

Engineering and the System of Health Care Delivery

Convocation Professional Engineering
Societies

April 20, 2009

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1999—The Institute of Medicine Published

To Err is Human

44,000 to 98,000 die annually
and over one million are injured
from medical errors

2000—Patient safety had become
a national concern

2002—Joint Commission for the
Accreditation of Healthcare
Organizations (JCAHO)
Required all hospitals to
implement 11 new safe practices



2001—The Institute of Medicine Published *Crossing the Quality Chasm*

Health Care System Should be

- Safe
- Effective
- Patient-Centered
- Timely
- Efficient
- Equitable



How well does our health care system
meet those six Objectives?

**Unfortunately, the answer is
--less than is desirable.**

State of the System

Safety failures—1 million injuries annually

Knowledge—Practice Gap

Waste, Inefficiency, Spiraling Costs—“30 to 40 cents of every health care dollar covers costs of system failures, poor communications and inefficiency” = \$480 billion/yr

Health care costs rising at double digit rates

Growing uninsured population ~ 45 million in 2006

Revenue squeeze on care providers

Mortality Amenable to Health Care Deaths per 100,000 population

(1998)	(2002)	
France 75	State Variation	
Japan 81	Average	110
Italy 88	Percentiles	10 84
Canada 92	25	90
Germany 106	medium	103
Denmark 109	75	119
US 115	90	134
Ireland 129		
UK 130		
Portugal 132		

Information on Performance

Aspirin at Arrival

University Of Michigan Hospital	273/273
Henry Ford Hospital-Detroit	234/236
Henry Ford Hospital-Wyandotte	254/273
St Joseph Mercy Hospital	411/415
St Mary Hospital	228/230
Detroit Receiving Hospital & University Health Center	192/196
Oakwood Hospital Heritage Center	55/56
St John Hospital & Medical Center	332/342
Sinai-Grace Hospital	371/391
Oakwood Hospital & Medical Center-Dearborn	508/535

Some Contributing Reasons:

- **Rapid Advances in Medical Science and Technology**
Increased Complexity of Health Care Delivery
- **Cottage-Industry Structure**
Large Fraction of Physicians are in IPAs
- **Acute- vs. Chronic-Care Orientation**
Aging Population
- **Lack of Understanding of Quality and Productivity**
Few Examples of Success
- **Persistent Underinvestment in Infom./Comm. Tech.**
Difficulty in IT Beyond EMR and CPOE Systems

While there is Little that Engineering Can Do about
the Health Care Industry Structure or the Focus
on Acute Care.

and

While Engineering Is Making Important Contributions to
Medical Technology Through Bioengineering, Mats, etc.

**There has been no concerted effort to exploit Engr.
Tools to Improve Quality and Productivity
and Enhance Use of Inform./Communication Tech.**

Again the IOM Six Goals for Health Care

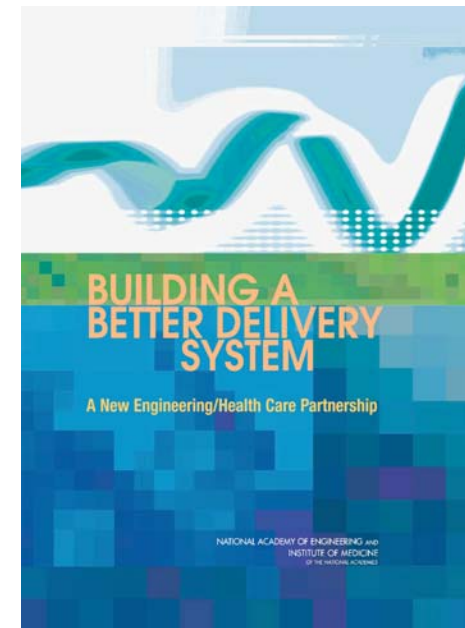
- Safe
- Effective
- Patient-Centered
- Timely
- Efficient
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**There Is Engineering
Content in Each of These**

**How do we go about Encouraging Engineers and
Health Care Professionals to Look Seriously
at the Possibilities for Utilizing Engineering Tools?**

**A Small Work Shop Recommended
That a Full Scale Study be Under-
Taken to Answer that Question.**

**This led the NAE and IOM to
Undertake an Effort that
Culminated in the Report**



*“Building A Better Health Delivery System
A New Engineering/Health Care Partnership”*

Study Committee

- W. Dale Compton, PhD, Cochair, Purdue Univ.
- Jerome Grossman, MD, Cochair, Harvard
- Rebecca Bergman, Medtronic
- John Birge, PhD, Univ. of Chicago
- Denis Cortese, MD, Mayo Clinic
- Robert Dittus, PhD, MD Vanderbilt Univ.
- G. Scott Gazelle, MD, MGH
- Carol Haraden, PhD, IHI
- Richard Migliori, MD, United Resource Networks
- Woodrow Myers, MD, WellPoint
- William Pierskalla, PhD, UCLA
- Stephen Shortell, PhD, UC Berkeley
- Kensall Wise, PhD, Univ. Michigan
- David Woods, PhD, Ohio State Univ.

