

Health Systems Engineering: Methods for Optimizing Healthcare Delivery

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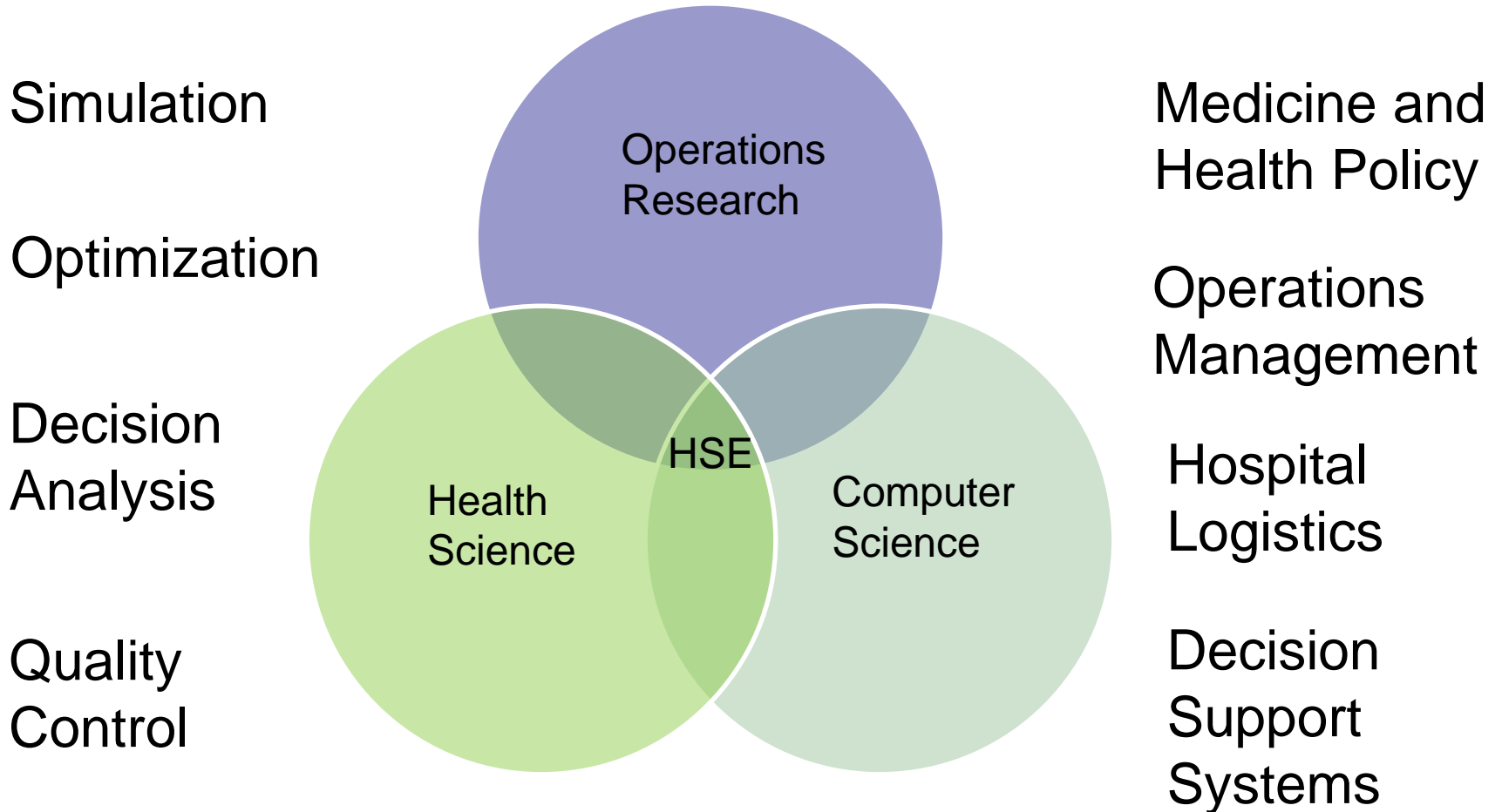
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Summary

- Health Systems Engineering
- Example: Optimization of Surgical Care
- Other Research Examples

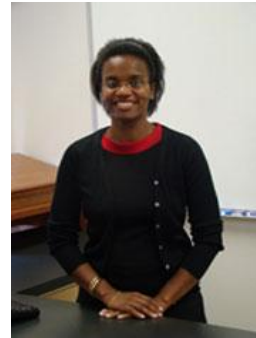
Health Systems Engineering



Health Systems Faculty



Steve Roberts



Julie Ivy



Javad Taheri



Brian Denton

+ Many other faculty specializing in biomanufacturing, human factors engineering, and other areas

