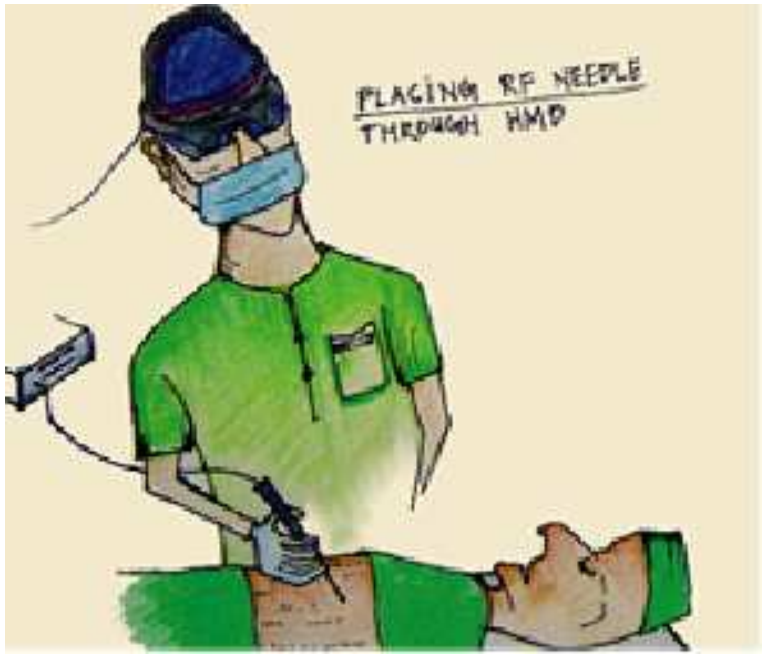
Collisions of robotic arms outside the field of view of the surgeons

Augmented robotic arms (robotic surgery)

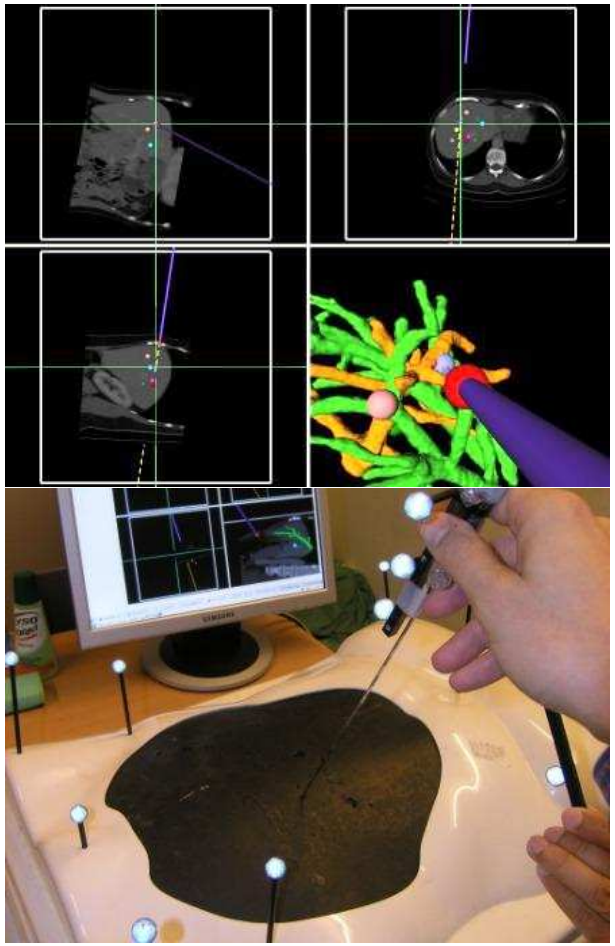


Tracking of robotic arm position
(magnetical for positionning, force sensor for collision detector)

Augmented Reality in Surgery (ARIS*ER) – Intervention radiology



How to visualize relevant anatomical information for (safe and efficient) abdominal needle placements?



