

Operational Performance of Endoscopy Suites

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Summary

- Systems Engineering
- Data Driven Decision Making
 - Process mapping
 - Measuring variation
- Examples:
 - No-shows
 - Appointment scheduling

Systems Engineering

- Systems engineering - a field with many names....
 - Industrial Engineering
 - Operations Research
 - Management Science
 - Decision Science

“We don't make a lot of the products you buy. We make a lot of the products you buy better”



History

Systems engineering emerged during World War II:

- Optimal design of convoys
- U-boat search strategies
- Network interdiction

After WWII systems engineers focused on:

- Factory scheduling
- Transportation systems
- Supply chain management



Service Industries

More recently systems engineering has been applied to services:

- Airlines
- Car rental agencies
- Hotels

Transportation Systems

Smith, B., Leimkuhler, J., Darrow, R. 1994, “Yield Management at American Airlines”, *Interfaces*, 22(1), 8-31

“In its 1987 Annual Report American Airlines broadly described the function of yield management as “selling the right seats to the right customer at the right prices” ”



Rental Agencies

Geraghty, M., Johnson, E. 1997, “Revenue Management Saves National Car Rental”, *Interfaces*, 27(1), 107-127.

On the verge of liquidation
“*National instituted a comprehensive revenue management program whose core is a suite of analytic models developed to manage capacity, pricing, and reservation*”



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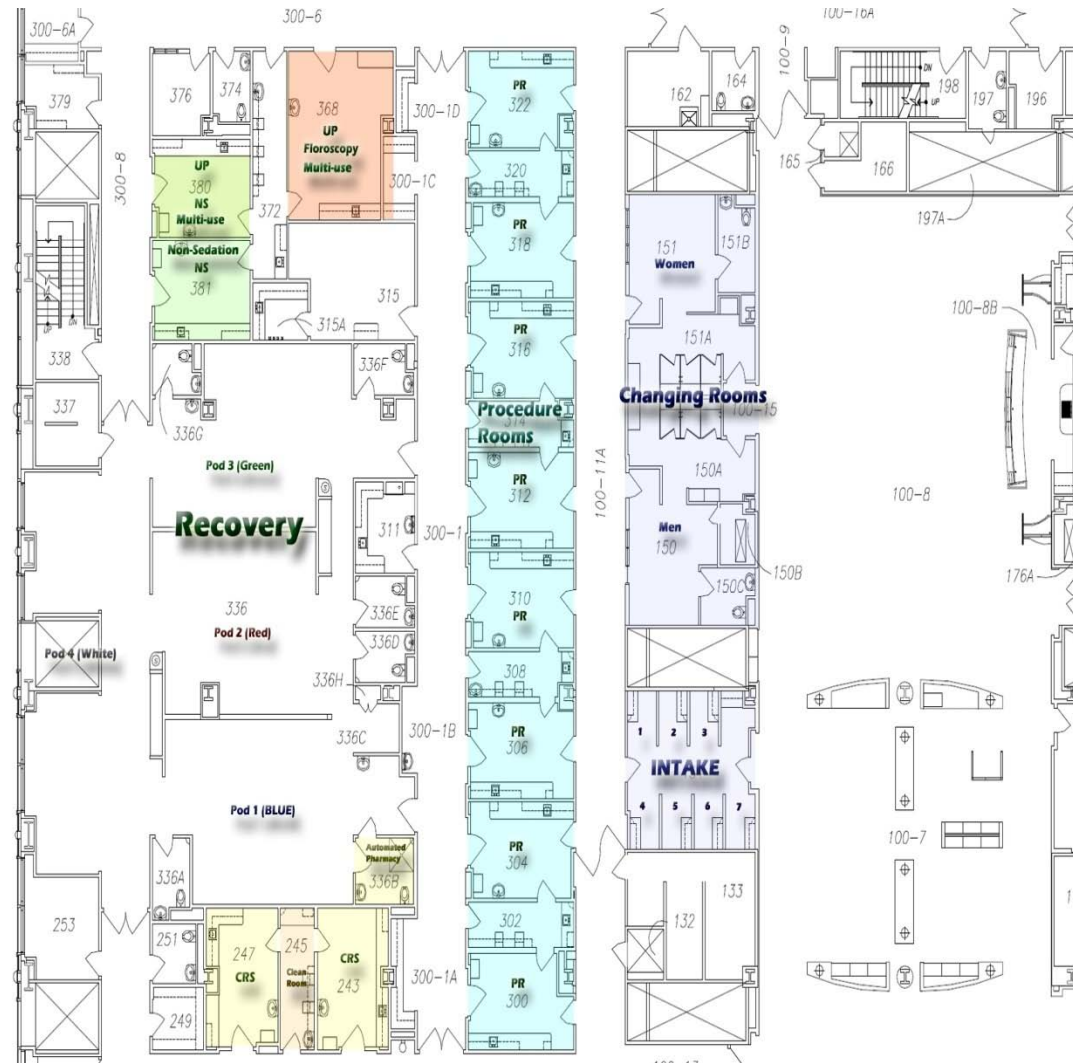
Magic Kingdom