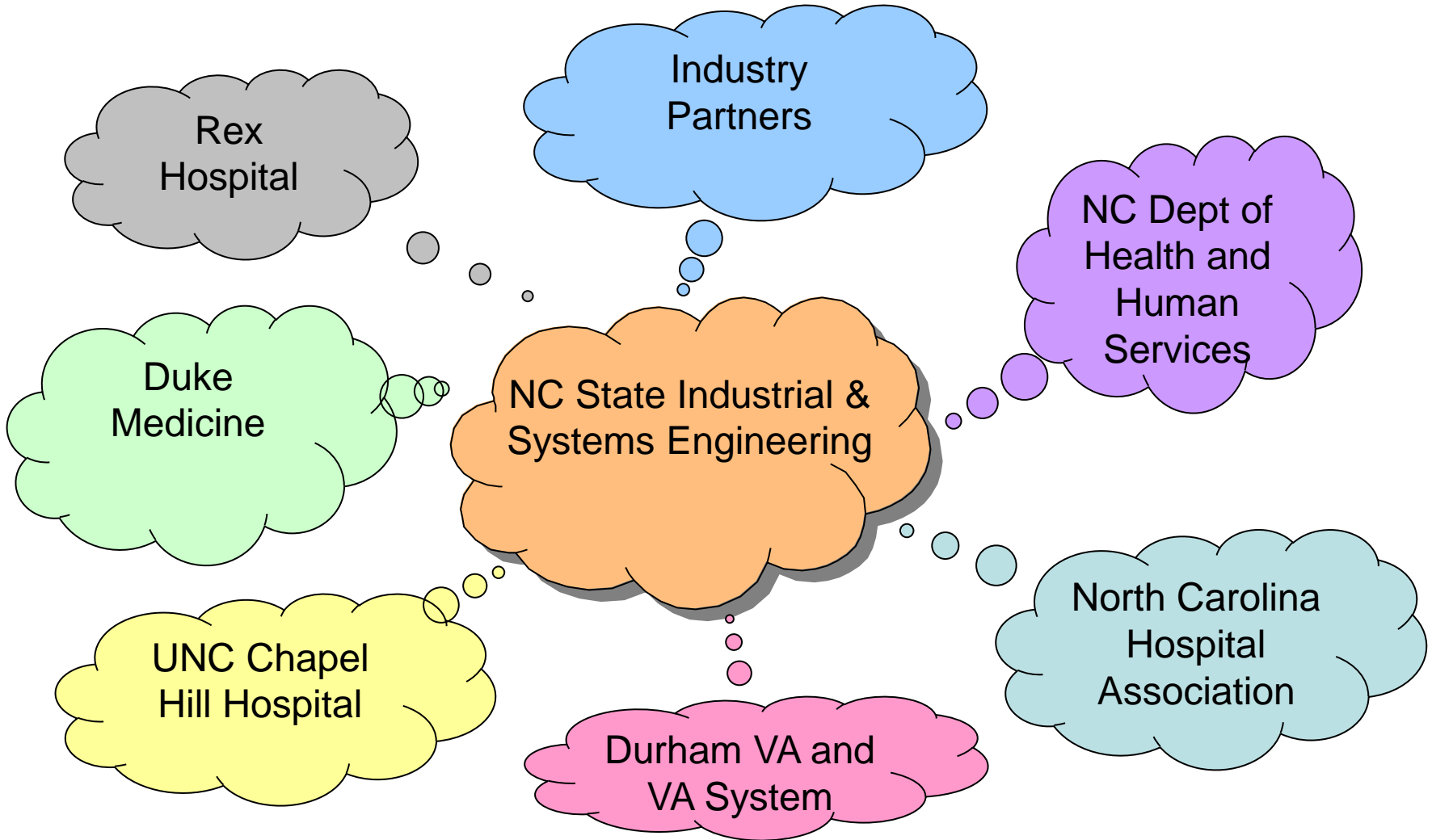
Research Interests



Research Interests

Queuing
Decision Analysis
Linear Programming
Operations Research **Graph Theory**
Discrete Optimization
Mathematical Programming **Stochastic Programming**
Markov Decision Processes
Dynamic Programming **Six Sigma**
Statistical Process Control
Simulation **Statistics**

