Logistics and Performance of the Operating Room

A collaborative design project between
Dr. Alex Langerman, University of Chicago, and IIT Institute of Design
Project Overview

In this project we investigated pain points and probed for unmet user needs, seeking to understand how design can add value where teams, tools and the context interact in the operating room.
Center for Care and Discovery
State of the Art $250 million facility

Dr Alex Langerman
Chicago, Illinois
Project overview

1 Design process overview
2 Introduction to research
3 Observation
4 Analogous research
5 Guiding insights and opportunities
6 Concept exploration
7 Design concepts
Design process overview

UNDERSTAND CONTEXT
UNDERSTAND PROCESS
ANALYSIS / SYNTHESIS
IDEATION
REFINE
EVALUATE
CONCEPT EXPLORATION
COMMUNICATION
PROTOTYPE
Areas where design can contribute to healthcare

- Save money
- Help people communicate better
- Make someone’s life easier
- Make the operating room safer
- Reduce complexity
- Teach better
We start with an exploration in OR
Research questions

What is the cycle of the surgical team?
What is the journey of supplies?
What does the OR look like with design eyes?
What does the surgical team need?
How can we improve performance?
Research activities

- Observed teams in the operating room
- Immersed ourselves in actual use context
- Visited analogous sites
- Conducted secondary research
- Made early prototypes
Introduction to Research
<table>
<thead>
<tr>
<th>Room Setup</th>
<th>Induction</th>
<th>Positioning &amp; Prep</th>
<th>Opening / Exposure</th>
<th>Intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overview:</strong> Pre-patient, pre-doctor setup</td>
<td><strong>Overview:</strong> Get patient in and under anesthesia</td>
<td><strong>Overview:</strong> Final pre-surgery preparations</td>
<td><strong>Overview:</strong> “Getting to where the surgeon needs to go inside the patient”</td>
<td><strong>Overview:</strong> “Do the thing the patient is there for”</td>
</tr>
<tr>
<td><strong>People:</strong></td>
<td><strong>People:</strong> Surgeon</td>
<td><strong>People:</strong> Surgeon</td>
<td><strong>People:</strong> Surgeon</td>
<td><strong>People:</strong> Surgeon</td>
</tr>
<tr>
<td>Circulator (nurse or tech)</td>
<td>Circulator</td>
<td>Circulator</td>
<td>Circulator</td>
<td>Circulator</td>
</tr>
<tr>
<td>Scrub (nurse or tech)</td>
<td>Scrub</td>
<td>Scrub</td>
<td>Scrub</td>
<td>Scrub</td>
</tr>
<tr>
<td>Specialists with equipment to set up</td>
<td>Anesthesiologist</td>
<td>Anesthesiologist</td>
<td>Anesthesiologist</td>
<td>Anesthesiologist</td>
</tr>
<tr>
<td>Engineering techs to help set up</td>
<td>Specialists</td>
<td>Specialists</td>
<td>Specialists</td>
<td>Specialists</td>
</tr>
<tr>
<td><strong>Actions:</strong> Patient brought into room from pre-op area on hospital bed</td>
<td>Get patient onto the operating table</td>
<td>Scrub finished setting up instruments</td>
<td>Anesthesiologist administers anesthesia and begins monitoring patient via equipment</td>
<td><strong>Actions:</strong> Surgeon and or specialist perform the necessary intervention</td>
</tr>
<tr>
<td><strong>Emergence</strong></td>
<td><strong>Debrief</strong></td>
<td><strong>Breakdown</strong></td>
<td><strong>Turnover</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Overview:</strong> Closing the incision and preparing the patient for removal from anesthesia</td>
<td><strong>Overview:</strong> Waking patient up from anesthesia</td>
<td><strong>Overview:</strong> Cleanup of surgical tools</td>
<td><strong>Overview:</strong> Getting the OR back to a blank slate</td>
<td></td>
</tr>
<tr>
<td><strong>People:</strong> Surgeon</td>
<td><strong>People:</strong> Anesthesiologist stops administering anesthesia and continues to monitor the patient</td>
<td><strong>People:</strong> Surgeon</td>
<td><strong>People:</strong> Techs</td>
<td></td>
</tr>
<tr>
<td>Circulator</td>
<td></td>
<td><strong>People:</strong> Circulator</td>
<td><strong>Actions:</strong> Techs mop the floor take out the trash.</td>
<td></td>
</tr>
<tr>
<td>Scrub</td>
<td></td>
<td><strong>People:</strong> Scrub</td>
<td><strong>Actions:</strong></td>
<td></td>
</tr>
<tr>
<td>Anesthesiologist</td>
<td></td>
<td><strong>People:</strong> Scrub</td>
<td><strong>Actions:</strong></td>
<td></td>
</tr>
<tr>
<td>Specialists</td>
<td></td>
<td><strong>People:</strong> Anesthesiologist tech</td>
<td><strong>Actions:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Actions:</strong> Remove all instruments, sponges, etc. from inside the patient</td>
<td></td>
<td></td>
<td><strong>Actions:</strong></td>
<td></td>
</tr>
<tr>
<td>Inventory of instruments, sags, etc., X-ray to double-check</td>
<td></td>
<td></td>
<td><strong>Actions:</strong> Circulator and scrub prepare all surgical implements for transport down to sterilization</td>
<td></td>
</tr>
<tr>
<td>Extract tubes, suture incisions</td>
<td></td>
<td></td>
<td>Anesthesia tech cleans, checks, and re-stocks the anesthesia machine / cart</td>
<td></td>
</tr>
</tbody>
</table>
Operating room lifecycle diagram

