A Lean Enterprise Systems Approach to Healthcare Transformation

Professor Deborah Nightingale
MIT Conference on Systems Thinking for Contemporary Challenges
Massachusetts Institute of Technology
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Agenda

- Research Motivation
- Cross-Industry Knowledge on Enterprises
- Case Examples
- Ongoing Research
- LAI Enterprise Healthcare Vision
Research Motivation

Cost
- Over 16% of US GDP spent in healthcare expenses
- Hospital care represents 30.8% of total expenditure
- 49% of expenditure concentrated in only 5% of population
- Individuals over 65 years old expected to increase over 50% by 2020

Quality
- 98,000 deaths attributed to medical errors
- Adults on average only receive 55% of recommended care
- Emergency Departments are overcrowded nationwide
- Provider fragmentation unable of creating sufficient volume

Access
- 45 million Americans are uninsured
- Fragmented provider network, 75% being small or single practices
- Recent survey indicated 40% of Americans received uncoordinated care
- Fragmented payment systems, health plans, information systems, etc

Life Expectancy at Birth and GDP Per Capita
2005 OECD Data

Life expectancy in years

GDP per capita (USD PPP)
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The Challenges of Complex Enterprises Requires a Systems Approach

- New strategic systems perspective
- Viewing enterprises as **holistic** and **highly networked** systems
- Integrating leadership processes, lifecycle processes and enabling infrastructure systems
- Balancing needs of multiple stakeholders working across boundaries

MOVING FROM THE PAST
(hierarchical) enterprise

TOWARDS THE FUTURE
(networked) enterprise
LAI - A Consortium Dedicated To Cross Industry Enterprise Performance

• Enable Enterprises to effectively, efficiently and reliably create value in a complex and dynamic environment

• Enable focused and accelerated transformation of complex enterprises

• Collaborative engagement of all stakeholders in Government, Industry and Academia

• Understand, develop, and institutionalize principles, processes, behaviors and tools
MIT Studies on Industrial Productivity

1989
Identified sources of major weaknesses in US productivity, including commercial aircraft & education.

1990
Identified Lean, based upon Toyota Production System as a successor to mass production.

2002
Translated Lean principles to aerospace and enterprise context.
## Cross Industry Enterprise Challenges

### Aerospace
- Overarching commitment to ensure global peace and security
- Incumbent higher, faster, farther mindset
- Declining defense dollars after Cold War (fewer military aircraft programs; industry consolidation)
- Inherently complex industry:
  - Multiple stakeholders with misaligned objectives and numerous constraints
  - Capital Intensive
  - Complex product development
- Uncertain outcome in contract awarding

### Healthcare
- Overarching commitment to provide world class medical care
- Incumbent overuse, underuse, and misuse mindset
- Overburdened healthcare expenditure as a % of GDP (proliferation of fragmented disjointed providers)
- Inherently complex industry
  - Multiple stakeholders with misaligned objectives and numerous constraints
  - Capital Intensive
  - Complex service provision
- Uncertain outcome in value sharing
Leveraging LAI’s Cross Industry Experience

7 Principles of Lean Enterprise Thinking

1. Adopt a holistic approach to enterprise transformation.
2. Identify relevant stakeholders and determine their value propositions.
3. Focus on enterprise effectiveness before efficiency.
4. Address internal and external enterprise interdependencies.
5. Ensure stability and flow within and across the enterprise.
6. Cultivate leadership to support and drive enterprise behaviors.

Enterprise Transformation Roadmap

**STRATEGIC CYCLE**
- Determine Strategic Imperative
- Purge & Sustain Enterprise Transformation

**EXECUTION CYCLE**
- Create Transformation Plan
- Implementation Results
- Implement & Coordinate Transformation Plan
- Long-Term Corrective Action
- Short-Term Corrective Action
- A Committed Leadership Team
- Understand Current State
- Capabilities & Deficiencies Identified

**PLANNING CYCLE**
- Envision & Design Future Enterprise
- Lean Enterprise Vision
- Align Enterprise Infrastructure
- Alignment Requirements Identified...
- Lean Enterprise Vision

**Source:** Nightingale, Srinivasan and Mize

http://lean.mit.edu
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Healthcare Case Examples

Case 1
- A Primary Care Satellite of a Hospital Provider
- For profit Hospital Provider owns 5 primary care satellites that refer patients to main hospital
- Problem statement:
  - Considerable amount of patient “no shows”
  - Backlog of patients scheduled for appointments
  - Capacity constraints