Local Connections



Optimization of Surgical Care

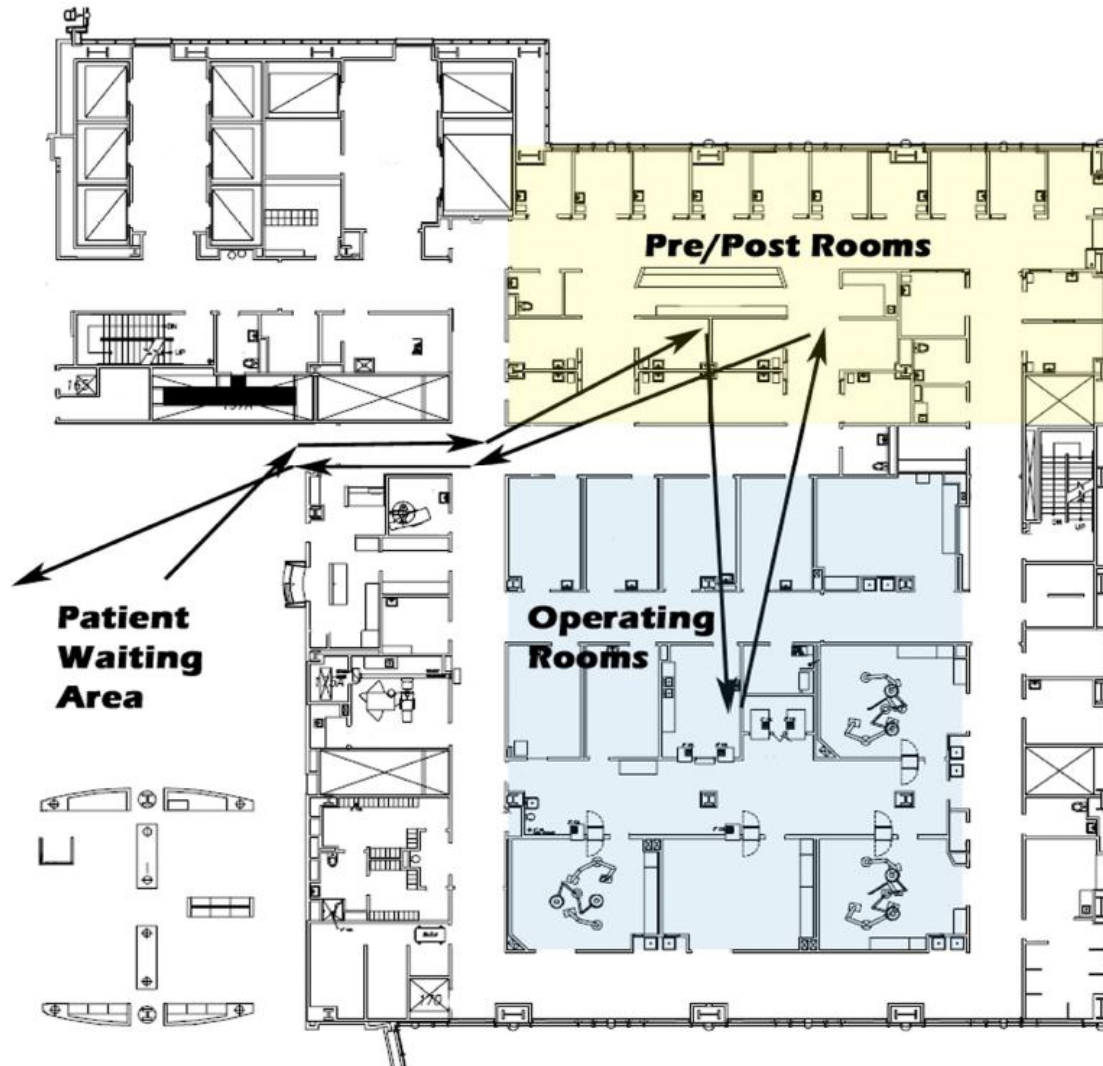
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Surgery

- Patient Intake: administrative activities, pre-surgery exam, gowning, site prep, anesthetic
- Surgery: incision, one or multiple procedures, pathology, closing
- Recovery: post-anesthesia care unit (PACU), ICU, hospital bed



