A Lean Enterprise Systems Approach to Healthcare Transformation

Professor Deborah Nightingale

MIT Conference on Systems Thinking for Contemporary Challenges

Massachusetts Institute of Technology

October 23, 2009

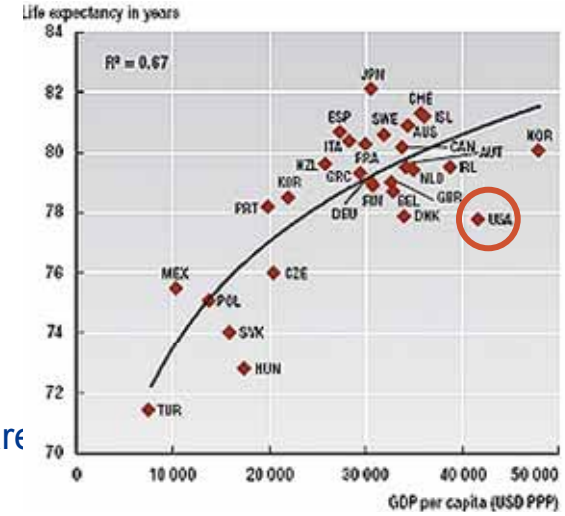
Agenda

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

Research Motivation

Life Expectancy at Birth and GDP Per Capita

2005 OECD Data



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

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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

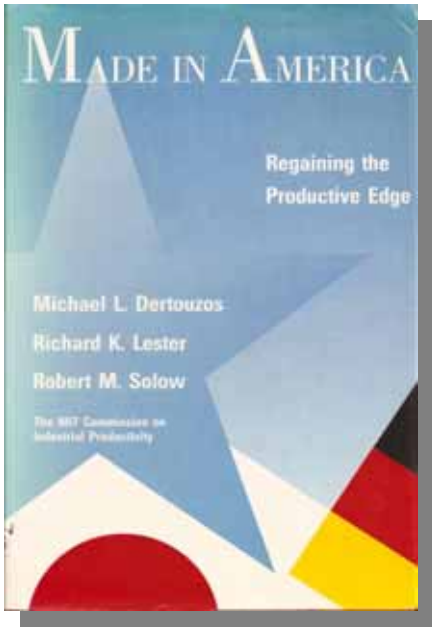
MOVING FROM THE PAST
(hierarchical) enterprise

TOWARDS THE FUTURE
(networked) enterprise

LAI - A Consortium Dedicated To Cross Industry Enterprise Performance

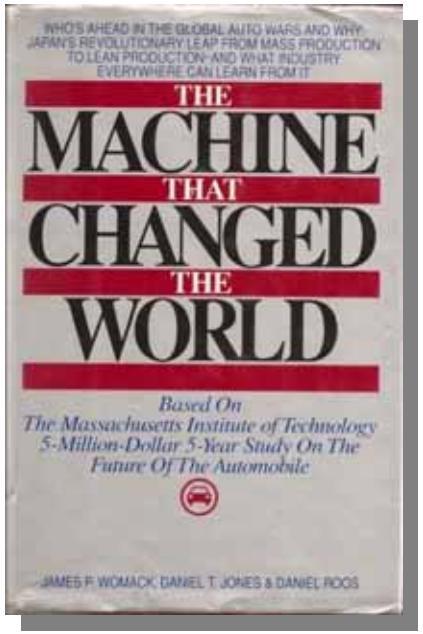
- Enable Enterprises to effectively, efficiently and reliably create value in a complex and dynamic environment
- Enable focused and accelerated transformation of complex enterprises
- Collaborative engagement of all stakeholders in Government, Industry and Academia
- Understand, develop, and institutionalize principles, processes, behaviors and tools

MIT Studies on Industrial Productivity



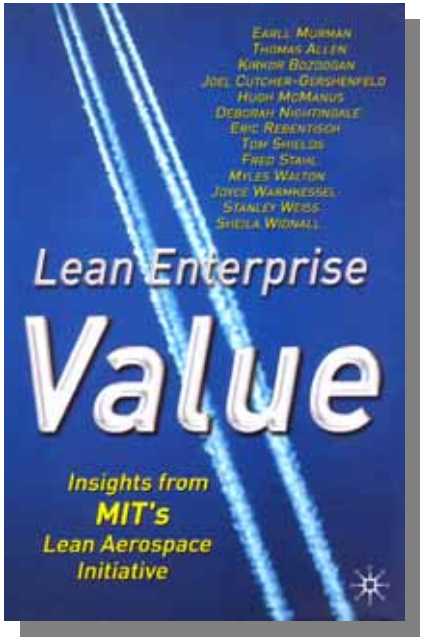
1989

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.

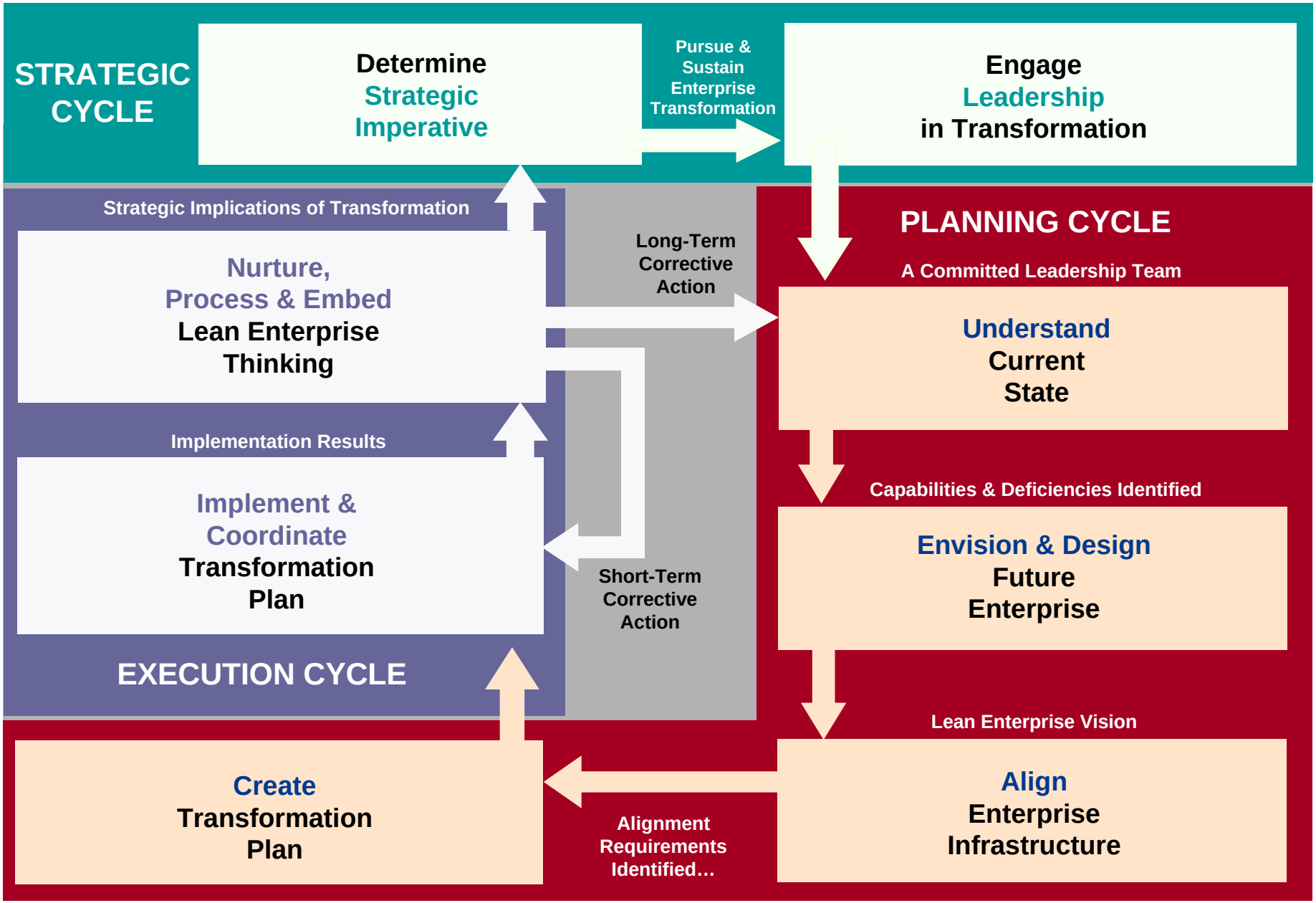
5. Ensure stability and flow within and across the enterprise.