Case 2
- An Emergency Department of a Hospital Provider
- Non profit Hospital Provider contracts with 11 primary care satellites and owns 3 hospitals
- Problem statement:
  - Emergency Department waiting time is considerable
  - Staff low moral leading to churning
  - Patients leaving without being seen

Case 3
- The New England Veterans Affairs Medical Center
Case 1: A Primary Care Satellite of a Hospital Provider

**Primary Care Satellite**
- Owned by main hospital provider
- Refers patients to main hospital services
- Physicians are not salaried

**Hospital Provider**
- Has patients from multiple insurance companies
- Has multiple referral primary care satellites

**Who is the customer?**
- Satellite administration concerned with attracting physicians and patients
- Physicians concerned with patient care
- Hospital concerned with insurers

**What are the metrics?**
- Insurers focus on different sets of metrics related to costs & preventive care
- Hospital focuses on total patient visits per satellite
- Satellite focuses on total patient waiting time and physician utilization

**What are some of the systemic issues?**
- Hospital attempts to satisfy different metrics from different insurers
- Hospital sets quality of care at a minimum (i.e. what insurance wants) and foregoes continuous improvement
- Satellite focuses on total throughput and neglects departmental variability
- Patients don’t feel the burden of care costs, are unhappy with wait times, and contribute to no show rate
Case 1: Key Process Interactions
Dynamics of Patient No-Shows

Factors
- Hire Doctors
- Limit New Patients
- Floor level improvements

Factors
- Bedside Manner
- Compassion of Support Staff

Factors
- Demand Smoothing
- Wait List Methods

Factors
- Transportation Convenience
- Socio-Economic Factors
- Patient Comprehension of Scheduling Impacts
- No Show Policies
Case 1: Satellite as a Lean Enterprise
Recommendation

Strategic Direction Setting

Objectives should be well understood, actionable, and measurable

No clear strategic objectives

Stakeholder Focus

Shift focus from shareholders to stakeholders

Focus is primarily on enterprise shareholders

Measurement

Metrics need to be consistent and standard

Current metrics do not gauge enterprise performance

Knowledge Management

Cross functional / Cross departmental knowledge review forums

Infrastructure for cross-department knowledge sharing not in place today

Measurement

Shift focus from shareholders to stakeholders

Current metrics do not gauge enterprise performance

Knowledge Management

Cross functional / Cross departmental knowledge review forums

Infrastructure for cross-departmental knowledge sharing not in place today
Case 2: Greater Boston Hospital Case  
(Jorge Fradinho Oliveira, ESD PhD Candidate)

- Leading multi specialty physician led group practice with national and international recognition (i.e. neuro, liver, heart & vascular, etc)

<table>
<thead>
<tr>
<th>2006 Highlights</th>
<th>Problem Statement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergency Visits: 38,631</td>
<td>Emergency Department (ED) struggling to keep up with demand</td>
</tr>
<tr>
<td>Total Beds: 293</td>
<td>Long wait times in the ED and patient leaving without being seen</td>
</tr>
<tr>
<td>Total Staff: 4263</td>
<td>ED staff blame inpatient staff and vice versa</td>
</tr>
<tr>
<td>Total Income: $679,454,000</td>
<td>ED staff turnover levels significant</td>
</tr>
<tr>
<td>Total Expenses: $628,525,000</td>
<td></td>
</tr>
<tr>
<td>Operating Income: $50,929,000</td>
<td></td>
</tr>
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</table>

What can be done to speed patient flow in the ED?  
Where should a process improvement initiative focus?
Emergency Department
Value Stream Mapping

Source: Jorge Fradinho Oliveira, MIT
Emergency Department Analysis

Description of patient time spent in ED

<table>
<thead>
<tr>
<th>Average Total Time Spent in the ED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patients Not Admitted:</td>
</tr>
<tr>
<td>4.14 hrs</td>
</tr>
<tr>
<td>Patient Admitted:</td>
</tr>
<tr>
<td>7.85 hrs</td>
</tr>
</tbody>
</table>

**Simulation Modeling**

Source: Jorge Fradinho Oliveira, MIT
Multi-Attribute Model Provides Framework for Evaluating Emergency Department

Source: Nightingale/Rhodes, MIT 2007
Enterprise Findings

Policy/ External Issues:
• Uninsured population
• Primary care unavailability
• Safety net compromised
• Fee for service payment

Result in:
• 6% of expenses not covered
• 30% non urgent care patients
• Lack of continuous care monitoring often resulting in poorer health and greater expenditure
• Encounter based patient care mentality vs. continuous care