Outpatient Procedure Center



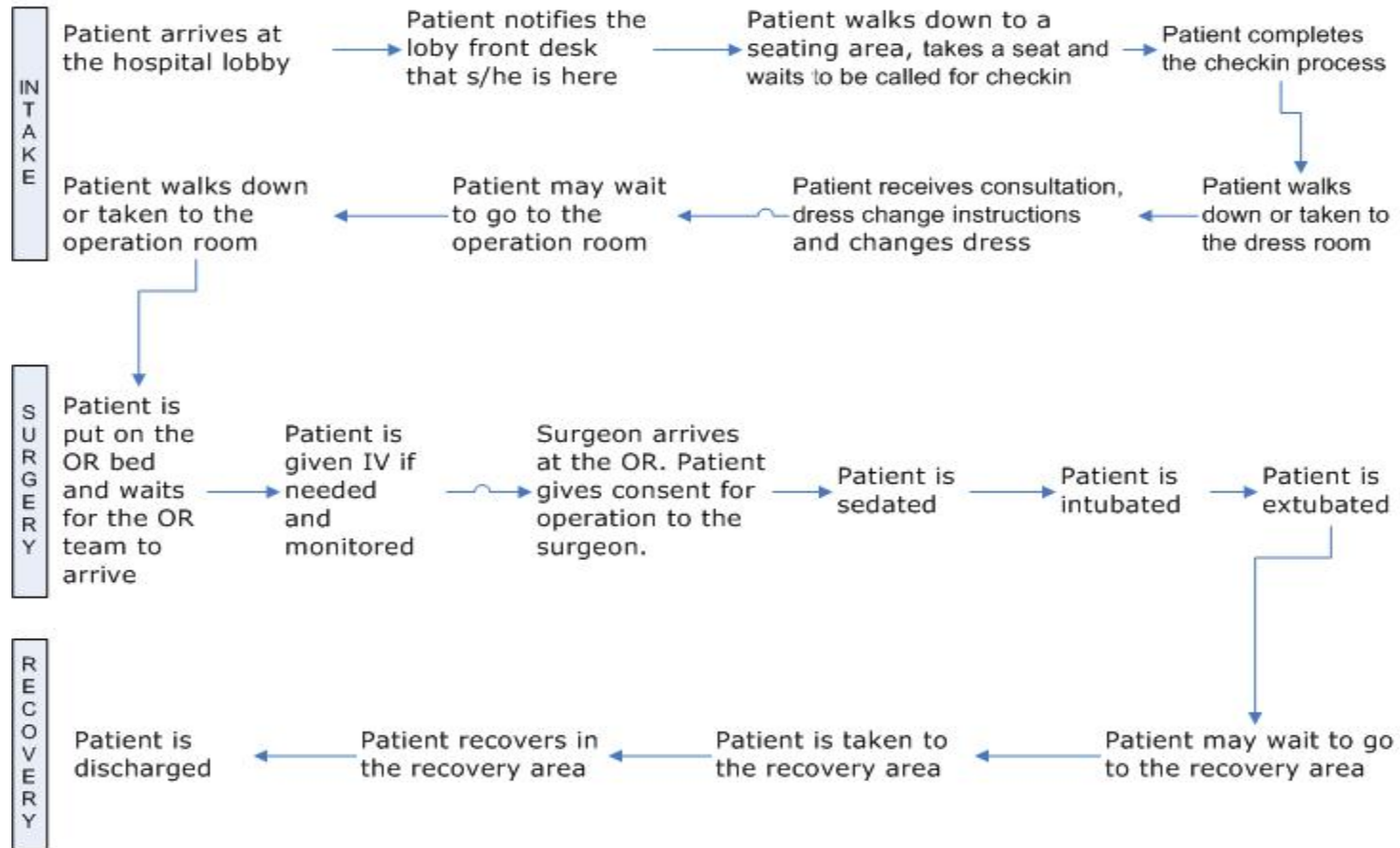
Complicating Factors

- Expensive resources
- Large number of activities
- Uncertain process times
- Fixed length of day
- Overtime
- Tardy patients and no-shows
- Many performance criteria

Model Building

- Process Map:
 - Sequence of activities
 - Patterns of resource utilization
 - Decision points
- Conceptual Model
- Quantitative Model