6. Cultivate leadership to support and drive enterprise behaviors.

7. Emphasize organizational learning.

Source: D. Nightingale and J.K Srinivasan, MIT 2008

Enterprise Transformation Roadmap



Source: Nightingale, Srinivasan and Mize

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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

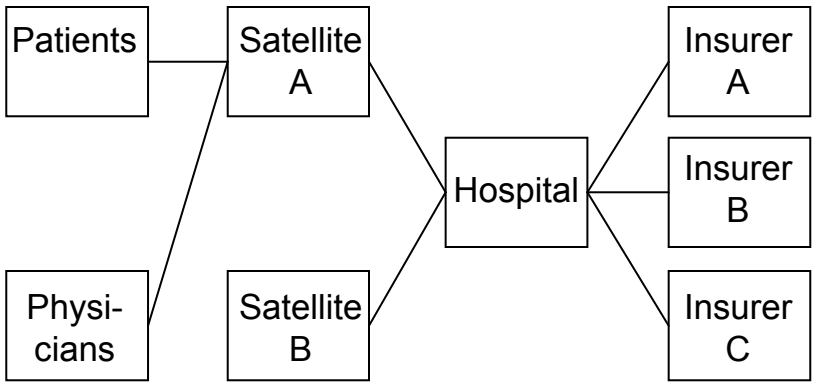
Case 3

- 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



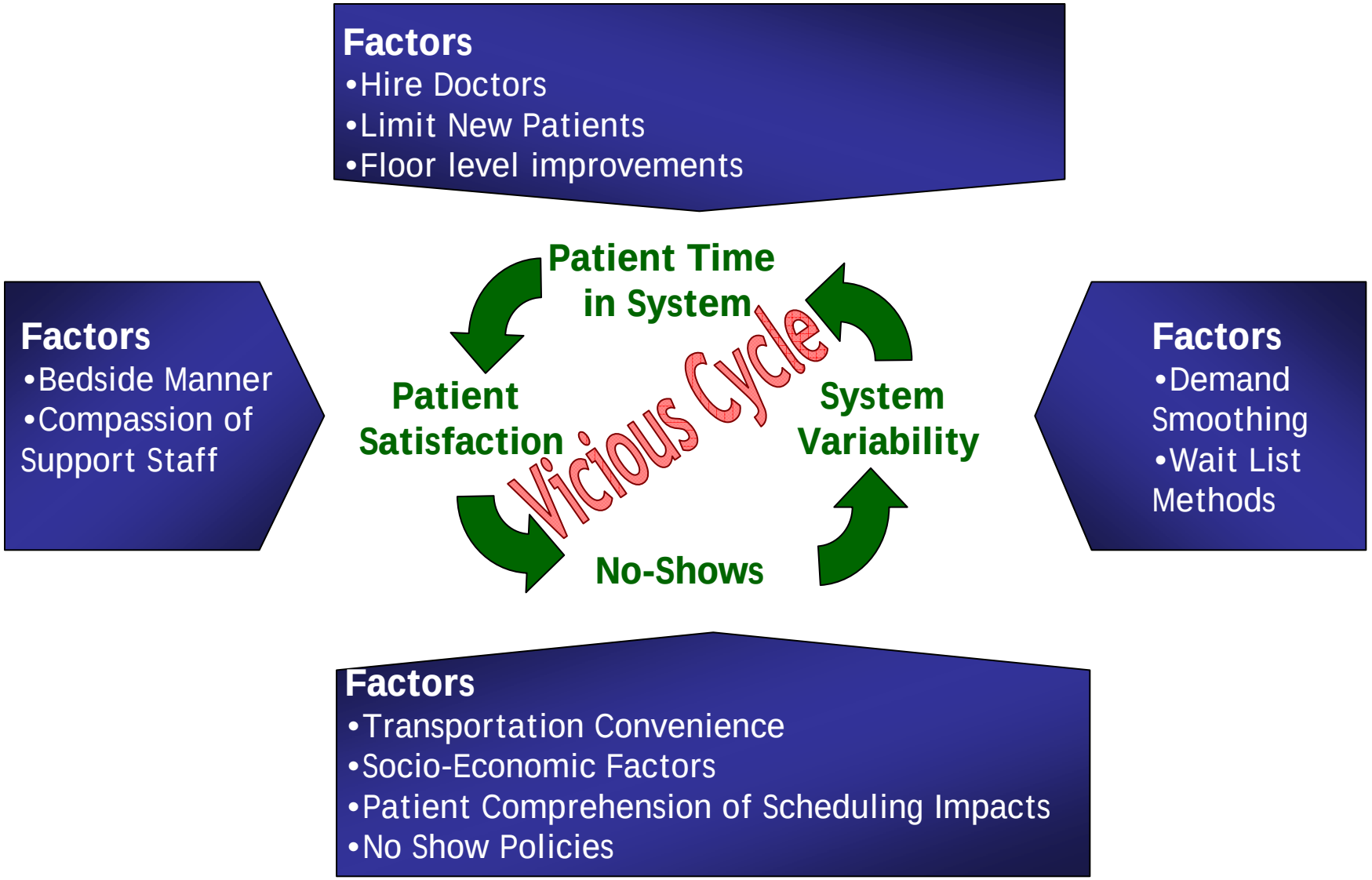
Who is the customer?
- Satellite administration concerned with attracting physicians and patients
- Physicians concerned with patient care
- Hospital concerned with insurers

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

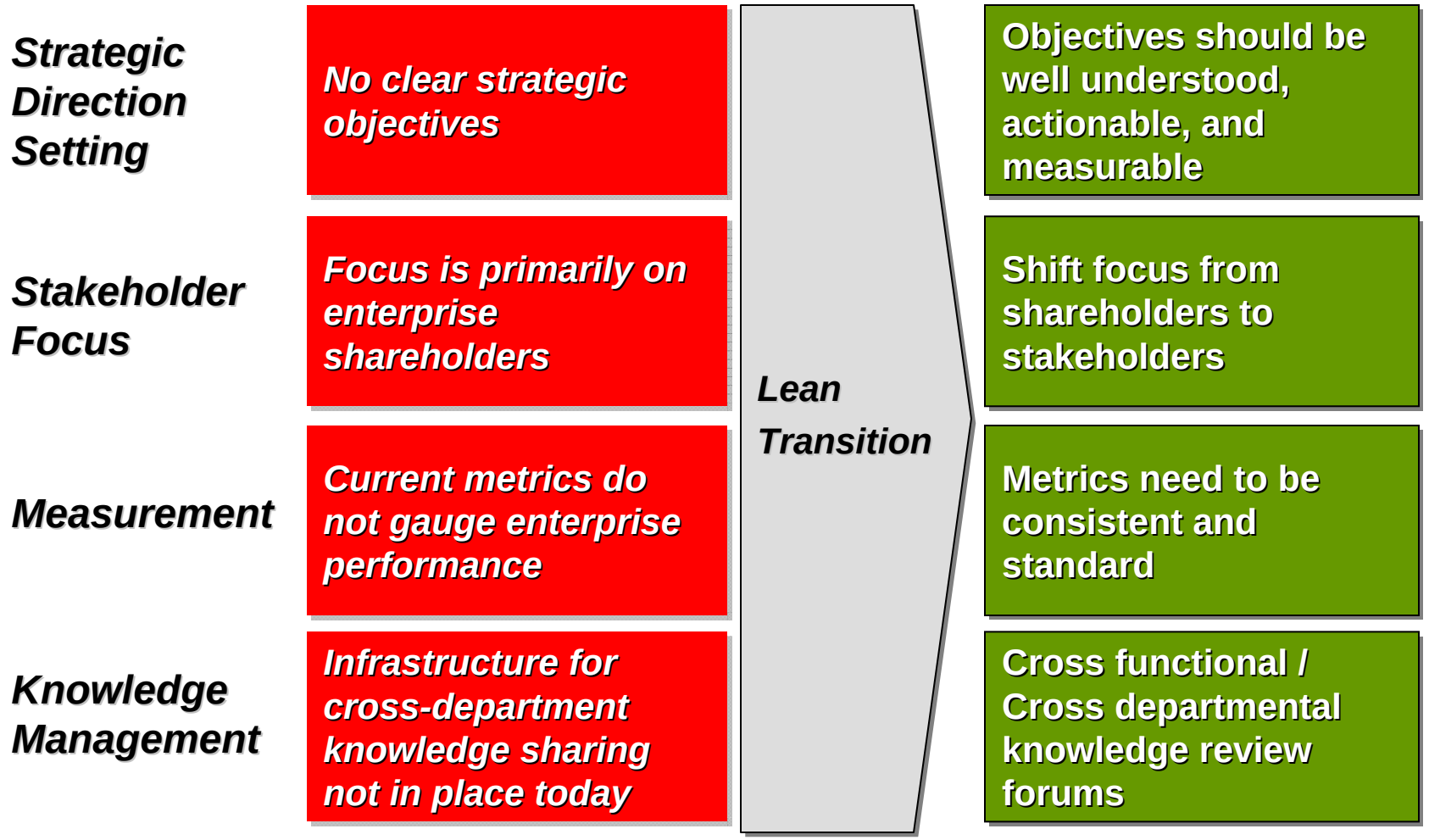
What are some of the systemic issues?
- Hospital attempts to satisfy different metrics from different insurers
- Hospital sets quality of care at a minimum (i.e. what insurance wants) and foregoes continuous improvement
- Satellite focuses on total throughput and neglects departmental variability
- Patients 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