Augmented needle trajectory line – 2D image & 3D map

Human Factors Engineering
HF&Ergonomics Know-How for Industries and Services

Tracking of RFA needle holder
(optical for holder, magnetical as option for tip tracking)

RFID - tool and person tracking

http://www.rfidjournal.com/
Medical applications of RFID

Agenda

- **Tracking in the operation theater and the radiology suit.**
  - Support for Imaging and Robotics, Navigation and motion guidance.
  - Support for Safety.
  - Optical tracking
  - Magnetic tracking
  - RFID tracking

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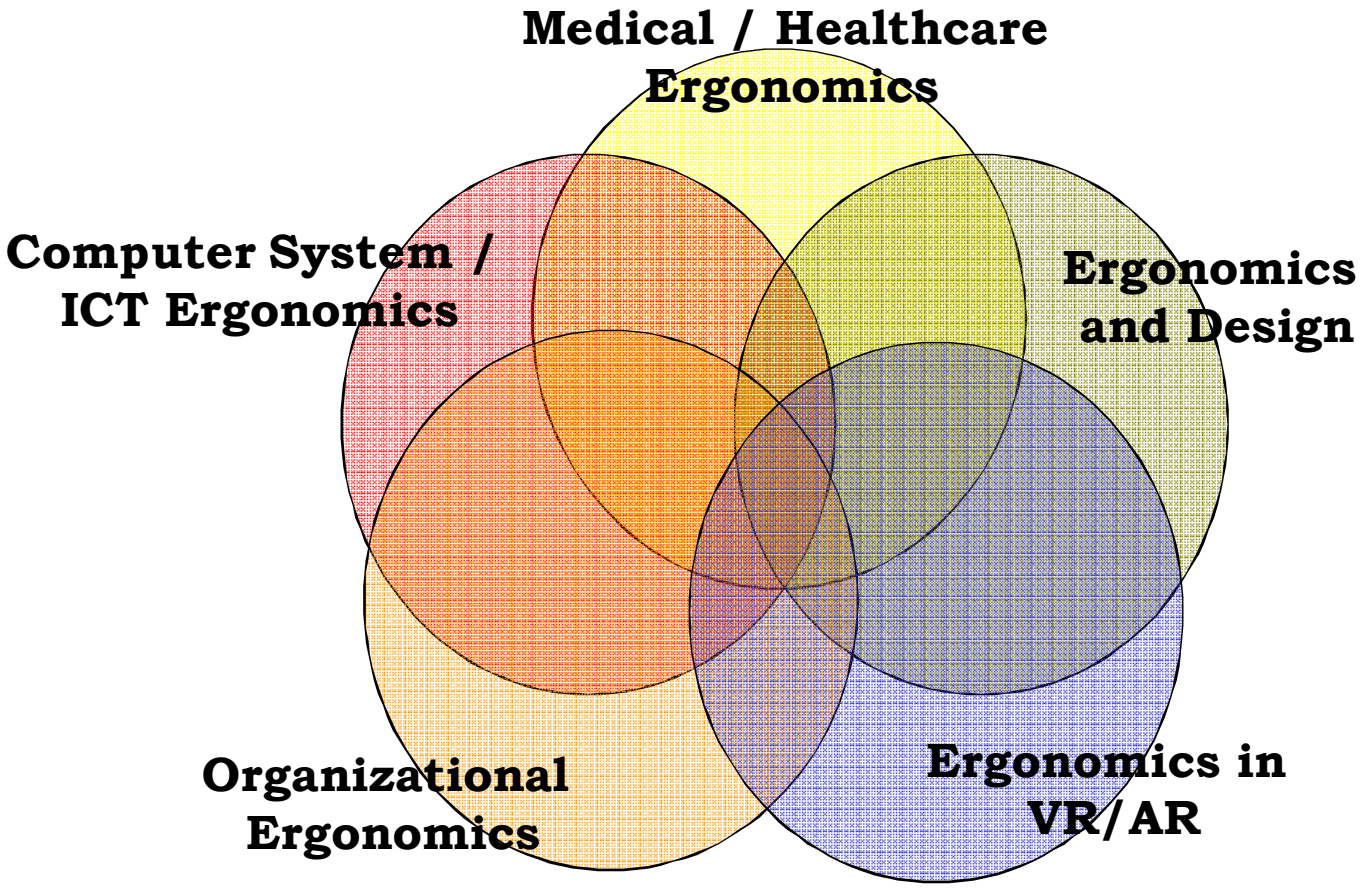
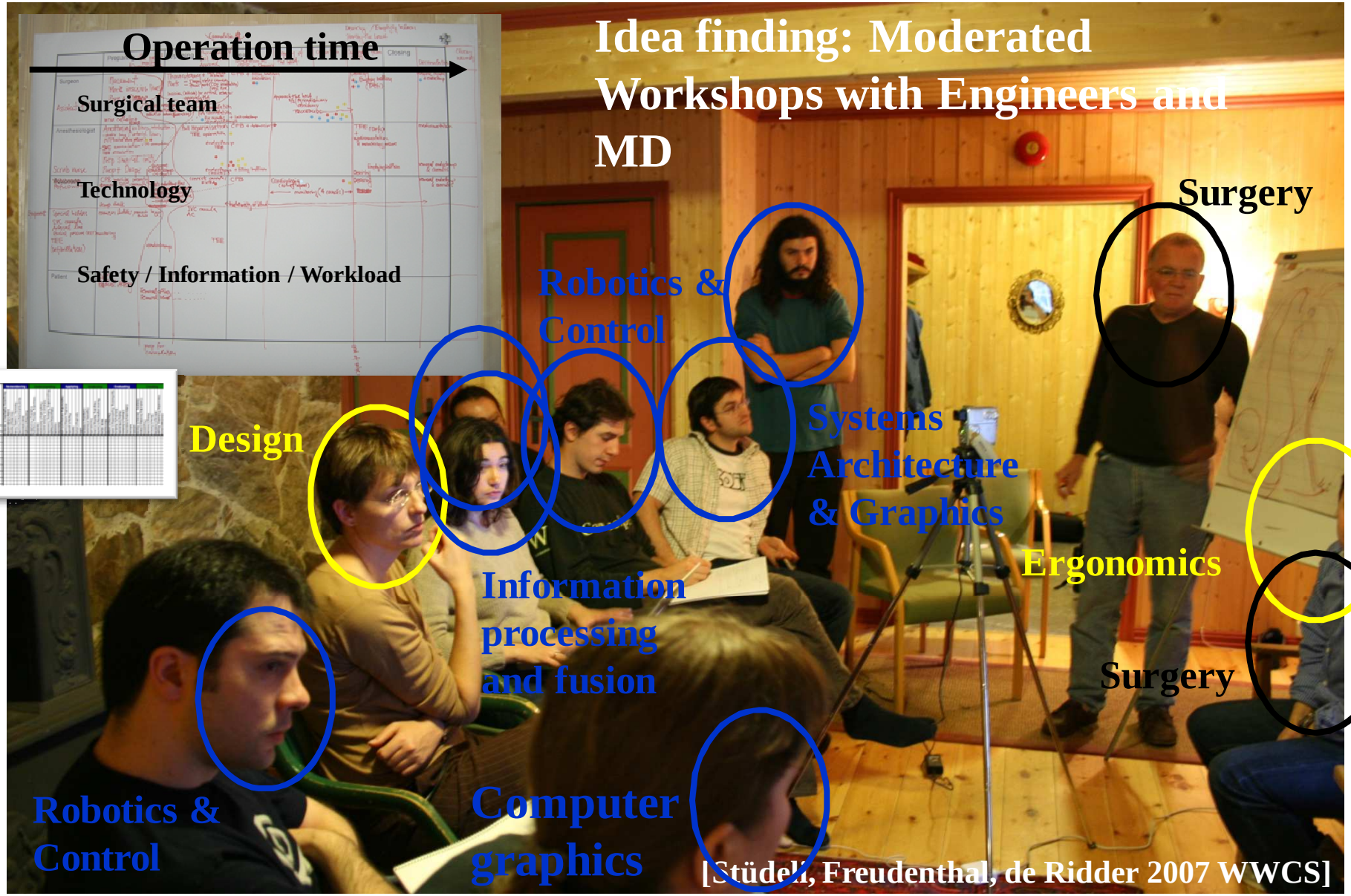
Ergonomics (of ICT) in the operation theater