Strategy Issues:
• Focus on revenue generating elective surgery
• 16 strategic objectives (trying to be all things to all people)
• ED absent of strategic plan

Result in:
• Lack of strategic focus
• ED competing for internal resources sought by elective surgery
• ED neglected

Source: Jorge Fradinho Oliveira, MIT
Process Issues:
- Non-standardized admitting process
- Patient boarding (admitted patients without inpatient bed remain in ED)
- Silo process definitions

Result in:
- Variability that leads to waste and compromises provision of timely care
- Costly process bolt-ons (pharmacy dispensing units) and costly care (ED cost structure) and image deterioration
- Lost opportunity to speed patient throughput

Source: Jorge Fradinho Oliveira, MIT
Organization Issues:
- Low staff morale
- Salaried physicians
- Physician cultural rifts

Result in:
- High staff turnover volume
- Lack of productivity incentive
- Finger pointing between ED and elsewhere

Knowledge Issues:
- Vast amount of evidence based medicine
- Reliance on heroes and bed czars
- Incomplete patient records

Result in:
- Less than ideal recommended care provision
- Prone to staff exhaustion and waste (i.e. empty bed goes unnoticed)
- Patient health put at risk due to unknown medical history

Source: Jorge Fradinho Oliveira, MIT
Information Technology Backbone Issues:
• Fragmented information systems
• Proprietary legacy software

Result in:
• Redundant human data entry tasks prone to error
• Frustrated patients requested to provide same information over and over again
• Expensive IT integration consulting fees
• Silo based view of information across the hospital (i.e. unable to see end to end value)

Source: Jorge Fradinho Oliveira, MIT
Non standardized admitting process; patient boarding (i.e. admitted patients held in ED due to lack of inpatient beds); costly bolt ons

Focus on revenue generating elective surgery; 16 strategic objectives; ED absent of strategic plan

Low staff morale; physician cultural rifts; high volume of staff turnover; lack of productivity; finger pointing between ED and elsewhere

Fragmented information systems; costly proprietary software

Uninsured population; primary care unavailability; safety net compromised; fee for service payment model

Timely provision of care compromised; overall hospital image compromised

Reliance on heroes and bed czars; incomplete patient record; high variation of evidence based medicine within and across providers

Source: Jorge Fradinho Oliveira, adapted from Nightingale/Rhodes 2007, MIT
## Preliminary Findings

<table>
<thead>
<tr>
<th>Main Findings</th>
<th>Questions For Further Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED average length of stay considered problematic, but <strong>non-admitted</strong> patients took 4 hours, whereas <strong>admitted</strong> patients took over 8 hours</td>
<td>Why was the ED managed as a <strong>silo</strong> rather than end-to-end?</td>
</tr>
<tr>
<td>ED interacted well with some patient wards but not with others</td>
<td>Was the varying performance of <strong>ED interactions</strong> due to the payment model?</td>
</tr>
<tr>
<td>ED <strong>heroic</strong> employee efforts said to be common rather than sporadic</td>
<td>Could it be that different observed <strong>EA configurations</strong> were directly related to the different observed performance levels?</td>
</tr>
<tr>
<td>ED metrics and strategic goals <strong>misaligned</strong> with overall hospital (X-Matrix)</td>
<td></td>
</tr>
</tbody>
</table>

“The problem of redesign gets harder and the evidence weaker as one moves from the microsystem to the organization.”

*Donald Berwick, President of Institute for Healthcare Improvement, 2002*

Source: Jorge Fradinho Oliveira, MIT
Health Care is a Complex Socio-Technical System

“Simply stated, the U.S. does not have a healthcare system.”

William Brody, President of Johns Hopkins University, 2007

Source: Jorge Fradinho Oliveira, MIT
Case 3: New England Veterans Affairs Partnership and Preliminary Insights

Evolving recent partnership between LAI and the New England Veterans Administration (VISN 1)

Rationale
- Richness of VA enterprise dataset which is shared across multiple regions
- Ability to control for potential misaligned behavior induced by traditional commercial and public healthcare payment models

Context
- “It is not impossible to get your head around the processes and activities in health care. Performance, demand, and structure can be modeled and can be used to improve the enterprise.”