Case 1: Satellite as a Lean Enterprise
Recommendation



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)**

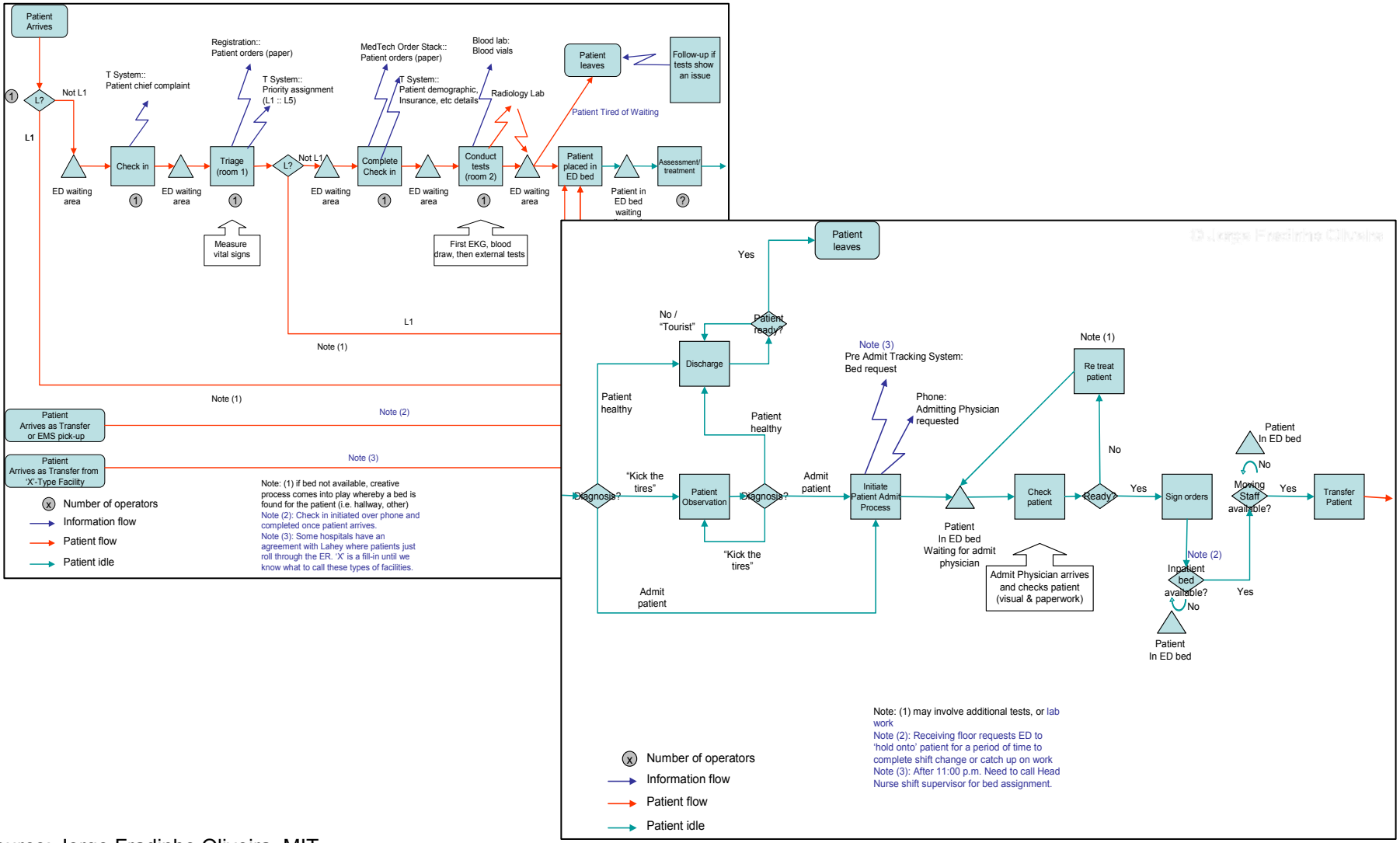
2006 Highlights	
• Emergency Visits:	38,631
• Total Beds:	293
• Total Staff:	4263
• Total Income:	$679,454,000
• Total Expenses:	$628,525,000
• Operating Income:	$50,929,000

Problem Statement

- Emergency Department (ED) struggling to keep up with demand
- Long wait times in the ED and patient leaving without being seen
- ED staff blame inpatient staff and vice versa
- ED staff turnover levels significant

What can be done to speed patient flow in the ED?
Where should a process improvement initiative focus?

Emergency Department Value Stream Mapping

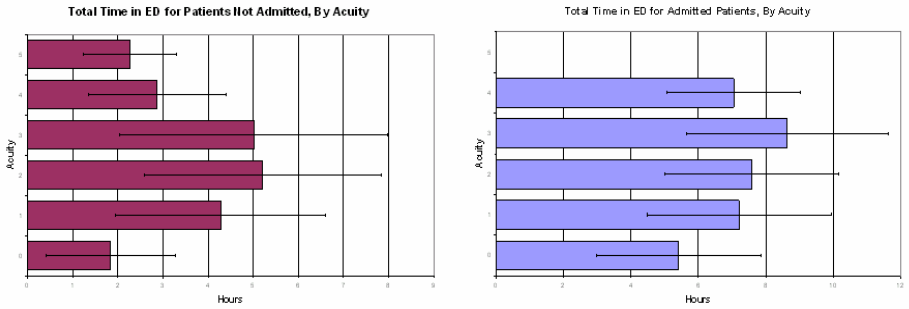


Source: Jorge Fradinho Oliveira, MIT

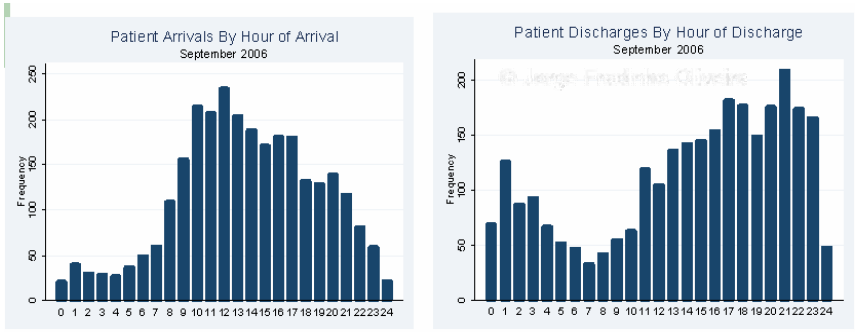
Emergency Department Analysis

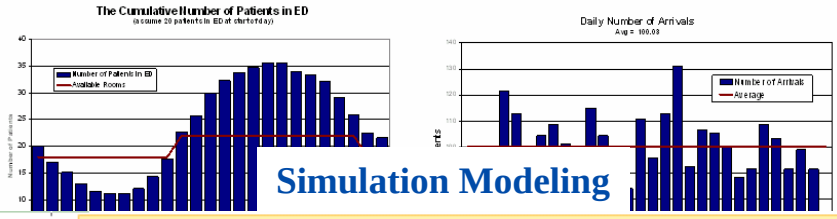
Description of patient time spent in ED

Average Total Time Spent in the ED	
Patients Not Admitted:	4.14 hrs
Patient Admitted:	7.85 hrs



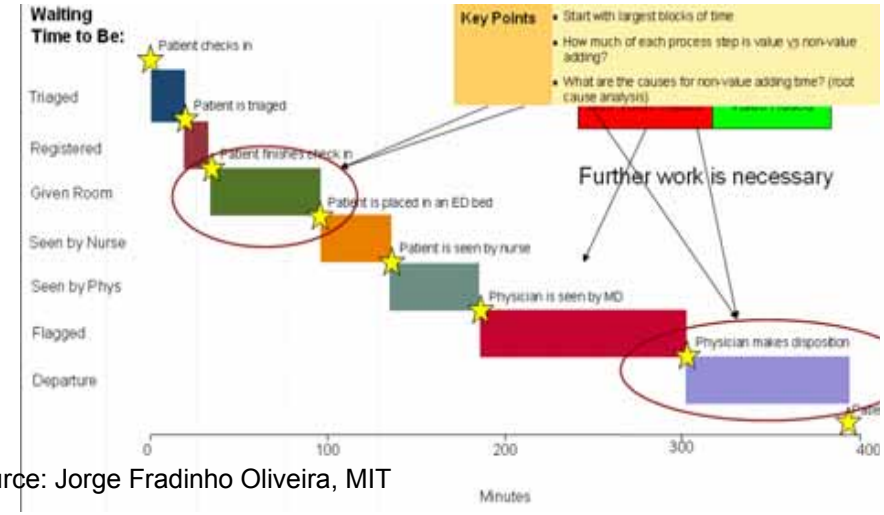
Description of patient arrivals and departures



