Healthcare Systems Engineering as an Improvement Strategy
(Week 1)

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www.HSyE.org
Objectives

1. Overview of HSyE
2. Common types of problems and methods
3. Examples
   a. Simple through advanced
   b. Micro, meso, macro
4. Discussion and interests
Mission: Broad measurable impact on health care, nationally, thru integration of research, education, and application of industrial and systems engineering.
Systems Engineering

Introduction
Ways to improve systems

Systems engineering
- Models approaches
- Methods approaches

Systems design

Systems thinking (Key)

Systems innovation
- CQI
- PDSA

Integration art/challenge

Hope & Pray
- Lean
- 6 sigma

Process and system can be used mostly interchangeably
What is systems engineering?

- Set of methods to understand, model, improve, and optimize process / system performance
- Used in almost every other complex industry
- Underused in healthcare

**Methods**
- (mathematical, computer, graphical)

**Uses**
- Improve, optimize, control

**Foci**
- Better systems & processes
Range of methods

- **Basic methods**:
  - Basic front-line improvement
  - Lean, Six sigma, PDSA
  - Simple

- **Advanced methods**:
  - PhD
  - Systems engineering
  - Industrial engineering
  - Operations research
  - Management science
  - Hard

- MS

- **PhD**
  - 100%

- **BS**
  - 70%

- **MS**
  - 90%

- **% of Benefits**
What is systems engineering?

Industrial and Systems Engineering

1. Methods-based
   - PDSA
   - Lean
   - Six Sigma
   - etc

2. Model-based
   - Computer simulation
   - Probability and stochastic models
   - Mathematical optimization
   - etc

3. User-centered design
   - Human factors
   - Socio-technical systems

One of most common quantitative IE methods

We already do a lot of this

Simple

Complex
Typical methods
## Typical applications

<table>
<thead>
<tr>
<th>Logistics &amp; efficiency</th>
<th>Patient flow &amp; Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Inventory and supply chains</td>
<td></td>
</tr>
<tr>
<td>• OR scheduling and turn-around</td>
<td></td>
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<tr>
<td>• Academic workforce logistics</td>
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<tr>
<td>• Regional network design</td>
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<tr>
<td>• Real time location systems</td>
<td></td>
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<tr>
<td></td>
<td>• Access, waits and delays</td>
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<tr>
<td></td>
<td>• Patient flow simulation</td>
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<td></td>
<td>• Workflow smoothing</td>
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<tr>
<td></td>
<td>• Capacity planning, scheduling, and demand management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Medical decision making</th>
<th>Quality &amp; patient safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Treatment optimization</td>
<td></td>
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<tr>
<td>• Screening and diagnostic tests</td>
<td></td>
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<tr>
<td>• Radiation therapy optimization</td>
<td></td>
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<tr>
<td>• Patient shared decision support</td>
<td></td>
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<tr>
<td>• Palliative and hospice care</td>
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<tr>
<td>• Medical alternative evaluation</td>
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<td></td>
<td>• Reliable and consistent care</td>
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<td>• Adverse events reduction</td>
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<td></td>
<td>• Preventable readmissions</td>
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<tr>
<td></td>
<td>• Care continuity</td>
</tr>
<tr>
<td></td>
<td>• Human factors engineering</td>
</tr>
<tr>
<td></td>
<td>• Quality/improvement science</td>
</tr>
</tbody>
</table>
Basic QI Methods

recap – more thursday
## Process improvement methods

### Variety of approaches

80%+ problems

### Common concepts:

- **Understand** current process
- **Draw picture** of process logic
- **Use data** (before/after)
- **Test** improvement ideas

<table>
<thead>
<tr>
<th>Approach</th>
</tr>
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<tbody>
<tr>
<td><strong>Total quality mgmt (TQM)</strong></td>
</tr>
<tr>
<td><strong>Continuous quality improvement</strong></td>
</tr>
<tr>
<td><strong>PDCA / “Model for Improvement”</strong></td>
</tr>
<tr>
<td><strong>Six Sigma</strong></td>
</tr>
<tr>
<td><strong>Lean Toyota Production System</strong></td>
</tr>
</tbody>
</table>
Common QI/6σ tools