Insights
- “Even if profit is not a significant factor, it is still worthwhile creating and understanding your strategic goals and using them to drive your enterprise forward.”
- “It is not enough just to serve patients as they enter, we must also plan ahead in health care, and work towards being proactive rather than reactive.”
- “We must align the enterprise on all levels and empower management on all levels with an understanding of the greater strategic goals.”
Case 3: X-Matrix

**Metrics vs. Objectives**
- Very strong alignment with most metrics on target
  - Goals are not formal or documented
  - Research is a goal but not measured locally

**Values vs. Goals**
- Strong alignment with areas in service, care, & research
  - Gap lies in aligning goals to values such as:
    - Operating within budget
    - Well-documented monetary transactions

**Metrics vs. Processes**
- Strong alignment with outpatient treatment and clinic wait times
  - Missing metrics for key processes
    - Transfers to inpatient
    - Program referrals

**Processes vs. Values**
- Strong alignment in areas of service, research, & quality
  - Processes addressing the least stakeholder values are primarily patient movement

**Enterprise Metrics**
- Strategic Goals
- Stakeholder Values
- Key Processes

**Processes**
- Strong Alignment
- Weak Alignment

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### Case 3: X-Matrix

#### Key Processes vs. Stakeholder Values
- **Key Processes** are primarily focused on satisfying specific stakeholders however all are taken into account.
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• LAI Enterprise Healthcare Vision
Ongoing Research

• High Performing Hospital Enterprise Architecture (Jorge Oliveira)

• New England Veteran Affairs: Ongoing Research in Process Classification (Jordan Peck)

• NEWDIGS Drug Development – Enterprise Systems Analysis (Center for Biomedical Innovation)

• Impact of Advanced DNA Sequencing Technologies on Clinical Microbiology Processes (Rob Nicol)
High Performing Hospital Enterprise Architectures
(Jorge Oliveira, ESD PhD Candidate)

- Two multi-method exploratory cases conducted at leading US and UK hospitals identified the following research questions and emergent phenomena:

  How is hospital enterprise performance currently measured?

  How could hospital enterprise performance measurement be improved using lean enterprise principles?

  What are different internal organizational design configurations capable of supporting higher performance for different service unit complexities?
Ongoing Research

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Health Care Professionals are starting to recognize predictability

- Emergency Severity Index (ESI)—a five-level emergency department triage algorithm that provides clinically relevant stratification of patients into five groups from 1 (most urgent) to 5 (least urgent) on the basis of acuity and resource needs.

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New England Veteran Affairs
Simulation and Modeling

How can we model Control Options and Interventions?

How do the people fit in?

How well can solutions cross between hospitals?

Source: Jordan Peck, MIT

Source: www.va.gov

Source: www.va.gov

Source: www.va.gov
Ongoing Research

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NEW Drug Development ParadIGmS (NEWDIGS)
CBI’s “NEWDIGS” Drug Development
Enterprise Strategic Analysis
Consortium of Stakeholders

MIT Center for Biomedical Innovation

- FDA & Other HHS Agencies
- Patient Advocacy
- NGOs
- Diagnostics
- Providers
- Systems Integrators
- Payers
- Biotechs & Pharmas
- NGOs
- Providers
- Payers
- Biotechs & Pharmas
• **Mission:**
  “Improve therapeutic product innovation in healthcare”

• **Preliminary Objectives**
  - Develop products that are more effective than existing therapeutic options
  - Reduce time to market, cost, and late stage attrition
  - Improve knowledge about benefit/risk profile of new products

• **Additional strategic objectives:**
  - “Catalyze change across the industry”
  - “Transformational, not incremental”
  - “Strategic, not just tactical”
  - “Global, not just US”
  - “Cross-stakeholder, not just pharma”
CBI’s “NEWDIGS” Drug Development
Enterprise Strategic Analysis Timeline

May 28
Washington, DC
Begin Current State Assessment

Meeting #1
May 28
Washington, DC

July 14
MIT
Continue Current State Assessment

Meeting #2
July 14
MIT

August 19 & 20
Washington, DC
Create Future State Vision

Meeting #3
August 19 & 20
Washington, DC

October 15
MIT
Create Action Plan

Meeting #4
October 15
MIT

November 5
MIT
Stakeholders Meeting

Share findings and solicit input from CBI Members

Meeting #5
November 5
MIT

Research team synthesizes outputs, performs interviews, & customizes methodology
An organization that:

• is lean and highly collaborative with all stakeholders from across the entire value chain;

• is not tied to developing one particular product (i.e., responsive to market need, flexible, adaptive) and rather focuses on integrated healthcare solutions;

• has expertise to understand market and customer(s) health needs and to design potential solutions that intervene earlier in the disease continuum than currently occurs;

• is informed by knowledge generated internally and externally (through pre-competitive, cross-stakeholder data sharing/collaboration) and processes that enable rapid-cycle learning (e.g., Learning Healthcare System);