**OR setup**
- Induction checklist:
  - Patient in room
  - Anesthesia

**Positioning**
- Positioning checklist:
  - Patient in position
  - Arrange room

**Turnover**
- Turnover checklist:
  - Floor mopped
  - Trash removed

**Breakdown**
- Breakdown checklist:
  - Instruments out
  - Carts sanitized

**Emergence**
- Emergence checklist:
  - Stable patient

**Intervention**
- Intervention checklist:
  - Intervention complete
  - Instruments counted
  - Close incision

**Closing**
- Closing checklist:
  - Stable patient
  - Objective found

**Debrief**
- Debrief

**Time-out**
- Time-out

**Exposure**
- Exposure checklist:
  - Stable patient
  - Objective found

**Instruments counted**

**Close incision**

**Trash removed**

**Floor mopped**

**Carts sanitized**
Observation
University of Chicago Hospital

100 hours observation
Center for Care and Discovery
The more customized the operation, the more communication is needed.
Complexity + Fatigue = Mistake (missing tools, not focused)
Organized OR is not a priority because surgeon and nurses do not have a sense of OR ownership
Procedures and surgeon’s preference drive OR’s set-up
OR accommodates equipment and supplies but not human comfort
Analogous Research

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PROTOTYPE
Analogous Research

Attention to Detail
90-minute CSO Teardown / Setup

Teaching In Real-Time
Sushi Preparation Class

Flexible vs. Rigid Roles
Floriole Bakery
Attention to Detail - Chicago Symphony Orchestra

1. Storage, movement, set-up
2. Attention to detail
3. Similar but unique tasks
Teaching In Real Time - Sushi preparation class

1. Teaching-centric spaces
2. Assumption of prior knowledge
Flexible vs Rigid Roles - Floriole bakery

1. Monitoring overall status
2. Responsibility for debris
3. Communication strategies
Guiding Insights and Opportunities

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CONCEPT EXPLORATION
Guiding Insight 1

Visual hierarchy in tool arrangement helps nurses identify the needed item quickly. More visual hierarchy in the OR in general could reduce the cognitive load of the staff.
Guiding Insight 2

Teams enhance energy and morale by bringing human elements into the OR such as music, whiteboard drawings, etc.
Guiding Insight 3

Surgery requires high situational awareness, and tools need to be laid out ahead of time so they are easily found when needed.
Guiding Insight 4

OR staff work around tools that are designed for specific surgical tasks, but not designed for the OR space.
Guiding Insight 5

The complexity of surgery requires the team to maintain a shared awareness of the surgery’s overall status.
### How Might We...

<table>
<thead>
<tr>
<th>FACILITATE INSTANT TEAM BUILDING</th>
<th>IMPROVE SEARCH SPEED IN OR THROUGH VISUAL HIERARCHY</th>
<th>EMPOWER PEOPLE TO ENHANCE MORALE</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTEGRATE TOOLS INTO OR SPACE TO REDUCE FATIGUE</td>
<td>MAKE TOOLS WORK COHESIVELY</td>
<td>REDUCE HUMAN ERRORS WITH SIMPLIFIED STEPS</td>
</tr>
<tr>
<td>TAKE THE TASK OF SYNTHESIZING INFO IN OR OFF THE SHOULDERS OF INDIVIDUALS</td>
<td>DESIGN A COHESIVE LAYOUT FOR RANDOM SET UP</td>
<td>CREATE A LEARNING FRIENDLY OR SPACE</td>
</tr>
</tbody>
</table>
Concept Exploration