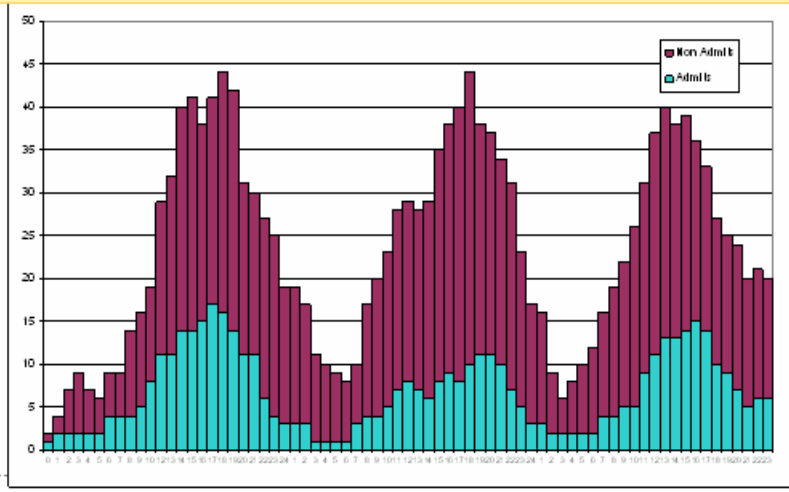


Simulation Modeling

Average time for each step of the patient process

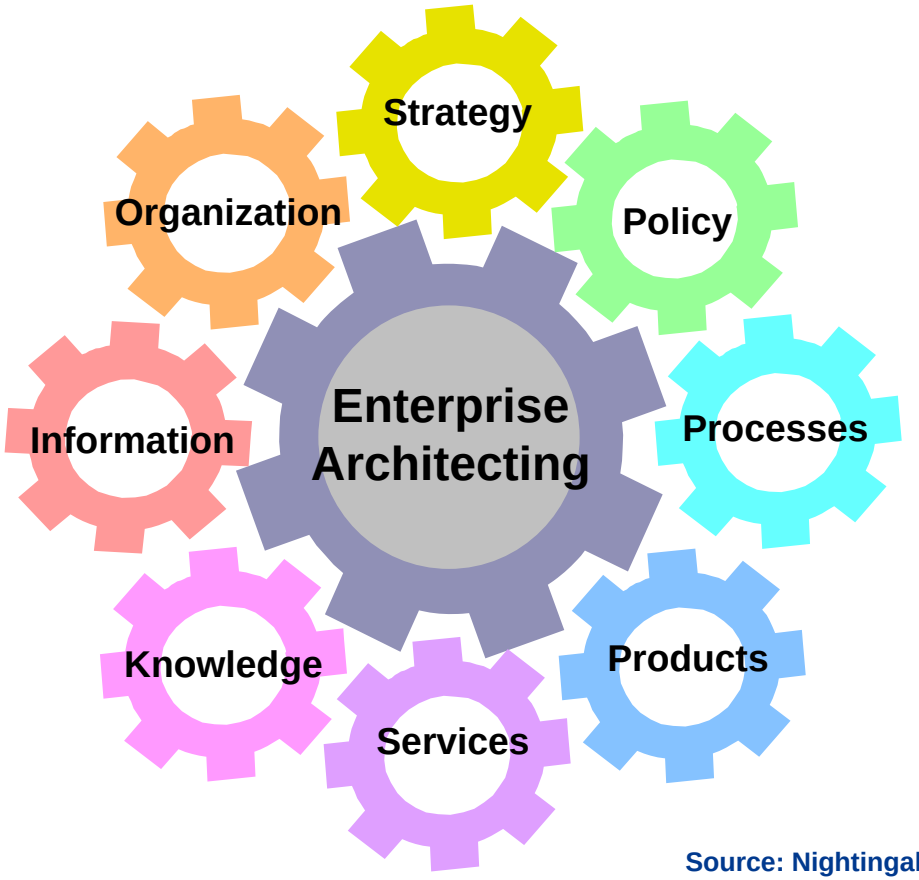


Simulation patient levels in ED over three days



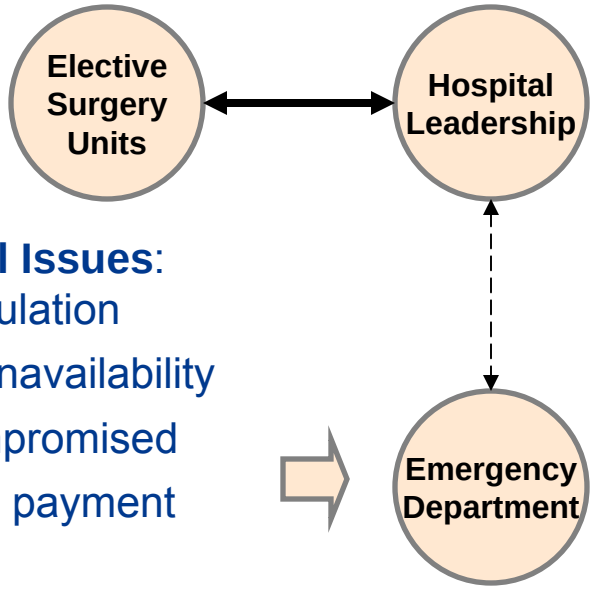
Source: Jorge Fradinho Oliveira, MIT

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

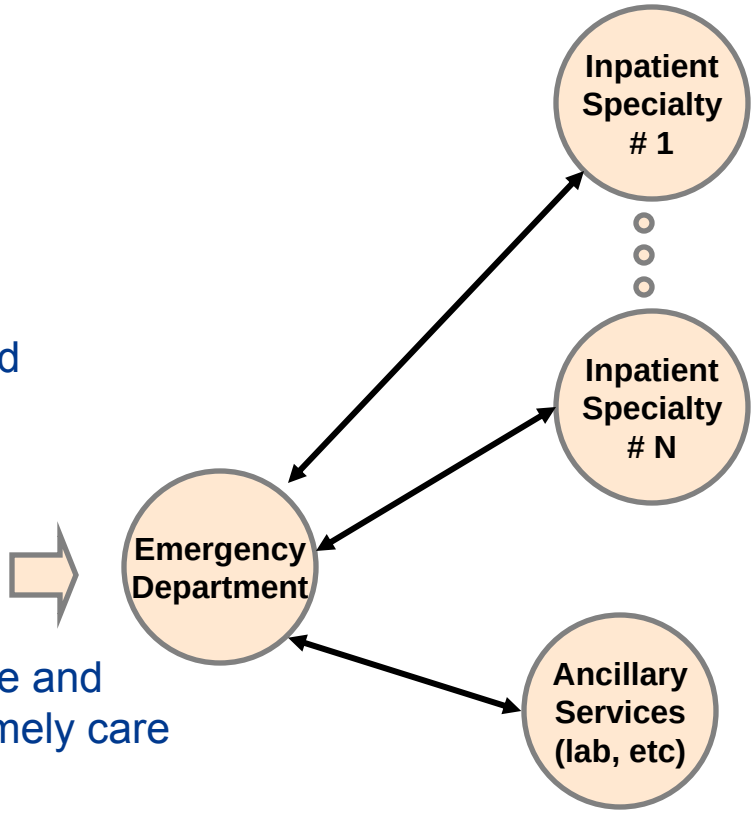
Result in:
- Lack of strategic focus
- ED competing for internal resources sought by elective surgery
- ED neglected

Source: Jorge Fradinho Oliveira, MIT

Enterprise Findings

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

Enterprise Findings

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

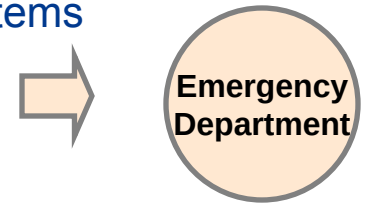
Result in:
- Less than ideal recommended care provision
- Prone to staff exhaustion and waste (i.e. empty bed goes unnoticed)
- Patient health put at risk due to unknown medical history

Source: Jorge Fradinho Oliveira, MIT

Enterprise Findings

Information Technology Backbone Issues:

- Fragmented information systems
- Proprietary legacy software

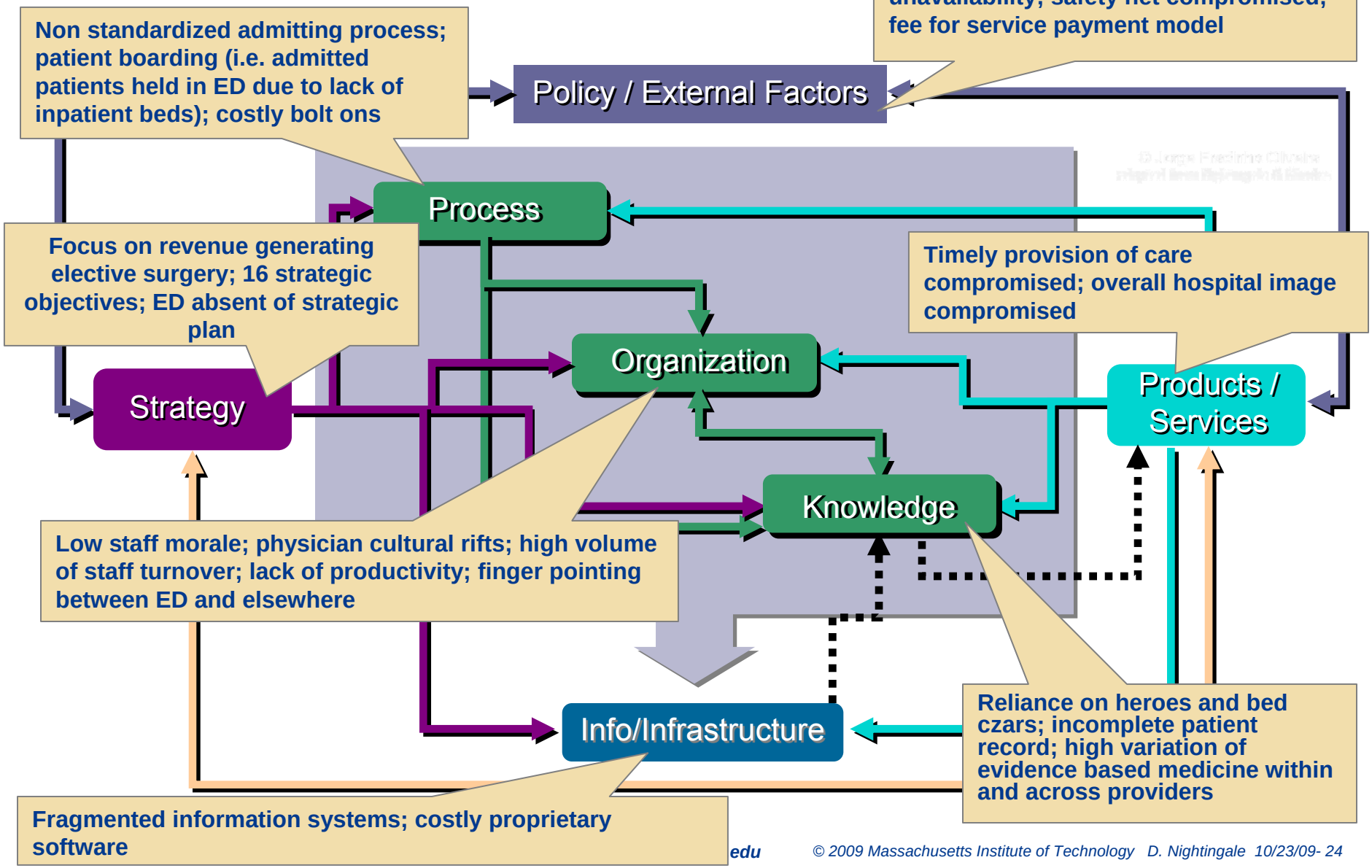


Result in:

- 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

Hospital Enterprise Architecture Diagnostic



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

Preliminary Findings

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

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

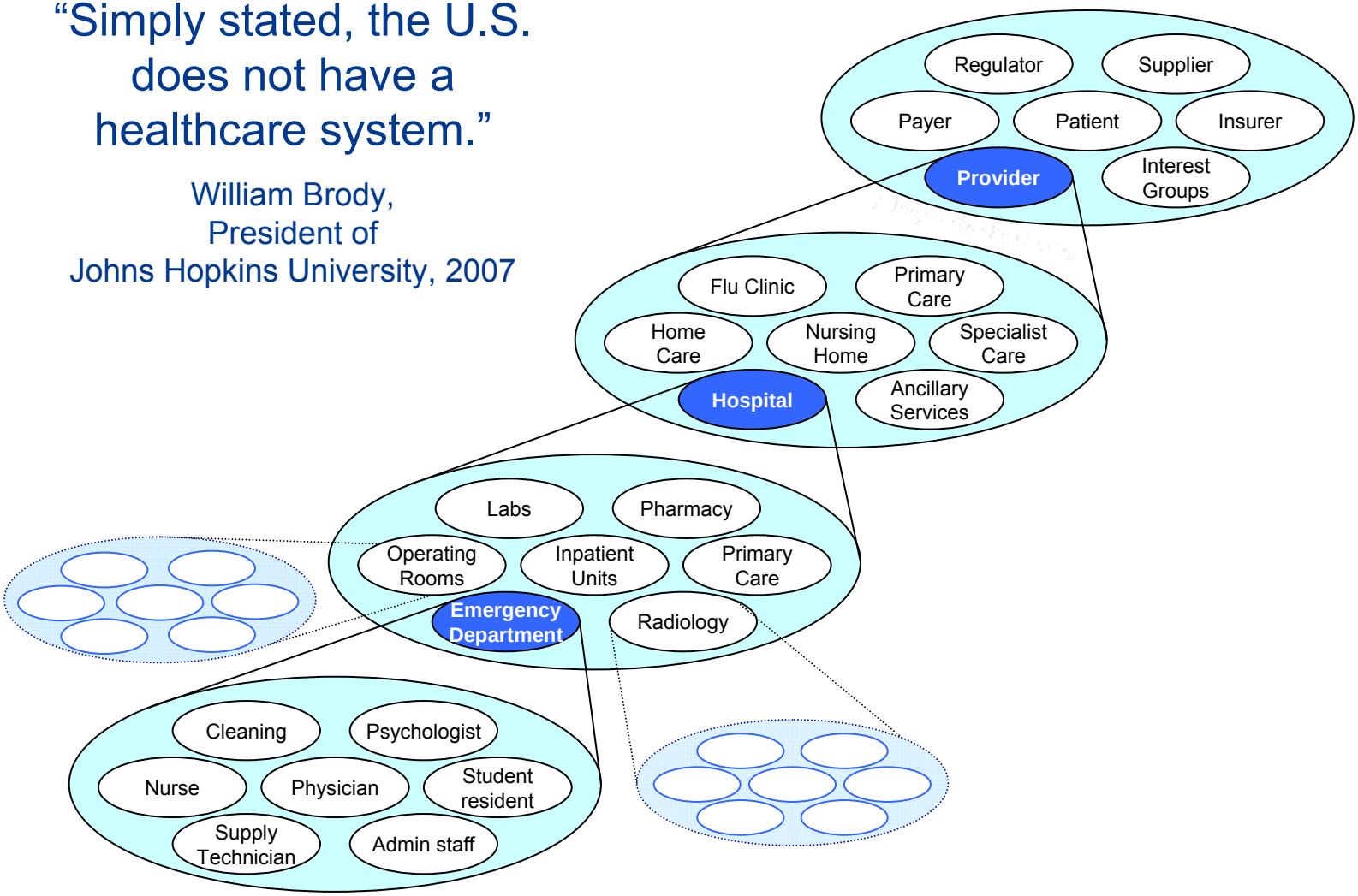
Donald Berwick, President of Institute for Healthcare Improvement, 2002

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 re-active."
- "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

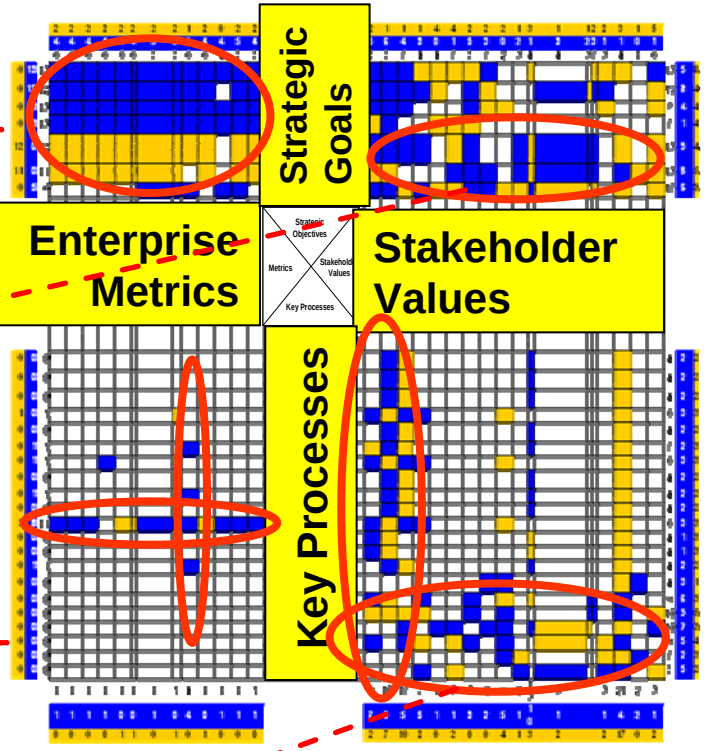
- Strong alignment with areas in service, care, & research
- Gap lies in aligning goals to values such as:
  - Operating within budget
  - Well-documented monetary transactions

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

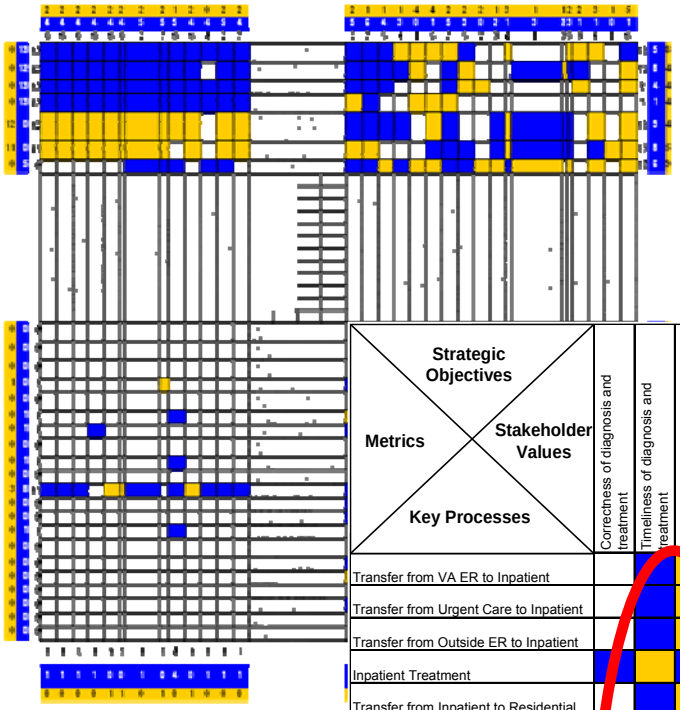
- Strong alignment in areas of service, research, & quality
- Processes addressing the least stakeholder values are primarily patient movement



