



INSTITUTE OF MEDICINE  
OF THE NATIONAL ACADEMIES

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# OR for the OR and Much More!

Richard C. Larson

## Engineering a Learning Healthcare System: A Look at the Future

April 29, 2008

The Keck Center

Washington, DC 20001

# Quotes from *Methods of Operations Research*, Morse & Kimball

**“Operations Research is a scientific method of providing executive departments with a quantitative basis for decisions regarding operations under their control.”**

“Operations Research ... is *an applied science* utilizing all known scientific techniques as tools in solving a specific problem.”

**“Operations Research uses mathematics, but it is not a branch of mathematics.”**

**“... Operations Research is often an experimental science as well as an observational one.”**

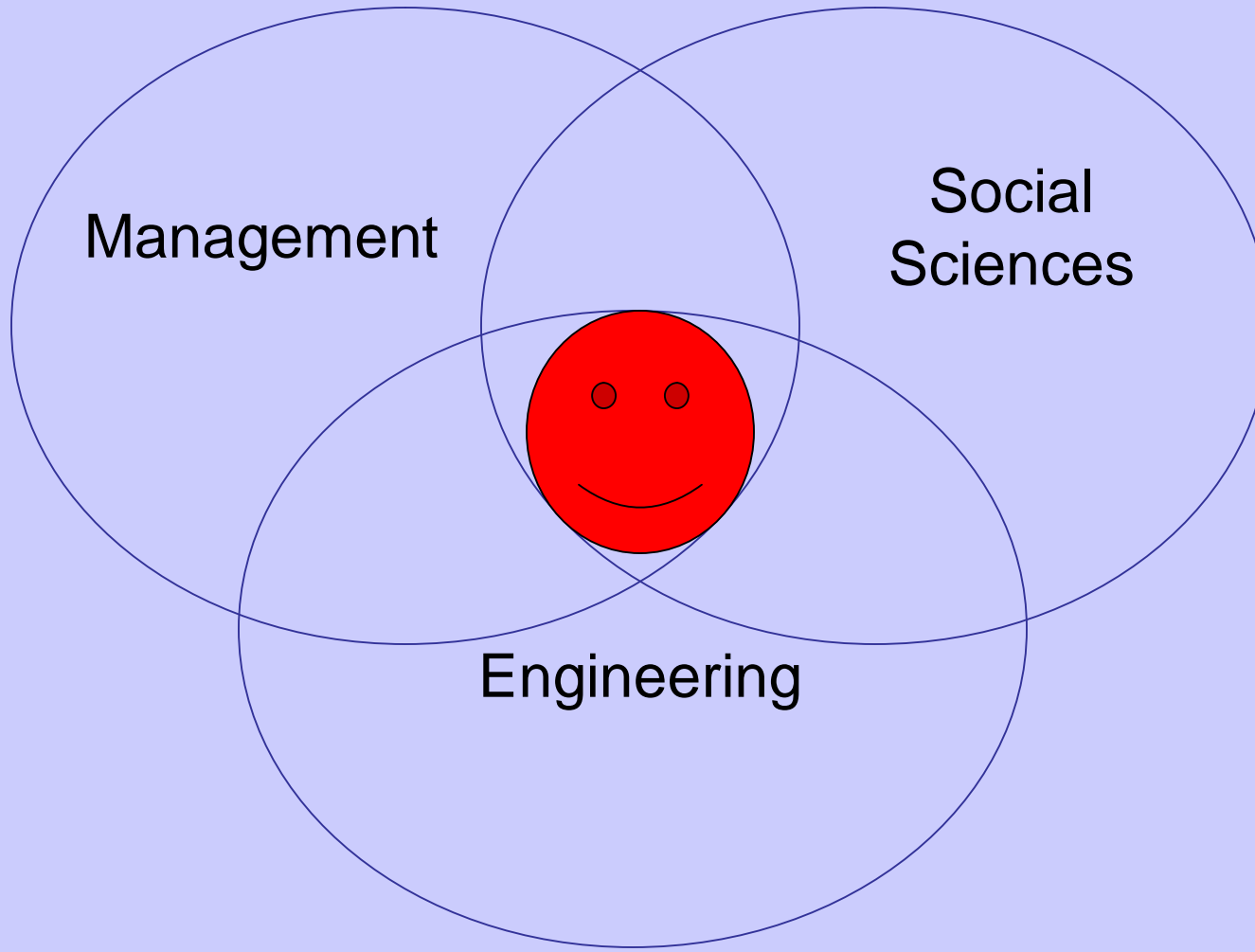
**“It often occurs that the major contribution of the operations research worker is to decide what is the real problem.”**