ID Prototype Workshop
University of Chicago Hospital Workshop
ID Workshop

First concept introduction and iteration
UC Hospital Workshop

Full day workshop in hospital
50+ surgeons, nurses, staff came and gave feedbacks
Is this realistically usable?
Would this disrupt sanitation?
How do we improve our design?
How would this change the way you communicate?
Learnings from workshop
<table>
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<tr>
<th>Learnings from workshop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Smart Table</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What gets back-up tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hip, Sutures</td>
</tr>
<tr>
<td>Lap pads tracking</td>
</tr>
<tr>
<td>What if unexpected tools are added to the table</td>
</tr>
<tr>
<td>Peel-pack cart</td>
</tr>
<tr>
<td>Actively antimicrobial</td>
</tr>
<tr>
<td>(UV pulse)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gather data for analytics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make it work with Epic</td>
</tr>
<tr>
<td>Kinect - needle - etc.</td>
</tr>
<tr>
<td>Robot room</td>
</tr>
<tr>
<td>Need room for a workspace</td>
</tr>
<tr>
<td>Communicate with the X-ray station</td>
</tr>
<tr>
<td>Useful downstairs tool</td>
</tr>
<tr>
<td>(CSP)</td>
</tr>
</tbody>
</table>

| Epic isn't based around operations, it's based around surgeon |
| Setups should be based around scrub team preference |
| Kits = inefficient |
| Lighter trays save $ |
| Tool feedback indicate surgery stage |
| Most back tables have way more stuff! |
| Notes on Dr. Press for scrub teams |
| Specimens note on Smart table |

<table>
<thead>
<tr>
<th>Soft goods, sutures, blades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display data from monitors</td>
</tr>
<tr>
<td>Needles? Hard to track</td>
</tr>
<tr>
<td>What works best for the back table?</td>
</tr>
</tbody>
</table>
Design Concepts

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Design Concepts

1. Induction
2. Positioning
3. Exposure
4. Intervention
5. Induced for the best operation
6. Carts and shelves
What if the operating room itself could be a checklist? The Bright Vision Room turns the operating room’s floors and walls into communicators that organize the activities of the room inside and out....
Bright Vision Room

1. Walls indicate stage of surgery to people inside and out of the room.
   - Color changing floor changes in relation to surgery’s furniture set-up.
   - Floor wipes to neutral when cleaned with bacteria-sensing mop.

2. Walls send messages to monitoring staff and patient’s families about stage of surgery.
   - Colored feet on furniture indicate where they are to be placed on the floor.

3. Induction, Positioning, Exposure, Intervention

   - Bright Vision Room
1

Bright Vision Room

It is used to set up surgery, using layouts indicated by surgeons.

It communicates with hospital staff and family’s smart phones to indicate stage of surgery. Smart floor technology tracks cleanliness of room and set-up preference with colored chemical tiles and sensor mops.
OR Table Platform

This bed platform is flexible. It is changeable and adaptable depending on types of operation or preferences of surgeons. It provides optimal operation environment.
OR Table Platform

- Movable Tray
- Control panel
- Secondary lights

Integrated stepper
Surgeons are able to control the screens above the OR table through this control panel, so that nurses or students can see where the surgeon is indicating during a teaching moment. Also, the control panel is connected to the tool cleaning room on the basement. If surgeons ask for a specific tool they need to use, through image sharing, surgeons are able to make sure the right tool is being brought up.
Centralizing critical information gives everyone around the room a single source for shared data and is placed at the focus of activity.
Central Information system

Central Screen
Motion Capture System
Fixed vs. Adjustable Mounting System
By aggregating the screen to the patient table, the OR team can focus attention to the operation instead of gazing around the room for important information.

A motion capturing “black box” records surgery for later review and teaching purposes.

Reducing the number of adjustable lights cleans out the OR space to reduce the sense of clutter and confusion. With a modular mounting system, doctors can request “plug and play” lighting and information systems for specialized surgeries.
4

Smart Table

Setting up the tools for an operation takes up valuable OR time and mastery of this process requires deep knowledge of operations and the surgeons’ preferences.

We believe that the back table should go from passive furniture to active team member by aiding the scrub team throughout the operation.
Smart Table

- Active projection surface
- Object reading capability
- Adaptable hands free user interface

Tools for the Next Operation
Smart Table

Active projection surface displays ideal tool layout based on operation and surgeon preference.

Camera provides feedback to track tools and layouts.

Tool usage and layouts will save to database for preferences and analytics.
Complex operations require more tools, ultimately bringing in more carts and adding complexity to the operating theater. By augmenting the standard cart with the ability to expand its usable surface, we can use fewer carts for more complex operation.
Pluscart

- Expandable surface
- Additional storage for secondary, just-in-case tool trays
Pluscart
Backstage Elements

Taking items common to all ORs—trash receptacles, sutures, personal storage—and building them into a system reduces cognitive load on staff members and introduces elements of consistency to a situation in which “every surgery is unique.”
Backstage Elements

Consistent visual language

Moves secondary or just-in-case items to the background
Next Step

- Review with surgeon, OR staff, hospital management
- Concept evaluation with stakeholders
- Feasibility study
- Final prototype
- Implementation plan
- Final proposal to hospital management
Thank You

Martin Thaler
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SeungCheol Lee
HsnCheng Lin
Brian Lucas
Beth Schwindt
Evan Scott
Kaiwei Tang