“Basic 7 Tools”

- Check sheets
- Pareto charts
- Cause-and-effect “fishbone” diagrams
- Process flow charts
- Histograms
- Scatter diagrams
- Run and control charts
1. Process improvement examples

Flow, capacity, utilization, bottlenecks
**Congestive heart failure readmissions**

**Aim:** Reduce CHF readmission costs 25% by increasing post-discharge follow-up appts ≤ 7 days

**Approach:** Basic process flow, data analysis, and CQI
Central line ICU infections

Aim
Reduce ICU CLABSI rate and associated costs by 50% within 9 months through implementation of “bundle”

Approach
• Process flow analysis
• Bundle implementation via reliability science and human factors models

CLABSI Bundle
1. Insertion technique, hand hygiene
2. Low risk site selection
3. Maintenance (sterile)
4. Daily removal assessment

<table>
<thead>
<tr>
<th>Reliability tier</th>
<th>Strategies</th>
<th>Measures</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Process</td>
<td>Outcome</td>
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<tr>
<td>Prevent</td>
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<td>Detect</td>
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<td>Mitigate</td>
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<tr>
<td>Redesign</td>
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</table>
Peri-operative inventory

Aim
Reduce peri-operative supply costs by 20% via inventory methods, lean concepts, and preference card reduction

Approach
• Establish/revise PAR levels for 80% of “A” items
• Standardize & reduce preference cards
• 5S inventory areas
“Six Sigma” DMAIC basics

- **Focus**: Quality improvement
- **Structured approaches, integrated measuring**
  - **DMAIC**: Improve existing process
  - **DFSS**: Design for Six Sigma
  - **DMADV**: Define, Measure, Analyze, Design, Verify
DMAIC example

- **Define**: Process maps for EBM delivery (AMI, SSI, CHF)
- **Measure**: Baseline element and composite measures
- **Analyze**: Weekly review of 10 random patient charts by change agents and case coordinators. Root cause analysis
- **Improve**: Staff education, order sets, Protocols, check lists
- **Control**: Standardize processes. Compliance monitoring

[Chart 1: Charleston Area Medical Center: Time from Arrival to Delivery of PCI Procedures, 2007]

SPC methods

‘Simple’ Methods

Ventilator-Associated Pneumonia (VAP)

![VAP Rate Chart]

NICU Birth Temperature

![Temperature Chart]

Advanced Methods

Complication Rate EWMA

![Complication Chart]

Background Improvement Trend

\[ Y_i = \beta_0 + \beta_1^* T_i = 11.15 + 0.087^* T \]
2. Breast milk feeding

- **Aim:** BMF during/after (↑)
- **Full or low birth weight babies (NICU)**
- **Better for baby, mom**
- **Complications, LOS, $ (↓)**
Simple tool support

Comparing multiple system or measures
z charts

Reliability process design

<table>
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</tr>
<tr>
<td>Redesign</td>
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</tbody>
</table>

Process mapping

Statistical diagnostic tools
Automated/Excel tools, dashboards

- Option for initial baselines
- **Tabs**: Data input, run charts, definitions, instructions
- Automatically plots run charts
Model-based improvement – beyond basic QI

Max \( Z = \sum_k \sum_t \sum_r \sum_s w_{kt} * p_{ktrs} \)

\( \sum_t A_{mts} \leq 1 \) \hspace{1cm} \( \forall i, s \) and \( \forall m \in G_i \)

\( \sum_s A_{mts} = R_{mt} \) \hspace{1cm} \( \forall i, t \) and \( \forall m \in G_i \)

\( A_{mts} = 1 \) \hspace{1cm} \( \forall (m, t, s) \in O_i \)

\( \sum_{n \in D_{mt}} A_{nts} \geq A_{mts} \) \hspace{1cm} \( \forall i, t, s \) and \( \forall m \in G_i, D_{int} \neq \emptyset \)