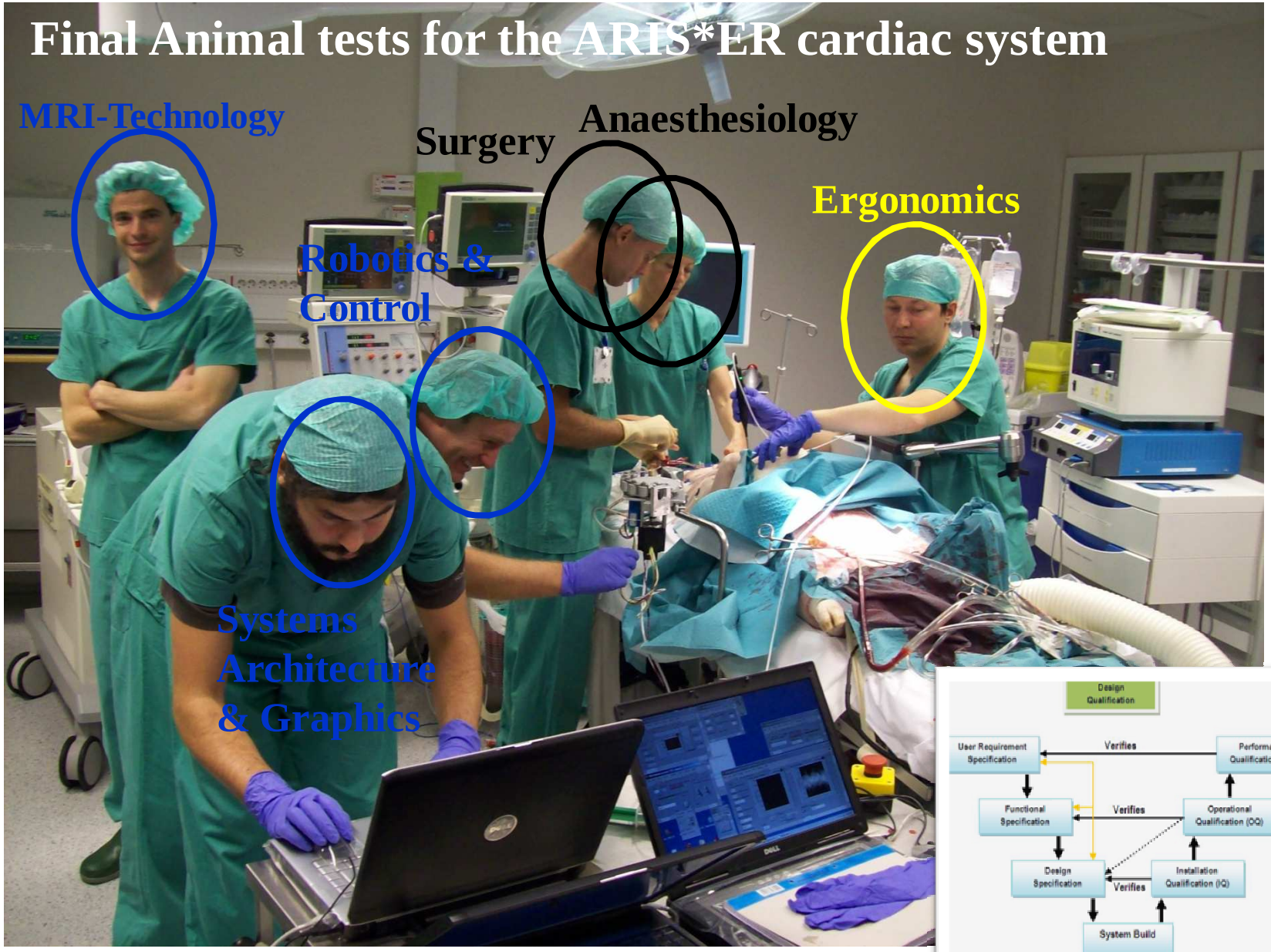


Challenges for the Ergonomist

- Work with Surgeons, Intervention Radiologists, Nurses, … & Operation room culture
- Interdisciplinary development team (MD, engineers of different specialties)
- Proactive approach needed *("quick and dirty ergonomics"?)*
- Effective transfer of ergonomic knowhow


Operation time
Surgical team
Technology
Safety / Information / Workload
Idea finding: Moderated Workshops with Engineers and MD
Surgery
Robotics & Control
Systems Architecture & Graphics
Design
Ergonomics
Information processing and fusion
Surgery
Robotics & Control
Computer graphics
[Stüdeli, Freudenthal, de Ridder 2007 WWCS]

Final Animal tests for the ARTS*ER cardiac system



Thank you for your attention!