Process Map



Data

Instance_ID	Location	Room	Proc	Endoscopist	Primary Nurse	Appt Time	Pt. Status	Status time.
00001						12/6/05 7:30	WAITING	7:27
00001						12/6/05 7:30	CHECK_IN	7:42
00001						12/6/05 7:30	HOLDING	7:47
00001	Building	250	Colon	Dr.X	Nurse Y	12/6/05 7:30	ROOMING	7:47
00001	Building	250	Colon	Dr.X	Nurse Y	12/6/05 7:30	MD_IN_ROOM	8:04
00001	Building	250	Colon	Dr.X	Nurse Y	12/6/05 7:30	INTUBATION	8:10
00001	Building	250	Colon	Dr.X	Nurse Y	12/6/05 7:30	EXTUBATION	8:23
00001						12/6/05 7:30	BEDDED	8:28
00001						12/6/05 7:30	DISCHARGED	9:04
00001						12/6/05 7:30	SIGN_OFF	12:22



Intake

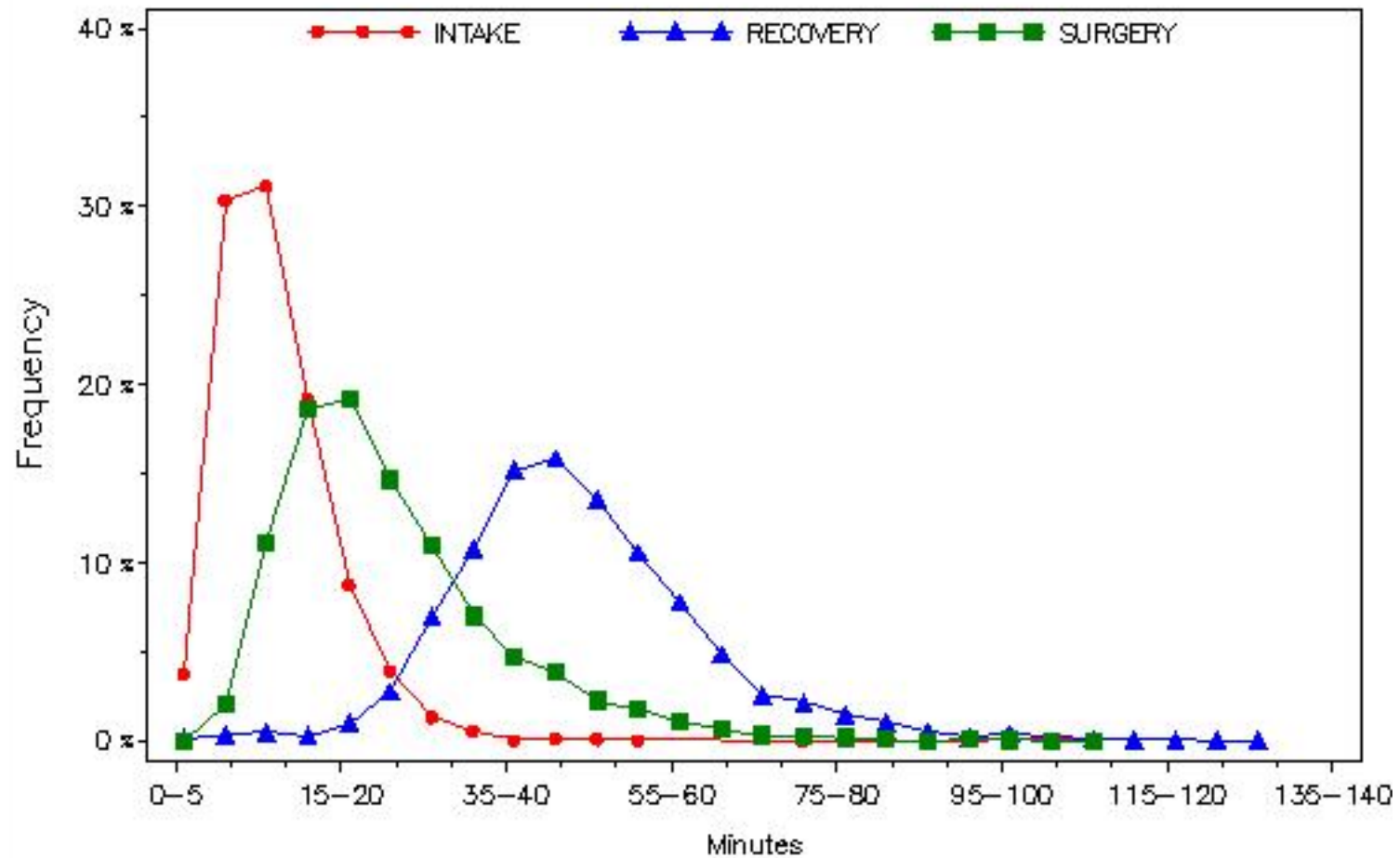


Procedure

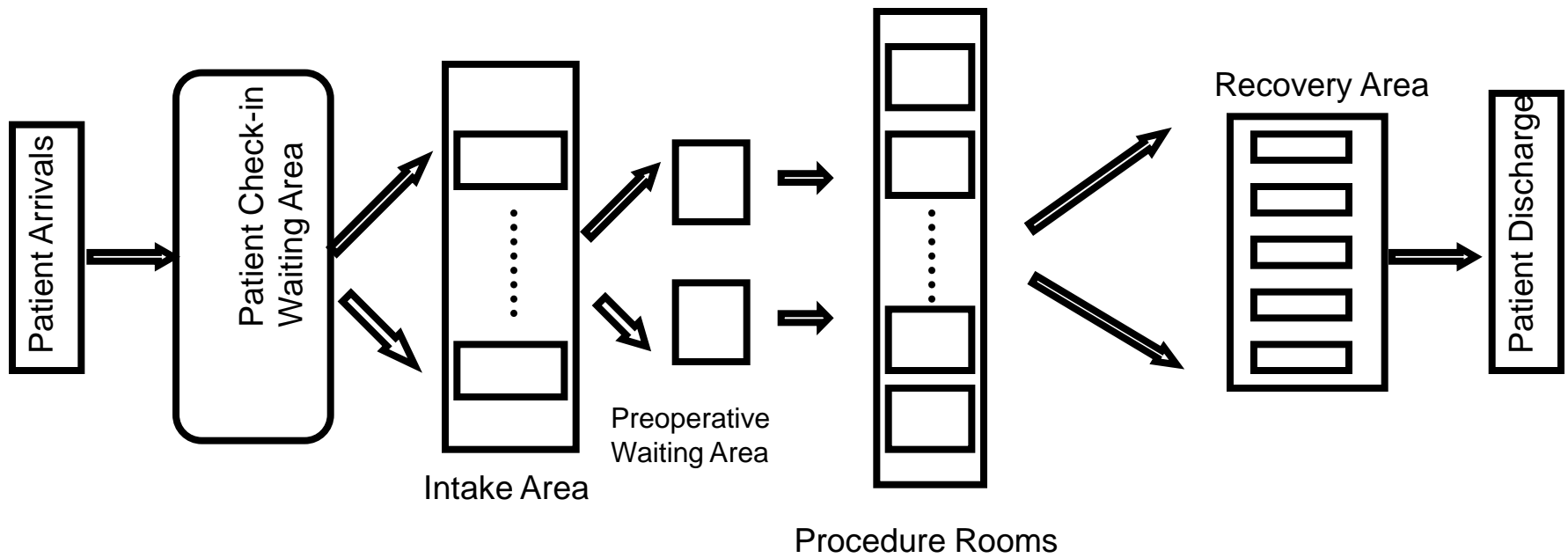


Recovery

Uncertainty



Conceptual Model



Performance Measures

- Patient throughput
- Waiting time:
 - Patients
 - OR Team
- Utilization:
 - Procedure room
 - OR Team
 - Recovery beds
- Overtime

Decisions

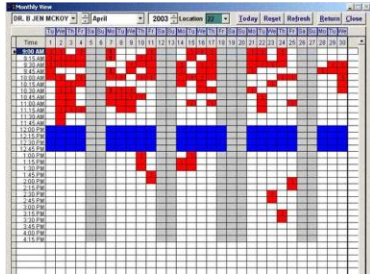
- Number and type of surgeries to schedule
- Staffing (nurses, surgeons, techs)
- Allocation of resources
- Capacity investment
- Scheduling