\( A_{nts} + A_{mts} \leq 1 \) \hspace{1cm} \( \forall i, t, s \) and \( \forall m \in G_i, \forall n \in U_{int} \)

\( \sum_m A_{mts} \geq C_{it} \) \hspace{1cm} \( \forall i, t, s \) where \( m \in G_i \)

\( \sum_m A_{mts} \geq \sum_k k * p_{ktrs} \) \hspace{1cm} \( \forall t, r, s \) where \( m \in Q_{r}^t \)

\( \sum_r p_{ktrs} \geq Goal_t \) \hspace{1cm} \( \forall t, s \)

\( A_{mts} \in \{0,1\} \) \hspace{1cm} \( \forall m, t, s \)

\( p_{ktrs} \in \{0,1\} \) \hspace{1cm} \( \forall k, t, r, s \)
What is a model...?

- An artificial representation of the real world
- Perhaps idealized, simplified; hopefully useful

“All models are wrong, some are useful”
- G.E.P. Box
3. Unnecessary referrals or consults

Flow logic

Potential referral need \rightarrow Model \rightarrow Predictive model * (logistic regression) \rightarrow Curbside consultation \rightarrow Leave system

%_1 \quad %_2 \quad 1-%_1

Appointment still required (for %_1 \times %_2 << 100%)

F2F referral \rightarrow Appointment occurs f2f

Threshold optimization

* regression, support vectors, classification trees, ensemble methods, etc
Results

Application
- One neurology sub-specialty
- One month off-line testing
- Retrospective review as gold standard

Results
- 23% reduction in F2F consults
- 3% remaining F2F’s unnecessary
- Corresponding improved access
- $223K/month estimated savings
4. Predictive modeling

Same day forecast (1-4 hours)

Long term forecast (1-30 days)

Inputs:
1. Starting conditions
   - Beds occupied
   - How long
2. Probabilistic
   - Flow paths
   - Lengths of stay
3. Arrivals
   - Scheduled
   - Emergent

Predicting Emergency Department Inpatient Admissions to Improve Same-day Patient Flow

Jordan S. Peck, MS, James C. Benneyan, PhD, Deborah J. Nightingale, PhD, and Stephan A. Gachde, MD, MPH
Weather forecast metaphor
Example of CCU bed demand model accuracy

CCU 2-week look-ahead forecast – Retrospective study
Patient no-shows

Approach

1. Reduce no shows (CQI)
2. Predict no-shows (regression)
3. Optimal over-book amount (probability cost model)
4. Decide when overbook (simulate)
5. Test/refine in practice (DOE)

\[
E(TC) = \sum_{x=0}^{N-1} C_u (N-x) P(X=x) + \sum_{x=N+1}^{M} C_o (x-N) P(X=x)
\]

where \( P(X = x) = \binom{M}{x} (1-p)^x p^{M-x} \)

Projected $236,000 savings (1 clinic)
5. Computer simulation: Flow example

Process Logic

Overview Flow of Pediatric Department

(4 Providers)

Patient Arrives to See a Particular Provider

(1 Receptionist)

Receptionist Available?

Yes

No

Wait To Check In...

Patient Checks In

(Random Check-In Time)

Provider’s Exam Rm Available?

No

Wait For Exam Room...

Yes

(Random MAs)

Medical Assistant Available?

No

Wait in Exam Room...

Yes

Put Patient in Room

(Random Prep Time)

Medical Assitant Preps Patient

Particular Provider Available?

No

Wait in Exam Room...

Yes

See Particular Provider

(Random Exam)

Make Follow Up and Depart

Analysis Results & Accuracy

Location of Patients in Pediatrics

Comparison Of Simulation Results and Collected Data

Model accuracy - Simulation vs real data

Pediatric clinic simulation

Comparison of Simulation Results and Collected Data
4 Providers, 2 "Up" MAs

<table>
<thead>
<tr>
<th>Observation unit simulation</th>
<th>Change in process &amp; model</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Wait Until See Provider</strong></td>
<td><strong>25.7</strong></td>
</tr>
<tr>
<td><strong>Wait for Reception</strong></td>
<td><strong>1.9</strong></td>
</tr>
<tr>
<td><strong>Wait for Up MA</strong></td>
<td><strong>9.6</strong></td>
</tr>
<tr>
<td><strong>Wait for Provider</strong></td>
<td><strong>8.8</strong></td>
</tr>
</tbody>
</table>