“Operation everything: It stocks your grocery store, schedules your favorite team's games, and helps plan your vacation.”, *The Boston Globe*



Endoscopy Suite Management

- Number of patients to schedule each day
- How to staff the suite (nurses, endoscopists)
- Allocation of resources
- Appointment scheduling



Complicating Factors

- High cost of resources
- Many activities to be completed in a fixed time
- Uncertainty in duration of activities
- Many competing criteria



Steps to Process Improvement

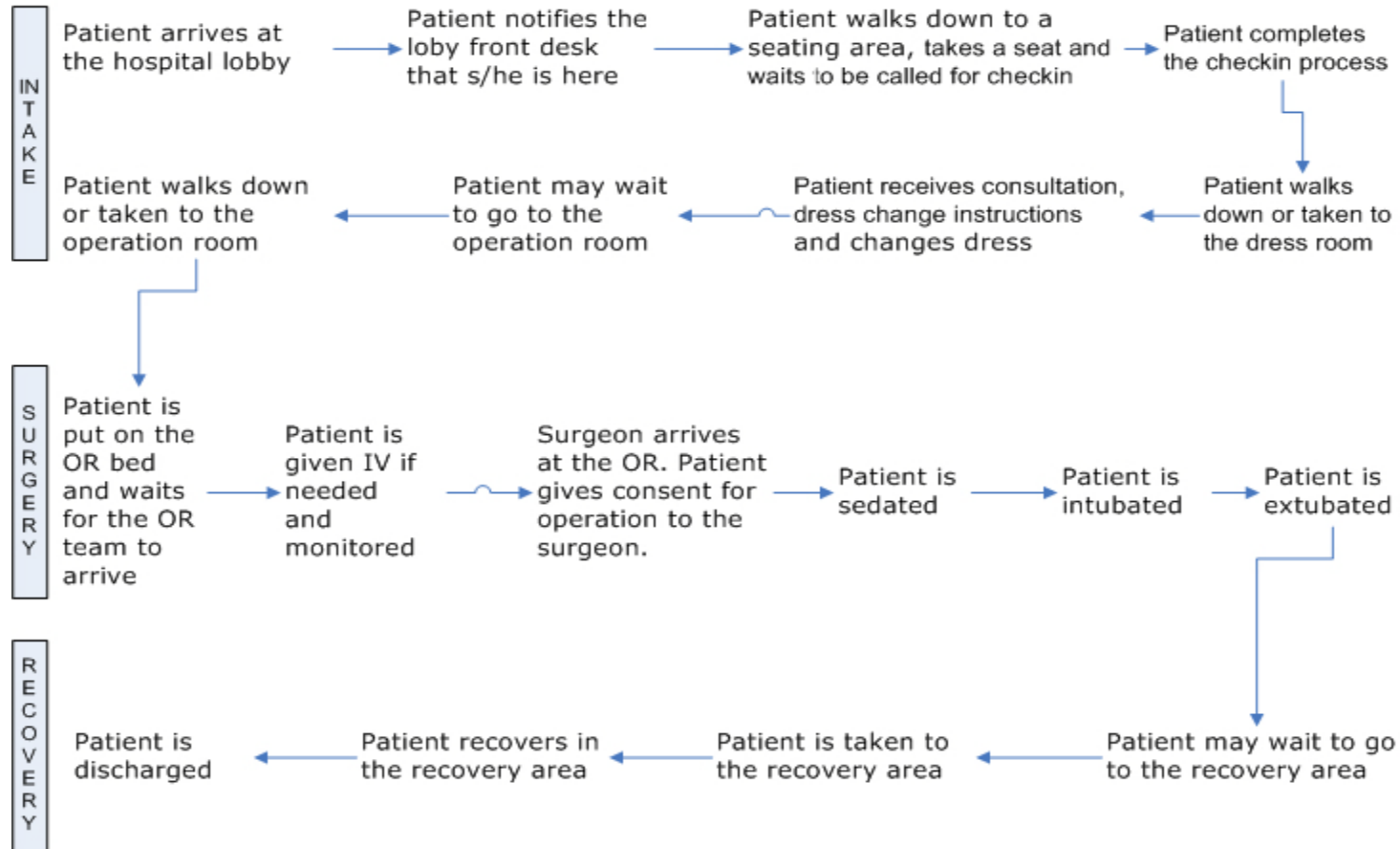
- Process Mapping
 - Definition of major activities and critical resources
 - Patient flow