- Strong Alignment
- Weak Alignment

LEAN ADVANCEMENT INITIATIVE

Case 3: X-Matrix



Strategic Objectives / Stakeholder Values / Metrics / Key Processes	Correctness of diagnosis and treatment	Timeliness of diagnosis and treatment	Quality of patient experience (minimal discomfort, respectful, etc.)	Timely and accurate information flow	Safety/Security of premises	Clean, High Quality Facility	Accurate Patient Records	Availability of medications, supplies, and equipment	Operating within budget	Fair Wages for services	Sufficient Inpatient and Outpatient Capacity	Reasonable expectations and respectful treatment of employees	Research Advancement	Knowledge Transfer	Communication and Implementation of VA culture and values	Efficient Resource Management	Accurate and well-documented monetary transactions	Upstanding member of local community			
Transfer from VA ER to Inpatient		■									■					■			4	2	2
Transfer from Urgent Care to Inpatient		■									■					■			4	2	2
Transfer from Outside ER to Inpatient		■									■					■			4	2	2
Inpatient Treatment	■		■	■					■							■			6	3	3
Transfer from Inpatient to Residential		■									■					■			4	2	2
Discharge from Inpatient	■	■									■					■			5	2	3
Residential Treatment	■		■	■					■							■			6	3	3
Transfer from Residential to Inpatient		■									■					■			4	2	2
Discharge from Residential		■									■					■			4	2	2
Transfer to Outside Facility		■									■					■			4	2	2
Outpatient Treatment	■		■	■					■							■			6	3	3
Referral to Inpatient	■										■					■			4	1	3
Referral to Residential	■										■					■			4	1	3
Walk-in to Outpatient		■									■					■			4	2	2
Purchasing (Supplies & Services)								■	■							■	■		4	3	1
Patient Data Management	■			■			■		■		■		■	■		■			9	6	3
Research							■		■				■	■		■			10	5	5
Facilities and Maintance			■		■	■		■	■		■							■	10	7	3
Quality Assurance	■		■				■		■							■			9	5	4
Payroll									■								■		5	2	3
Human Resources				■						■		■				■			7	5	2
	9	6	5	7	1	3	3	2	9	2	13	3			3	21	2	3			
	7	9	5	5	1	1	3	2	5	1	10	1			1	4	2	1			
	2	7	10	2	0	2	0	0	4	1	3	2			2	17	0	2			

Key Processes vs. Stakeholder Values

- **Key Processes are primarily focused on satisfying specific stakeholders however all are taken into account.**

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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)

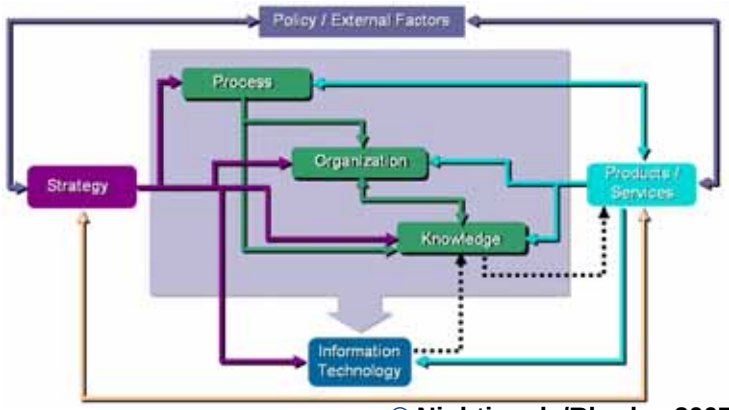
High Performing Hospital Enterprise Architectures
(Jorge Oliveira, ESD PhD Candidate)

- 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?



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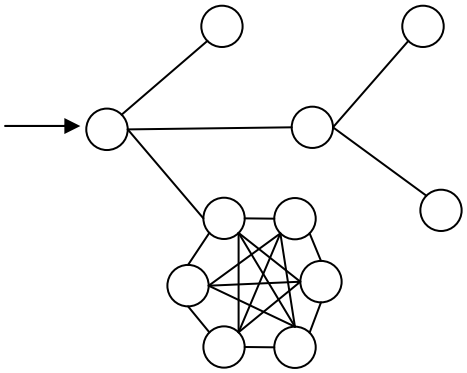

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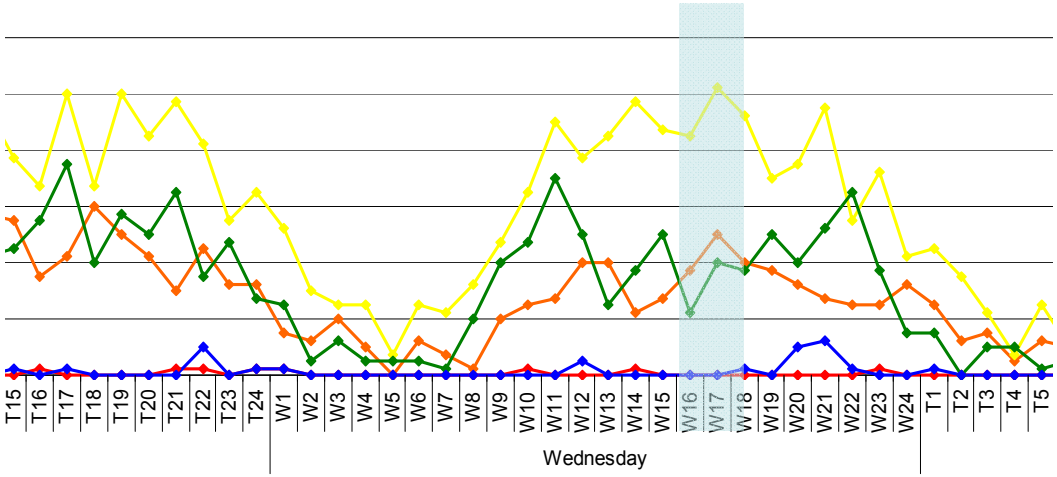
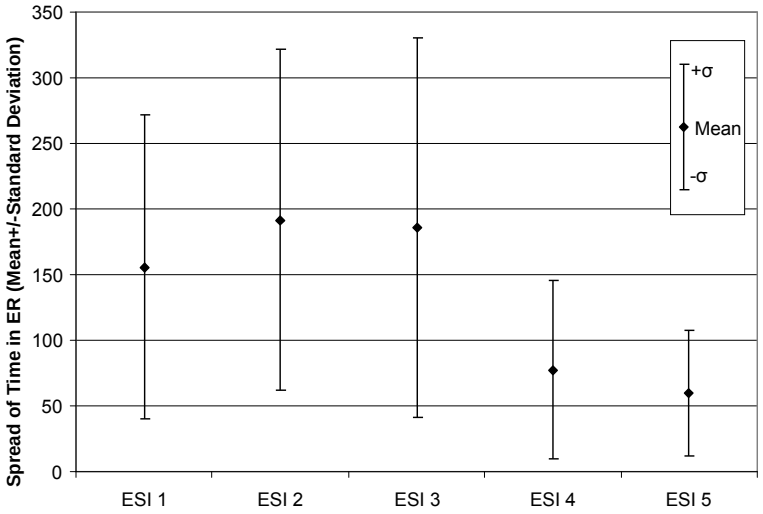
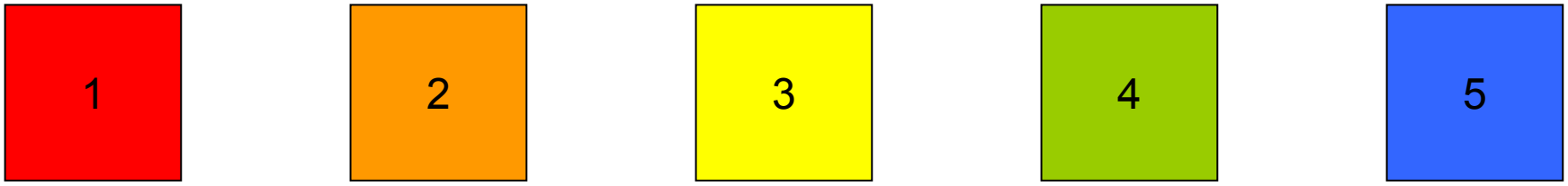
New England Veteran Affairs

Ongoing Research in Process Classification (Jordan Peck, ESD Ph.D.)