**Validation Output:** Comparison of Simulation Results to Real Process

**Comparison of Simulation Results and Collected Data**
3 Providers, 2 "Up" MAs

<table>
<thead>
<tr>
<th></th>
<th>Collected Data</th>
<th>Simulated Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total Wait Until See Provider</strong></td>
<td><strong>23.4</strong></td>
<td><strong>22.8</strong></td>
</tr>
<tr>
<td><strong>Wait for Reception</strong></td>
<td><strong>1.9</strong></td>
<td><strong>1.7</strong></td>
</tr>
<tr>
<td><strong>Wait for Up MA</strong></td>
<td><strong>6.3</strong></td>
<td><strong>6.8</strong></td>
</tr>
<tr>
<td><strong>Wait for Provider</strong></td>
<td><strong>8.8</strong></td>
<td><strong>7.9</strong></td>
</tr>
</tbody>
</table>
Room utilization logic

Aim
Consolidate low utilized patient rooms to eliminate ~$2m/yr overflow space costs by hybrid room pooling

Approach
• Room sharing simulation
• Open availability real-time RTLS tool
• Pareto/CQI of reasons new process not followed
**ED Observation Unit**

### Standard Process Improvement

- Chest Pain Arrivals
- ST Elevation?
  - Yes (15%)
  - No (85%)
- History and Check-Up
- 1st Troponin Test
- Positive Troponin?
  - Yes (18%)
  - No (82%)
- Wait Until Bam
- Exit Model (Obs. Complete)
- Check Patient Status
- Stress Test Interpretation
- Stress Test
- Resource Available?
  - Yes
  - No
- Wait for 2nd Troponin Test Time
- 2nd Troponin Test

### Computer Simulation Analysis

#### OU LOS Bin (Hours)
- **Computer model**
- **Real system**

#### Average wait time
- CTA: 0:09
- ET Stress: 0:48
- PET/CT: 11:21
- SPECT: 0:31
- SPECT/CT: 0:16
- Stress echo gram: 2:42

#### Process ave time
- CTA: 1:35
- ET Stress: 1:13
- PET/CT: 1:06
- SPECT: 1:31
- SPECT/CT: 2:25
- Stress echo gram: 1:59

#### % of all tests
- CTA: 1%
- ET Stress: 51%
- PET/CT: 22%
- SPECT: 19%
- SPECT/CT: 3%
- Stress echo gram: 3%

---

Troponin: 3 hrs
Lab: 4 pm
Stress test: 10%

**OU LOS (hours)**

- **Current State**
- **Trop Delay, ST Fraction**
- **All 3 Improvements**
Macro system example

- New facility master space planning
- Queuing flow simulation

Number people in Lobby by time of day

- 95th percentile
- 50th percentile
- 5th percentile

Graph showing the number of people in the lobby by time of day with 50 random days and 95th percentile.
Regional EMS example

- Ambulance location and routing
- Maximize survival probabilities

GWENT NEWS

Welsh ambulance review urges end to 8-minute 999 target

By Andy Rutherford - Health correspondent
Policy examples (Monte Carlo)

Cancer Screening Policies
Comparison of alternate policies

Spread of Epidemics (or improvements)

Cellular automata Monte Carlo
Spread of Bird Flu
System dynamics example

• Typically macro level or policy analysis

• Concepts of ‘flows’, ‘stocks’, ‘rates’, feedback loops

• Based in differential equations

• Also very useful thinking exercise
# 6. Optimization models

## Basic elements

- **Objective function**
  - Cost, quality, safety...

- **Constraints**
  - Resources, capacity, time, sequences, etc

- **Decision variables**
  - Staff level, start time, locations, capacity...