• has relationships with best-in-class providers of solution components (industry, academia, non-profits), and collaborates effectively with them to develop solutions;

• operates successfully in an outcomes-based reimbursement environment;

• delivers dramatically increased value over the current approach (faster, more efficient, reduced resource expenditure without compromise in outcomes); and

• find solutions focused on patient outcomes driven by patient and payor value as well as scientific/medical community value.
CBI’s “NEWDIGS” Drug Development
Enterprise Strategic Analysis
Proposed Initial Workstreams

Workstreams
1) New Paradigms: Modeling, Simulation, & Decision Support
2) Data, Evidence, and Decision-making
3) Policy Design
4) Organizational Design
5) Others TBD

#1 New Paradigms: Modeling, Simulation, Decision-Support

#2 Process Knowledge IT

• What decisions must be made, when, and by whom?
• What evidence is required to inform these decisions?
• What data is required to generate the necessary evidence?
• What can we do in NEWDIGS to optimize all of the above?

#3 Policy & External Factors

Policy as enabler of scientifically & ethically sound innovation

#4 Products & Services

Organization

Organizational Design – NEWDIGS and the broader Learning Healthcare System
Ongoing Research

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Motivation / Problem

• Antibiotic Resistance Surveillance: Key Healthcare Problem
  • Rapidly increasing resistance
  • Few effective antibiotics remain
  • Limited system level surveillance
  • Process improvement difficult

• Complex Healthcare Processes
  • Large number of tasks and rapidly changing technology
  • Numerous disconnected stakeholders
  • Vast technical design space
  • Highly distributed information (tacit and explicit)

• Severe Health and Cost Impacts
  • 2 Million hospital acquired infections per year
  • $5 Billion (est.) and over 90,000 deaths per year (source: IDSA)

Source: CDC; MRSA = methicillin-resistant Staphylococcus aureus; VRE = Vancomycin-resistant enterococci; FQR = Fluoroquinolone-resistant Pseudomonas aeruginosa
Key Questions

• How can the true system level complexity of healthcare processes be modeled and measured?

• How does this system level process model and complexity measures work on a real world healthcare process design and implementation effort?

• How does process complexity impact change and adoption in healthcare?
• Novel Network Based Process Representation and Complexity Analysis Methodology (model)

• Novel Theory for Process Innovation Adoption as a Function of Process Complexity (model observations)

• First Specification of a Whole Genome Clinical Microbiology Process for MRSA Surveillance (test case for model)

• First Operational Demonstration of a Whole Genome Clinical Microbiology Process for MRSA Surveillance (test case for model and complexity measures)

• First Whole Genome MRSA Diversity Study (real biological results showing policy change needed)
Contributions (Significant Biology Too…)

MRSA Surveillance Process designed and implemented as part of thesis yielded significant insight into MRSA biology which in turn suggests system policy changes needed

Reference (should all be the same as this)

Multiple Genome Alignment of BWH Samples Compared to Reference at the Top

- 50 Genomes Sequenced (<15 existed previously)
- All Supposed to be identical based on current hospital diagnostics
- Significantly different! (look at length)
- Highlights need for surveillance and policy changes
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In 1992 US Air Force asked:
*Can the concepts, principles and practices of the Toyota Production System (TPS) be applied to the military aircraft industry?*

MIT answered: **YES!**

*Over a decade of significant research was conducted well beyond TPS to the Enterprise system level and ultimately delivering superior results for aerospace commercial and governmental sectors*.

In 2009 the Healthcare Community asks:
*Can the concepts, principles and practices of Lean Enterprise Value be applied to the healthcare industry?*

Our Research to date says: **YES!**
What processes are required to support the enhancement, shortening, and improvement of technology and pharma innovation?

How does hospital enterprise performance relate to its enterprise architecture?

What role should Information Technology play in improving information accessibility and flow?

What are key knowledge and decision support tools that enable healthcare system effectiveness?

What are enhanced methods for evaluating and assessing future state health care systems? (e.g., simulation, …)

What can be learned from other industries with regards to holistic enterprise analysis and redesign?
Relevant Research Questions

Metrics and Stakeholder Alignment

- What are the key incentives that drive stakeholder behavior?
- What are the strategies capable of achieving and sustaining multiple stakeholder alignment?
- What are new collaborative stakeholder models?
- How can long-term value propositions be created across multiple providers?
- How should hospital/healthcare service complexity be measured?
- What are the appropriate health care enterprise metrics?
Questions and Answers

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