Health Care Professionals are starting to recognize predictability





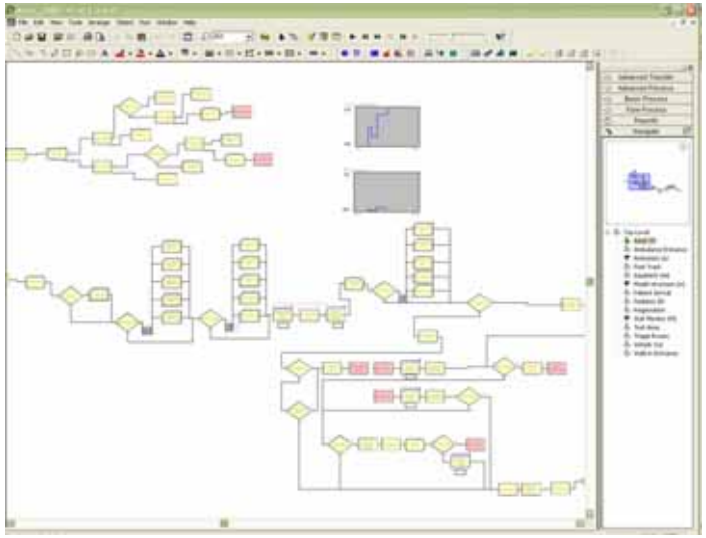


- Emergency Severity Index (ESI)—a five-level emergency department triage algorithm that provides clinically relevant stratification of patients into five groups from 1 (most urgent) to 5 (least urgent) on the basis of acuity and resource needs.

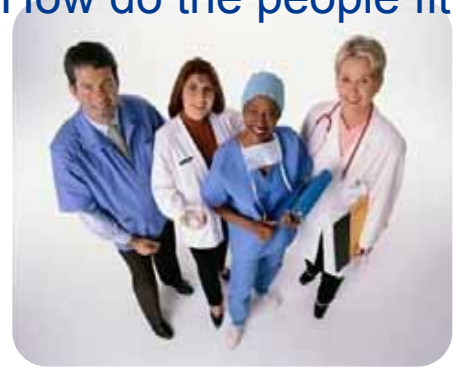
New England Veteran Affairs

Simulation and Modeling

How can we model Control Options and Interventions?



How do the people fit in?



Source: Jordan Peck, MIT

How well can solutions cross between hospitals?

VA
Boston, MA

VA
Togus, ME

VA
Manchester, NH

Source: www.va.gov

Ongoing Research

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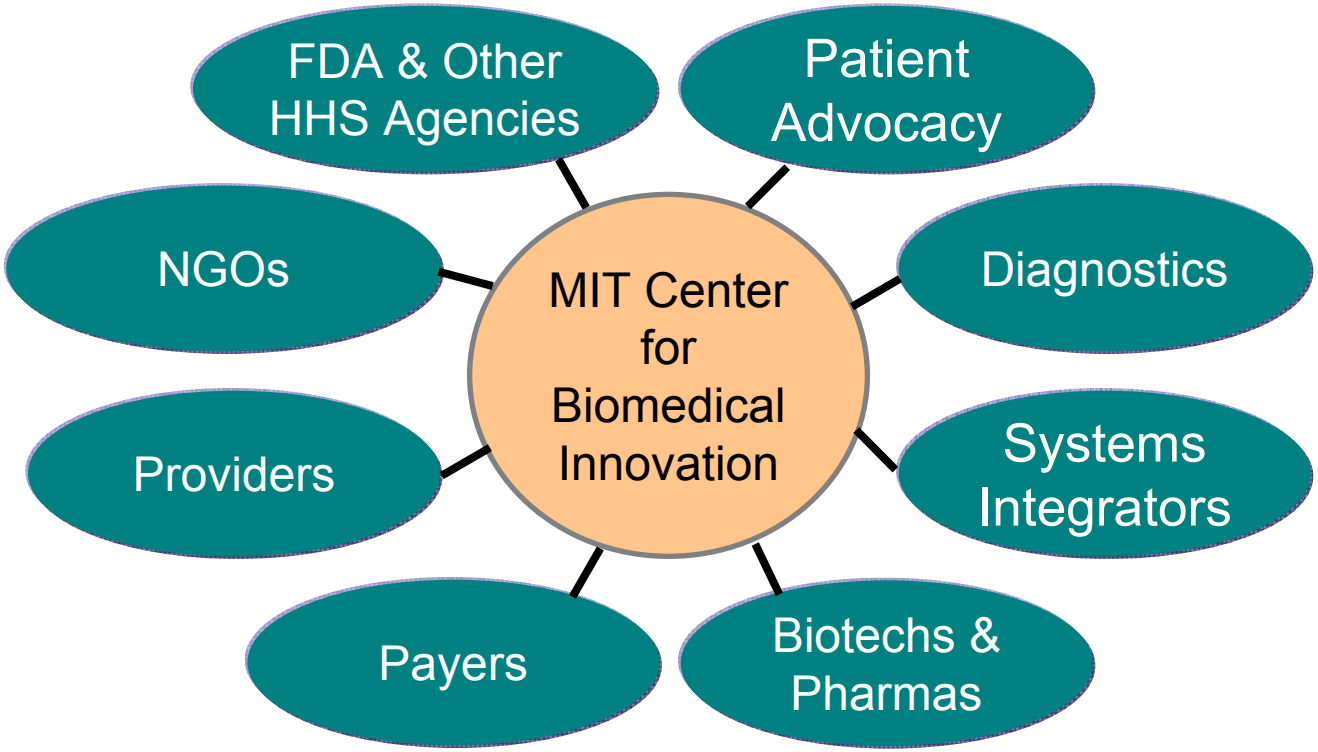
LEAN ADVANCEMENT INITIATIVE

Center for Biomedical Innovation

NEW Drug Development ParadIGmS (NEWDIGS)

CBI's "NEWDIGS" Drug Development

Enterprise Strategic Analysis
Consortium of Stakeholders



CBI's "NEWDIGS" Drug Development

Enterprise Strategic Analysis
Mission and Strategic Objectives

- **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

Meeting #1 May 28 Washington, DC	Meeting #2 July 14 MIT	Meeting #3 August 19 & 20 Washington, DC	Meeting #4 October 15 MIT	Meeting #5 November 5 MIT
Begin Current State Assessment	Continue Current State Assessment	Create Future State Vision	Create Action Plan	Stakeholders Meeting Share findings and solicit input from CBI Members

Research team synthesizes outputs, performs interviews, & customizes methodology

CBI's "NEWDIGS" Drug Development

Enterprise Strategic Analysis
Draft High Level Future Vision

An organization that:

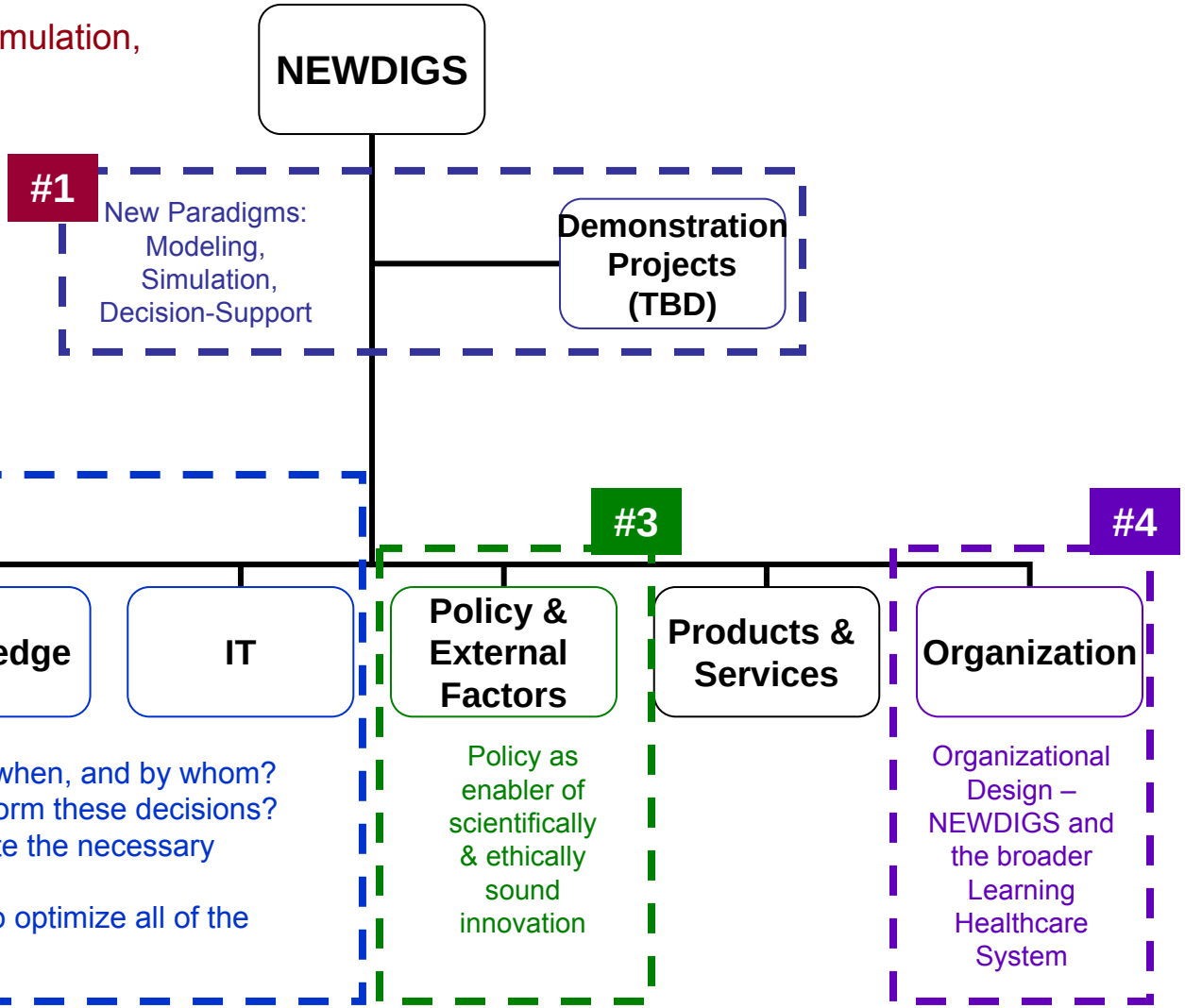
- is lean and highly collaborative with all stakeholders from across the entire value chain;
- is not tied to developing one particular product (i.e., responsive to market need, flexible, adaptive) and rather focuses on integrated healthcare solutions;
- has expertise to understand market and customer(s) 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….*