## Types of methods

- **Math programs**
  - Linear programming
  - Nonlinear, integer

- **Search optimization methods**
  - Genetic algorithms
  - Random searches

- **Calculus-based methods**
### 3. Optimization models

<table>
<thead>
<tr>
<th>Description</th>
<th>Example: Inventory Purchasing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Objective function</strong></td>
<td>What are trying to achieve? (Maximize / minimize some thing of interest)</td>
</tr>
<tr>
<td></td>
<td>Minimize total purchasing cost of all inventory</td>
</tr>
<tr>
<td><strong>Decision variables</strong></td>
<td>What can we change? (What model solves for)</td>
</tr>
<tr>
<td></td>
<td>How much of each item to buy from each potential vendor</td>
</tr>
<tr>
<td><strong>Constraints</strong></td>
<td>What can't we change? (Logistical givens)</td>
</tr>
</tbody>
</table>
| | • Must buy $\geq N_i$ quantity of Item $i$
| | • Can not buy more from Vendor $K$ than they produce |
Supply contract example

- \( J \) types of items
- Need to buy \( n_j \) of each
- \( K \) vendors
- Complex purchasing contracts based on total volume bought from each vendor annually
- \( m_{j,k} \) = Maximum item \( j \) available from vendor \( k \)
- \( x_{j,k} \) = Number item \( j \) bought from vendor \( k \)

Minimize: Total cost of all items from all vendors

Subject to:

\[
\begin{align*}
x_{1,1} + x_{1,2} + \ldots + x_{1,k} &= n_1 \\
x_{2,1} + x_{2,2} + \ldots + x_{2,k} &= n_2 \\
&\vdots \\
x_{j,1} + x_{j,2} + \ldots + x_{j,k} &= n_j \\
0 &\leq x_{j,k} \leq m_{j,k} \quad \text{for all } (j, k)
\end{align*}
\]
Scheduling examples

**General Problem**

- Scheduled cases
  - Advance scheduling
- Urgent cases
  - Add-on scheduling

**Anesthesia**

- Breast Cancer Surgery
  - Oncology surgeon team
- Reconstruct Surgery
  - Plastic surgeon team

**Lag = 0**

**Surgery only**

**Elective**

**Integrated Approach**

- Co-availability & Care team scheduling
- Input
- Downstream linked event scheduling
- Output
- Optimal surgery schedules
- Input
- Simulation evaluator & local optimizer
- Output
Models

Monte Carlo Simulation

1. User inputs
2. Replication loop
3. OR loop
   - Yes → Evaluate the assignments
   - No → OR = n?
      - Yes → Calculate results
      - No → Replication = R?

Integer Programming

Maximize $\sum_{\phi} \sum_{j} \sum_{k} R_{\phi j k}$

subject to,

- $\sum_{j} s_{i j k} \leq 1 \quad \forall i, k$
- $\sum_{j} n_{i j k} \leq 1 \quad \forall l, k$
- $\sum_{j} a_{m j k} \leq 1 \quad \forall m, k$
- $\sum_{i} s_{i j k} = 1 \quad \forall j, k$
- $\sum_{i} n_{i j k} = 1 \quad \forall l, k$
- $\sum_{m} a_{m j k} = 1 \quad \forall j, k$
- $\sum_{j} \sum_{k} s_{i j k} \leq K \quad \forall i$
- $\sum_{j} \sum_{k} n_{i j k} \leq K \quad \forall l$
- $\sum_{j} \sum_{k} a_{m j k} \leq K \quad \forall m$

$s_{\phi j k} + n_{\phi j k} + a_{\phi j k} = B_{\phi j k} \quad \forall \phi, j, k$

$B_{\phi j k} - 3x_{\phi j k} - 2y_{\phi j k} - 1u_{\phi j k} = 0 \quad \forall \phi, j, k$

$r_{1} * x_{\phi j k} + r_{2} * y_{\phi j k} = R_{\phi j k} \quad \forall \phi, j, k$

$x_{\phi j k} + y_{\phi j k} + u_{\phi j k} + v_{\phi j k} = 1 \quad \forall \phi, j, k$