- Data Collection
 - Activity durations, no-shows, resource utilization, patient waiting

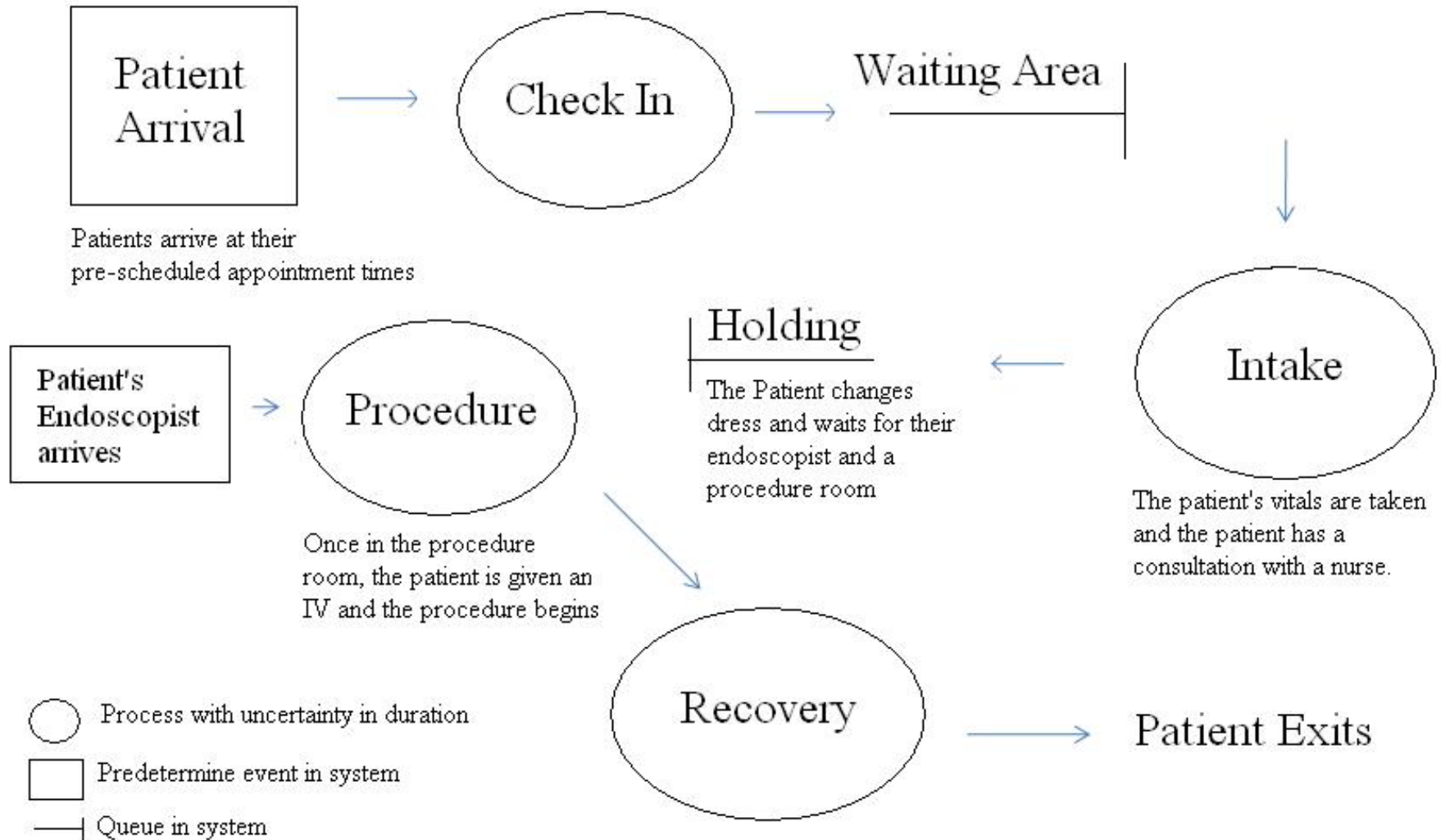
- Quantitative Analysis
 - Spreadsheets
 - Quantitative models