Methods

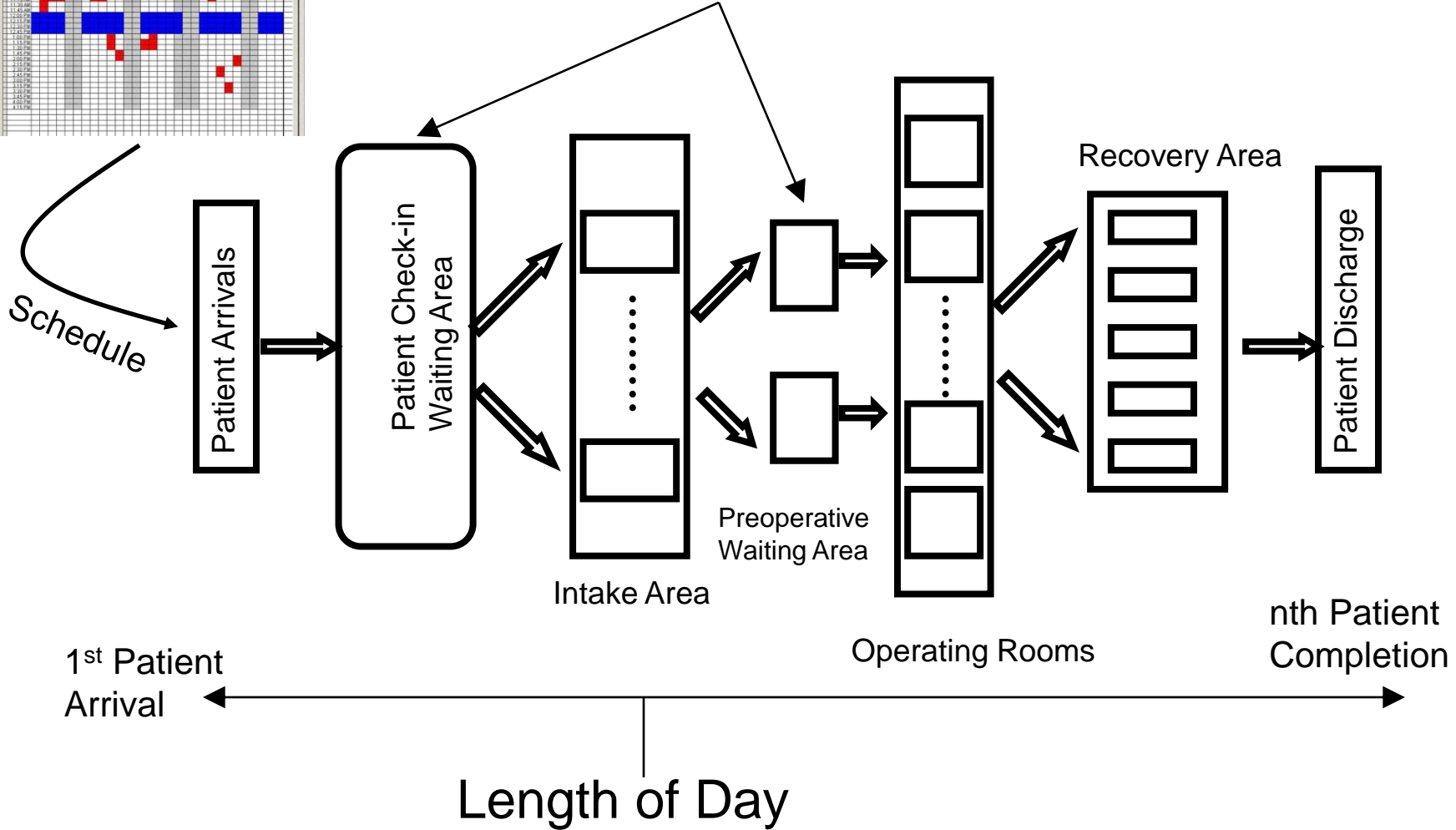
- Stochastic programming
 - Two stage recourse problems
 - Multi-stage stochastic programs

- Simulation Optimization
 - Discrete event simulation
 - Selection of the best
 - Genetic algorithms