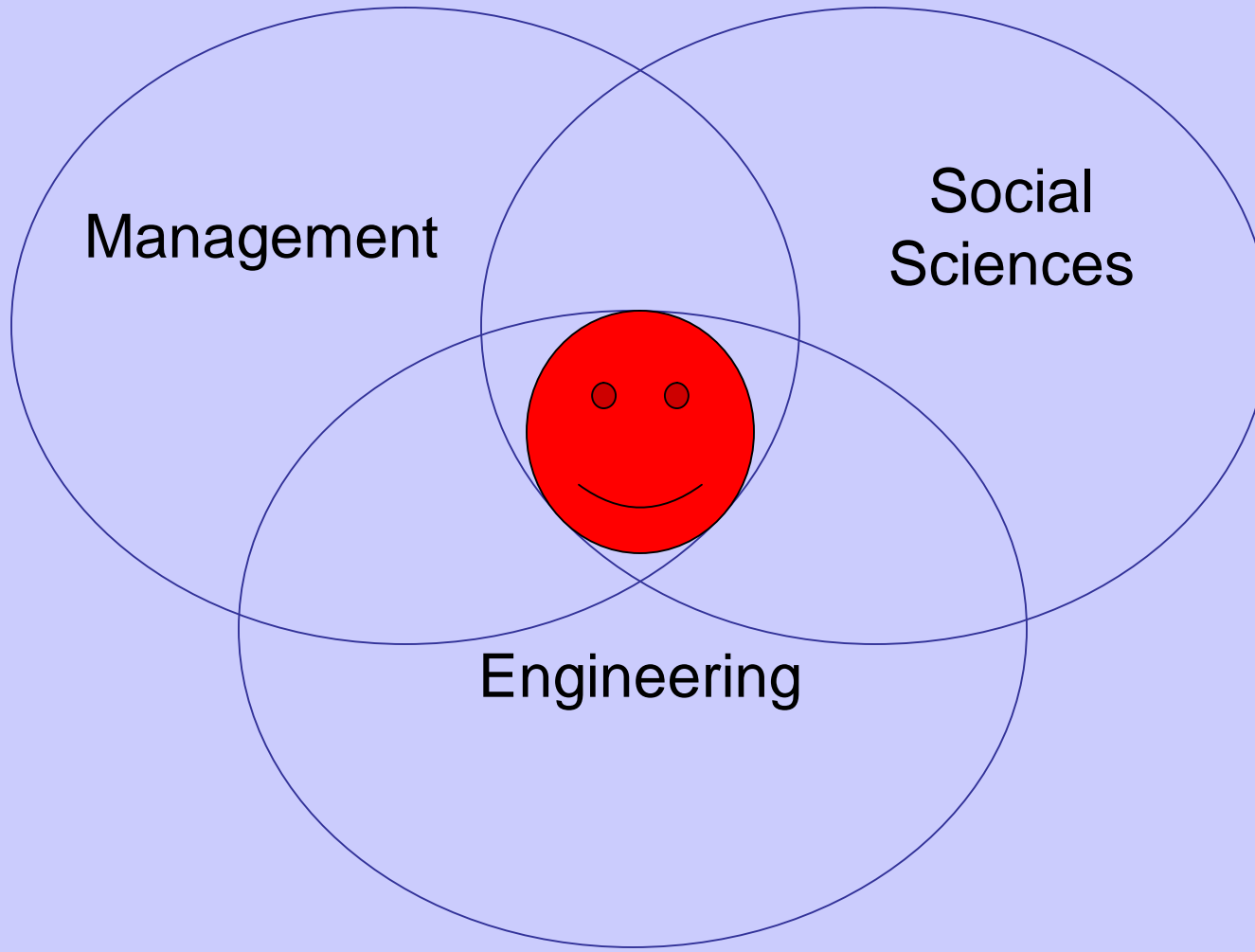
Philip M. Morse

# Engineering Systems:

At the intersection of  
Engineering, Management & Social Sciences



The health care system has  
myriad such problems!



Operations Research of 1940's, 1950's  
= Engineering Systems of Today!

Lot's of Progress!