Report Outline

Background

System Engineering Tools

Information and Communication Systems

Strategy to Accelerate Change

The Workshop Presentations—38 in all—grouped as

- Framing the Health Care Challenge
- Equipping the Patient and the Care Team
- Engineering Tools and Procedures
- Information Technology for Clinical Applications
and Microsystems
- Barriers and Incentives to Change

Three workshops—Presentations by Experts in Health Care and Relevant Engineering Activities

Findings—Engineers have the Capability to Make a Significant Contribution

—Few Providers of Health Care are Aware of Relevant Engineering Tools

—Few Engineers Understand the Issues that Health Care Confronts

Report has Sought to Provide some Insight to the above and to Recommend How to Improve the Situation

The overwhelming conclusion was

Ways must be found to effectively apply **system engineering tools** to dramatically improve the efficiency and productivity of the care delivery system.

Why system engineering?

Engineering has a long history of dealing with large, complex, distributed systems.

Central focus for the study became the **SYSTEM**

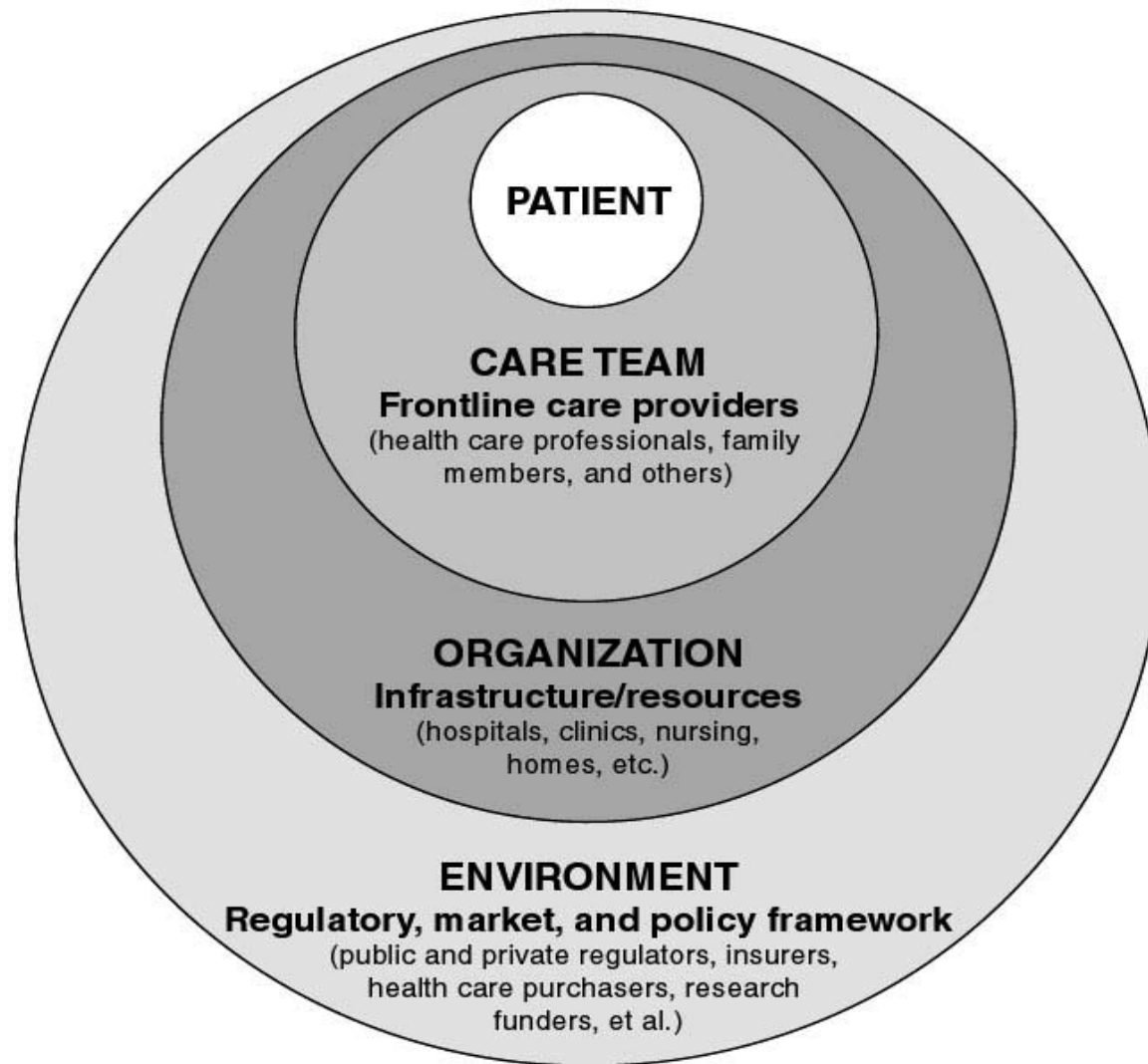
Presents a Special Challenge

The “healthcare delivery system” **was not designed as a system and does not operate as a system**—with few exceptions it is a collection of discrete entities that tend to operate largely independent of each other—the “silos.” Thus the term “Cottage Industry.” Furthermore there is no single point of Control or Responsibility.