Appointment Scheduling

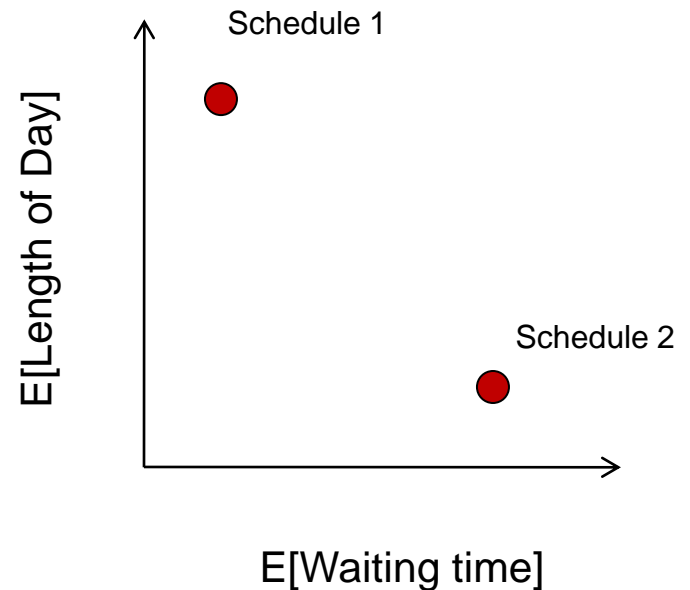


Patient Waiting Time

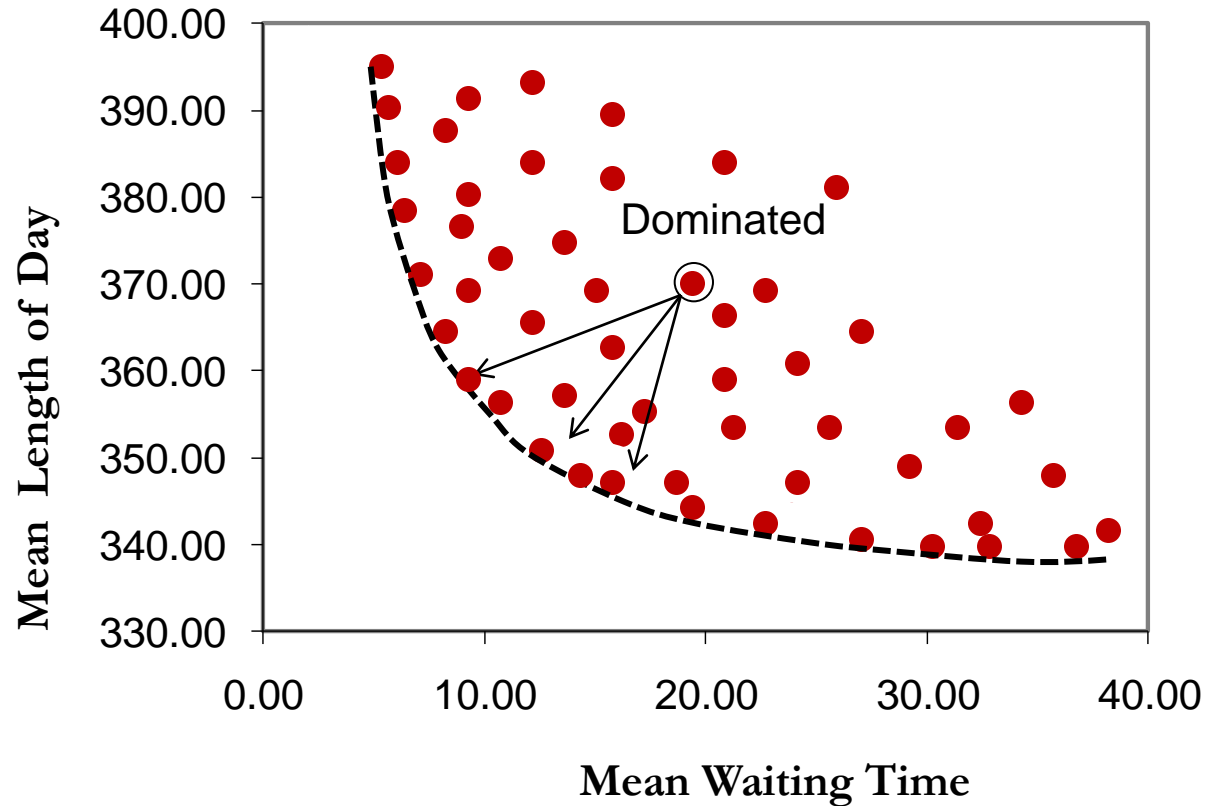


Competing Criteria

- Patient Waiting Time:
 - negatively correlated with patient inter-arrival times
 - waiting early in the day causes waiting later in the day
- Length of Day:
 - Positively correlated with patient inter-arrival times



Appointment Schedules



Other Projects

- Chronic disease screening and treatment systems (AHRQ, NSF)
- Outpatient planning and scheduling systems (Mayo, UNC, MGH)
- Surgical care delivery (Mayo Clinic, NSF)
- Disaster response (CDC)
- Cancer Center Operations (Duke Medicine)
- Endoscopy Suite Management (UNC Hospitals)

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