$x_{\phi j k}, y_{\phi j k}, u_{\phi j k}, v_{\phi j k} \in \{0, 1\} \quad \forall \phi, j, k$

$R_{\phi j k}, B_{\phi j k} \geq 0 \text{ and integer} \quad \forall \phi, j, k$

$s_{i j k} \in \{0, 1\} \quad \forall i, j, k$

$n_{i j k} \in \{0, 1\} \quad \forall l, j, k$

$a_{m j k} \in \{0, 1\} \quad \forall m, j, k$
More complex example: PCP team continuity

Team 1

Teamlet Continuity

Access
Third next available appt

Team 2

Teamlet Continuity

Access
Third next available appt

Team 3

Teamlet Continuity

Access
Third next available appt
Marco example: Network design

Conceptual model

- Abnormal sleep breathing
- 20% veterans, $534m (2010)
- Inadequate access to testing

5 - 15% cost ↓
10 - 35% access ↑
15% in-house care ↑
Questions
• Where to locate which care services?
• In what capacities?
• Which patients receive care where?
• What if demand changes?

Objectives
• Max within network care
• Minimize cost
• Minimize distance
• Inappropriate evening ED use (~$30m/year)
• Cross-coverage for after-hours
End-user tools (excel example)

Model in Words

Maximize: Coverage preferences
While:
Satisfying all demand
Balancing burden on MDs

Model in Math

\[
\begin{align*}
\text{Max} & \quad \sum_i \sum_j c_{ij} x_{ij} \\
\text{subject to} & \quad \sum_j x_{ij} = D_i \quad \forall i \\
& \quad \sum_i x_{ij} \geq S^{\text{min}} \quad \forall j \\
& \quad \sum_i x_{ij} \leq S^{\text{max}} \quad \forall j \\
& \quad x_{ij} \in \{0, 1\} \quad \forall i, j
\end{align*}
\]
7. Policy and clinical decision making

Incentive policy analysis (readmissions)

Diabetes self-care adherence

System dynamics behavior change model

Abx stewardship

Total joint replacement decision and timing

Treatment decision optimization
History of IE in HC
Historical IE applications

Long history of application
Do we just need more...?
Or do we need to do it differently...?

Scientific Mgmt
Curiosity Phase

1910

IEOR Utility
Demonstrating Usefulness:
Methods Improvement

1950

IE/OR Growth
Growth in Applications
of IE Techniques

1965

Ops Res
Mgmt support
Management Support,
Costing, Information
Services

1980

Advanced / nuance
applications

1988

Doers → Assistors

1992

(Adapted from
Sahney, JSHE, 1993,
4(1):3-17)

1999

2000

Safety
Access
Clinical
Meaningful use
1970s examples

**Operating Room Usage**

![Graph showing block scheduling](Image)

**Ergonomics**

**Capacity Planning**

<table>
<thead>
<tr>
<th>TABLE 14-1. Facilities Required for Maternity Service</th>
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</thead>
<tbody>
<tr>
<td><strong>Admissions</strong></td>
</tr>
<tr>
<td><strong>beds per 100 patients per yr</strong></td>
</tr>
<tr>
<td>580</td>
</tr>
<tr>
<td>1693</td>
</tr>
<tr>
<td>2771</td>
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<tr>
<td>3874</td>
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<td>5000</td>
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<td>7229</td>
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<tr>
<td>8161</td>
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<tr>
<td>9424</td>
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</tbody>
</table>

*LR = Labor rooms; PPR = Postpartum rooms; CSR = Caesarean section rooms; DR = Delivery rooms
Nurse rotations - IP (H. Wolfe, 1965)

Cancer screening - Markov (D. Eddy, 1980)


Founder and medical director of Archimedes
Oldies but goodies

Time and Motion Study

SINCE the very beginning of time and motion study, hospital problems have been closely associated with it. During his early years in the construction business Frank Gilbreth had a friend who was going through his internship and through him became tremendously interested in problems of hospital administration, in the techniques of management and in all the activities that go on in a hospital. Naturally, the most fascinating of these were in the area of surgery and in the work of the surgeon and all those who assisted him in the operating room. Several accidents at this time gave him first-hand experience as an observer which he utilized to the full.