Report focused on four **strongly interacting parts**

- The Patient
- The Care Givers
- The Organization
- The Enterprise

A Patient-Centered Model of the Health Care System



Examples of the application of **system engineering tools** to health care delivery issues

Scheduling of personnel & capital equipment

Flow of patients through a facility

Simulation of an operating room

Supply-chain management of resources

Statistical process control of operations

Knowledge discovery in large data bases

Financial engineering tools for risk management

Measuring and monitoring productivity—Metrics

Value of quality

Pharmacological Genomics

Three Families of Systems Tools for Use at Different Levels of the HC System:

- Systems Design
- Systems Analysis
- Systems Control

System Analysis Tools

	Patient	Team	Org.	Envir.
Modeling and Simulation		X	X	(X)
Enterprise Management		X	X	X
Financial Engr. and Risk Analysis		(X)	X	X
Knowledge Discovery in Data Bases		(X)	X	X

Barriers to Implementation

- Inadequate Information and Information Tech.
- Policy and Market
- Organization and Managerial
- Educational

Crying NEED for Good DATA!

Information and Communication Systems

From Electronic Medical Records (EMR) and
Computerized Physician Order Entry System (CPOE)

to

National Health Information Infrastructure (NHII)

Microelectronic Systems and Emerging Modes of Communication

- Making Every Room an Intensive Care Unit
Wireless Integrated Microsystems for Health Care
- Advancing Patient Self-Care
- Therapeutic Uses

What will be the Long-term Role of the Internet in Health Care?

Major Caveat

No intention of making engineers clinicians
nor
of making clinicians system engineers

What is Needed

**Engineers who understand the constraints of the
health care system**

**Clinicians who know what questions to ask and
what to do with the answers**

How do we Accelerate Change?

Recognize Barriers—Education of both the Health Care Professionals and Engineers Need to Change

Platforms Must be Provided for Interdisciplinary Research, Education and Outreach

Aggressively Attack Short-term Opportunities

Systems Engineering Agenda—Recommendations

*Actions to promote development, adaptation,
and use of systems engineering tools*

3rd party payers to incentivise tool use

Expand/coordinate outreach & support

Educational materials/NLM website

Increase public/private support for R,D&D

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Establish multidisciplinary centers at institutions of higher learning capable of bringing together researchers, practitioners, educators, and students from relevant fields to

- **Conduct basic and applied research** on the system challenges to health care
- **Demonstrate and diffuse** the use of these tools, technologies and knowledge
- **Educate and train** a large cadre of current and future health care and engineering professionals

30 – 50 Multidisciplinary Centers

Geographically Distributed

\$3.25 M Annual Ave. Core Support for each Center

**Annual Total Core Funding between \$100M
and \$160M**

**Support for 240-400 Faculty and 700-1200
Engineering & Medical Graduate
Students Annually**

Many Activities Have Attacked the Problems Associated with Health Care

Business Roundtable

Leapfrog Group—150 public and private
organizations that provide health care
benefits

Institute for Healthcare Improvement
“Pursuing Perfection”

Agency for Healthcare Research and
Quality

Department Veterans Affairs

Robert Wood Johnson Foundation

A Few Words About Where We Are Now.

Veterans Administration

Creating three centers combining a VA health care facility and academic engineering

Regenstrief Center for Health Care Engineering Purdue Experience

Mission—Transforming healthcare-delivery systems by applying the principles of engineering, science and management

Established—1/05--Annual Funding--\$1M
Review---2/08--Annual Funding--\$2M

Research Areas

- Patient-Provider Interaction
- Patient Care Processes
- Patient Care Outcomes
- System Support

84 affiliated Researchers

5 researchers to develop research program

Research Associates across campus—participants

Research funding

Grants

72 % government

2005 \$ 3.5 M

22 % foundations

2006 \$ 4.7 M

6 % industry

2007 \$ 8.7 M

2008 \$11.6 M

Partnerships

Living Laboratories

Indiana Univ. Medical Group

Community Health Network

Indiana School of Medicine

St. Vincent Health

Roudebush Veterans Affairs Medical Center

National Dissemination Organizations

Ascension Health

Wellpoint, Inc

American College of Physicians

VHA, Inc.

Mayo Clinic

Two Additional Outreach Activities Associated with the Center

- **Healthcare TAP**

Partners with Indiana healthcare providers in short-term projects to improve healthcare quality, safety and efficiency
(IHA, Purdue TAP, RCHE)

- **Pharma TAP**

Optimizing patient safety by strengthening the reliability and sustainability of healthcare systems
(School of Pharmacy and Pharmaceutical Sciences, Purdue TAP, RCHE)

All NAE, IOM and NAS reports can be accessed
at

www.nap.edu