# OPERATIONS RESEARCH



**SPECIAL ISSUE: HEALTH CARE**

## **Special Issue on Operations Research in Health Care**

**Guest Editors**

**Edwin Romeijn and Stefanos Zenios**

**Submission deadline: November 30, 2006**

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The field of health care has traditionally provided a broad range of applications suitable for analysis using Operations Research (OR) techniques. Most of the historical applications were either motivated or were a consequence of the burdens new medical technologies pose on complex health care delivery systems.

However, as medical technology progresses further, the spectrum of possible OR applications is only going to become broader and more exciting. In fact, the recent explosion of technological innovations in health care, which has been fuelled by new knowledge and information, has been matched by renewed interest

<http://www.powells.com/biblio?isbn=978140207629>

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# Great OR Success Stories in Health Systems

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**The original needle exchange van,  
pictured at left, began making rounds  
in the city's neighborhoods in 1990.  
It was painted by a Yale librarian and  
New Haven high school students.  
In 1991, Yale faculty members  
Edward Kaplan and Robert Heimer  
made national headlines when their  
study demonstrated that needle  
exchange resulted in a one-third  
reduction in new AIDS infections.**

**Once controversial program  
proves its impact in fighting AIDS**

**2007: Memorial Sloan-Kettering Cancer Center:**  
***Operations Research Advances Cancer Therapeutics***

**Marco Zaider,**

Memorial Sloan-Kettering Cancer Center,

**Eva K. Lee,**

Georgia Institute of Technology, School of Industrial and  
Systems Engineering; Health Systems Institute

The team has devised sophisticated optimization modeling and computational techniques to implement an intra-operative 3-D treatment planning system for brachytherapy (the placement of radioactive "seeds" inside the tumor) that offers a much safer and more reliable treatment. The system eliminates pre-operation simulation and post-implant imaging, saving an estimated \$459 million per year on prostate cancer alone. Quality-of-life is improved through drastic reduction (45-60%) of complications due to plans that deliver less radiation to healthy structures.

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2008: Edelman Finalist. The City of **Stockholm, Sweden** for “Operations Research (O.R.) Improves Quality and Efficiency in Social Care and Home Help.” An annual savings of 20-30 million Euros (\$30-\$45 million). The quality of home help care to patients has improved, as well.

# Policies on bio-terror attacks - Larry Wein, Ed Kaplan

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***Modeling Flu Progression 1:  
 $R_0$  & Effects of Heterogeneities***

X-Sieve: CMU Sieve 2.2

Date: Sun, 17 Dec 2006 17:14:13 -0800 (PST)

From: Google Alerts <[googlealerts-noreply@google.com](mailto:googlealerts-noreply@google.com)>

To: [rclarson@mit.edu](mailto:rclarson@mit.edu)

Subject: Google Alert - Flu Pandemic

Google News Alert for: **Flu Pandemic**



# Fighting Flu with NPI's= Non-Pharmaceutical Interventions

- Social Distancing
  - Government-mandated
    - Schools closed
    - No large public gatherings
  - Personal choice
    - Telecommuting
    - Altered shopping patterns
- Hygienic Behavioral Changes
  - Hand washing
  - Proper coughing/sneezing
  - Face masks
  - Avoiding crowds

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# Flu Fundamentals:

$R_0$  = Mean number of  
new infections generated  
by a typical newly  
Infected person in a  
fully susceptible population

$I$  = frequency of daily contacts (“lambda”)

$p$  = probability of transmitting infection,  
given contact

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# There are Many Roads Forward

- See Paul O'Neill's *OR/MS Today* article,  
**Why the U.S. healthcare system is so  
sick ... and what O.R. can do to cure  
it**
- <http://www.lionhrtpub.com/orms/orms-12-07/frhealthcare.html>

# Needed Research: Physician's Understanding and Use of Uncertainty

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- Most people - including physicians - seem not to understand probability and risk to the extent that they should. For a good counterexample, read **Complications: A Surgeon's Notes on an Imperfect Science**, by [Atul Gawande](#).

## Additional Examples for Promising Research and Practice

- Queues: use organ donation queues and emergency room queues
- Optimization: be careful, but it can be useful in countless applications.  
(Ambulances, scheduling)
- Probabilistic modeling at all levels
- Use of data to improve decisions.  
Computerize patient records.

# Going Forward

- But most likely, the truly transformative applications of Operations Research (Engineering Systems) to Health Care have not yet been identified.
- Need more feet on the ground.
- And we need to ask fundamental questions, such as: *Who is the Harry Truman for any given patient in a hospital?*

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