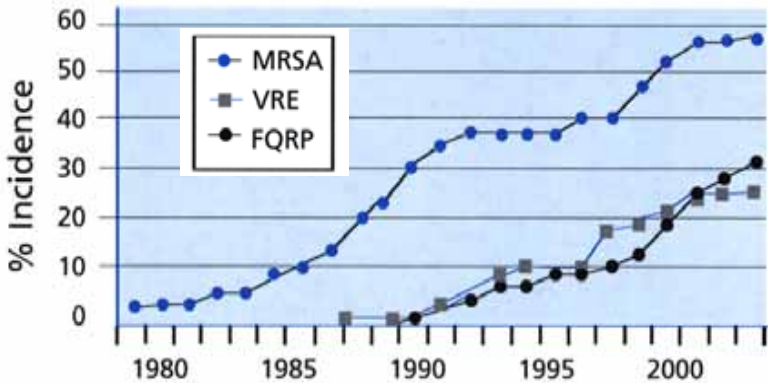
Ongoing Research

- 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)

Motivation / Problem

Rob Nicol

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



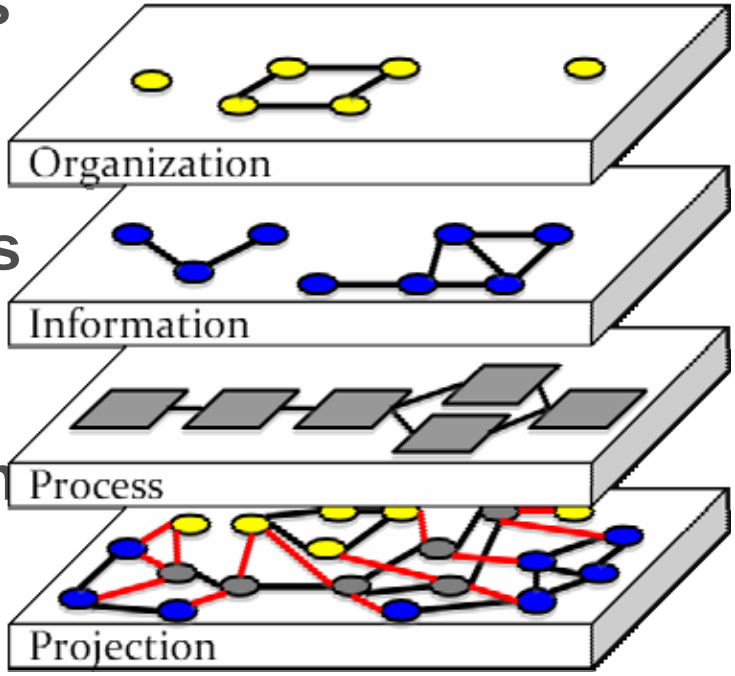
Source: CDC; MRSA=methicillin-resistant *Staphylococcus aureus*; **VRE**=Vancomycin-resistant *enteroccoci*; **FQRP**=Fluoroquinolone-resistant *Pseudomonas aeruginosa*

- **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)

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?**



Contributions

Rob Nicol

- **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…)

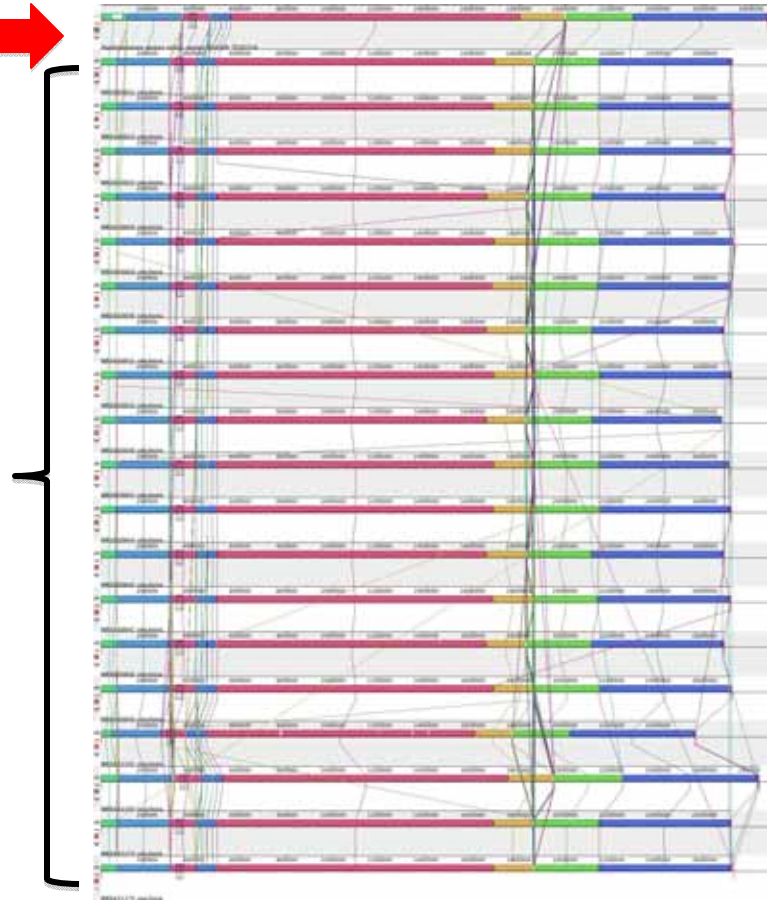
Rob Nicol

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

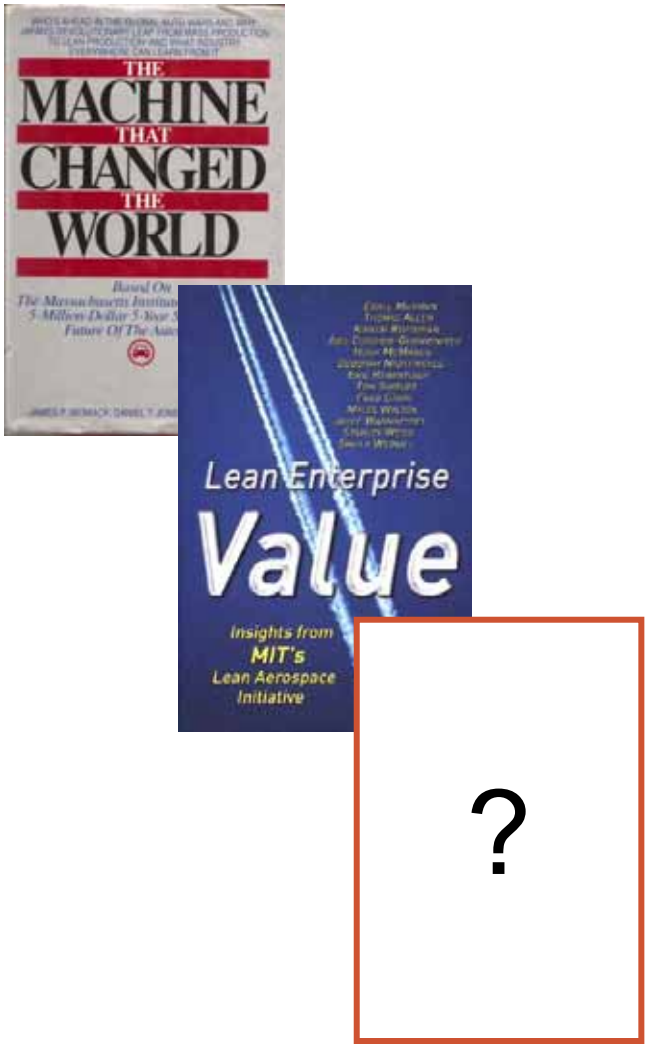
- 50 Genomes Sequenced (<15 existed previously)
- All Supposed to be identical based on current hospital diagnostics
- Significantly different! (look at length)
- Highlights need for surveillance and policy changes



Agenda

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

LAI Enterprise Healthcare Vision



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!

Relevant Research Questions

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 appropriate health care enterprise metrics?

How should hospital/healthcare service complexity be measured?

What are the key incentives that drive stakeholder behavior?

What are new collaborative stakeholder models?

How can long-term value propositions be created across multiple providers?

What are the strategies capable of achieving and sustaining multiple stakeholder alignment?

Questions and Answers

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