Later, as he developed the techniques of micromotion study and of the cyclograph method of recording the tasks of motions, he had the needs of the hospital in mind, and the publications of the time and since that time, both in the hospital field and in that of industrial management, take account of the applications of these techniques in the hospital field.

Since that time those who have been carrying on the development of time and motion study or work simplification have added to and adapted the techniques until it would now seem time for the hospital group itself to take over the entire project of the utilization of available material in this field, to evaluate what has been done, to estimate what needs to be done and to utilize to the fullest the cooperation that is available from all of us who are working in the time and motion study field.

Of the material that is available for review and evaluation, much concerns itself directly with hospital problems. Groups of doctors, nurses, hospital administrators, hospital personnel people, those in charge of dietary, of laundry and of other areas of hospital work have invited management men and specialists in time and motion study to speak at their meetings and in many cases have discussed the papers intelligently and comprehensively and have followed the meetings with applications of principles and techniques to their own problems or with

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projects which have been carefully carried through.

In many cases material that might be of great and immediate use in hospitals is in the management literature but not in the hospital vocabulary. The underlying principles of time and motion study are applicable in the hospital field as in all other fields, but it is for the hospital man rather than the time and motion man to make clear how many of these are directly applicable in the hospital field and how many must be adapted for use there.

Through the years we have been accustomed to having every person who becomes interested in time and motion study and the possibility of its application to his work start by saying, “But of course my work is different.” When such a person sees similarity in his work to work in other areas we have made a good start, and review and evaluation can take place. We usually establish these likenesses through the old questions: What is being done? Who does it? Where? When? How? Why? These would certainly apply to all fields. It is through attempts to answer these questions that organization charts, functional charts, job analyses, personality analyses and all

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Surgical Demand Scheduling: A Review

By James M. Magerlein and James B. Martin

This article reviews the literature on scheduling of patient demand for surgery and outlines an approach to improving operations in hospital surgical suites. Reported scheduling systems are described, and the implications of scheduling patients in advance of the surgical date are discussed. Available patient on the day of surgery. Approaches to reducing surgical procedure times are also reviewed, and the article concludes with a discussion of the failure to implement the majority of reported scheduling schemes.

During the past decade, considerable work has gone into the development of less-costly hospital systems that can also maintain or even improve the associated quality of care. The surgical suite, which has now recently received attention, is a potentially major area of hospital cost containment for two interrelated reasons: (1) surgical suites generally have high costs and historically low facility and/or personnel utilization rates; and (2) surgical patients provide a significant portion of the demand served by other hospital departments. To realize the full potential for cost containment, surgical suite management policies must consider both the surgical suite itself and its interactions with other areas of the hospital. The primary benefits to be derived from improved management policies would result from better coordination of the demand for hospital services by surgical patients and the levels of resources provided—beds, operating rooms, surgeons, anesthesiologists, and surgical and floor nurses. Improved coordination of demand and supply would allow resource reduction and would limit periods of overuse of resources, thus lowering hospital costs and/or improving the quality of care.

There are four basic approaches to achieving improved coordination of demand and supply:

1. Providing the proper levels of resources. Examples include the number of operating rooms within the surgical suite and the

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FIGURE 4-1. Frames from early Gilbreth film depict motion study of a surgical procedure. (By permission from the Society for Advancement of Management.)
Healthcare and IE today
Lots of basic CQI methods + Some more advanced methods

Airlines
• Reliability
• Scheduling
• Overbooking

Lean / Six sigma
• Waste reduction
• Quality improvement

Human factors
• Error, safety, Ultra-reliability
• Redundancy, forcing functions

Medication Errors
- Nurse gives the patient a medication to which he is allergic
- Patient arrests and dies
- Nurse borrows medication from another patient
- Fax system for ordering medications is broken
- Tube system for obtaining medications is broken
- ICU nurse staffing

J. Reason, 1990
J. Reason and Johns Hopkins Medicine
Discussion

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