Process Map Example



Endoscopy Process



Data Collection

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	Bld A	250	Colon	Dr.X	Nurse Y	12/6/05 7:30	ROOMING	7:47
00001	Bld A	250	Colon	Dr.X	Nurse Y	12/6/05 7:30	MD_IN_ROOM	8:04
00001		250	Colon	Dr.X	Nurse Y	12/6/05 7:30	INTUBATION	8:10
00001	Bld A	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



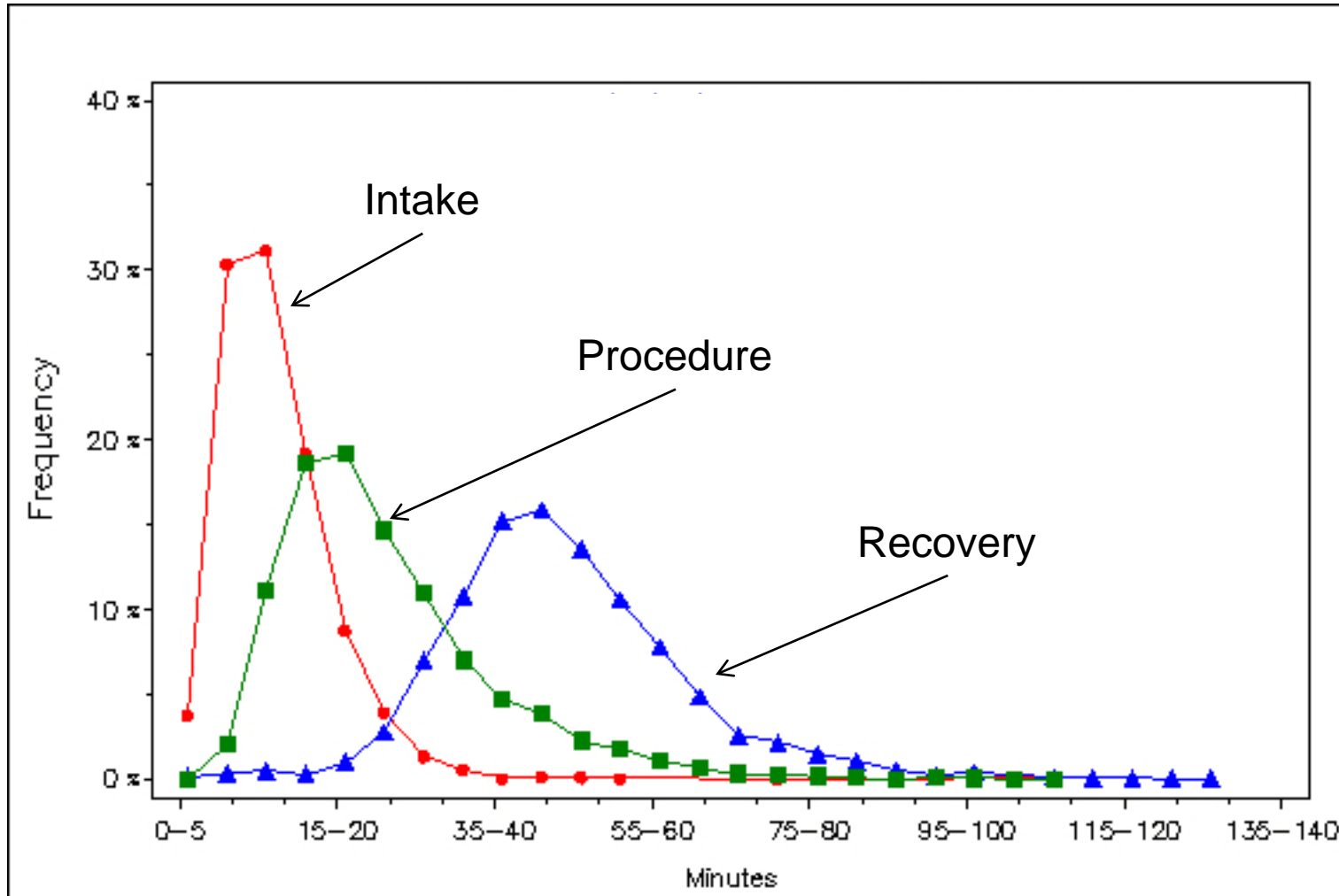
Intake

Procedure

Recovery



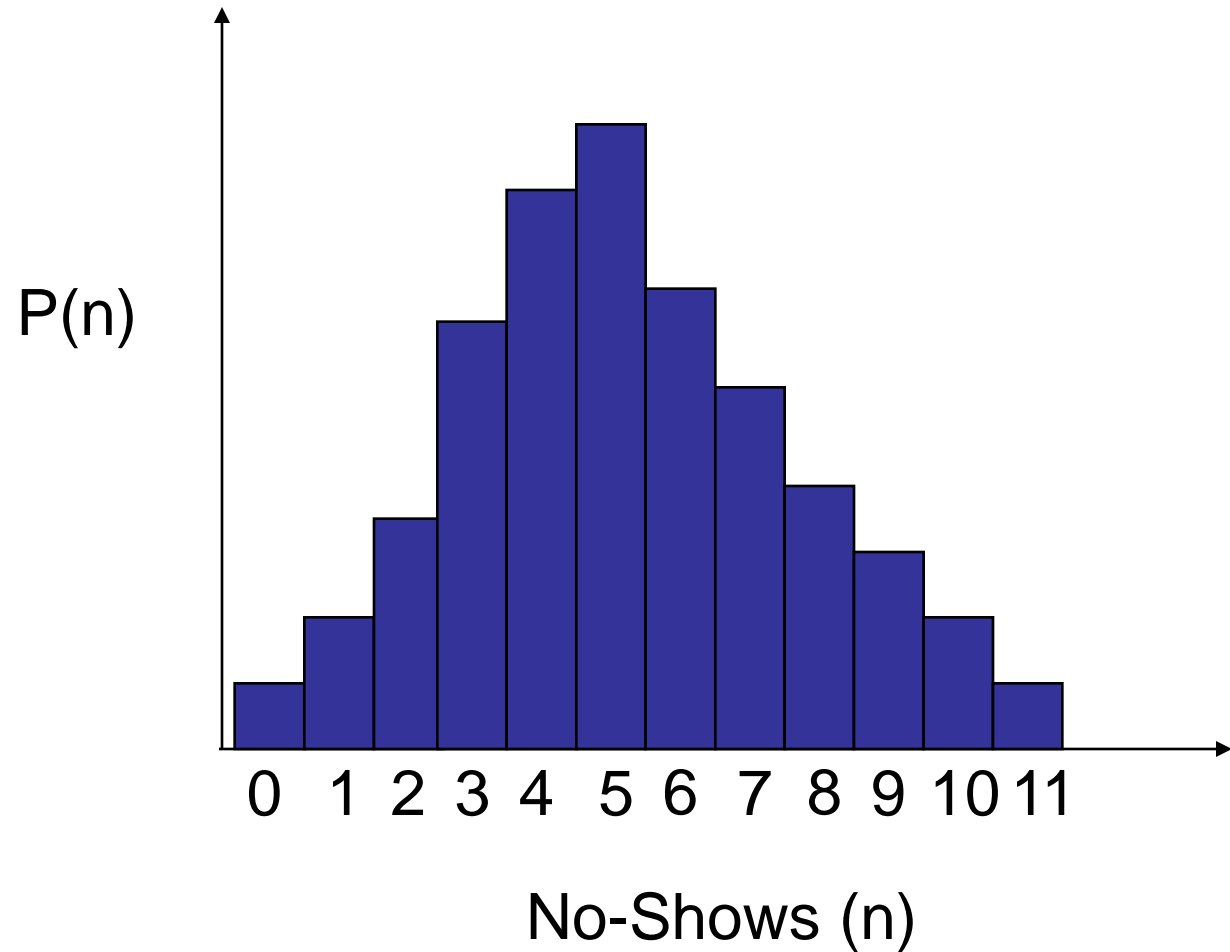
Measuring Variation



Examples



No-Shows



Optimal Booking Level

Average Underage:

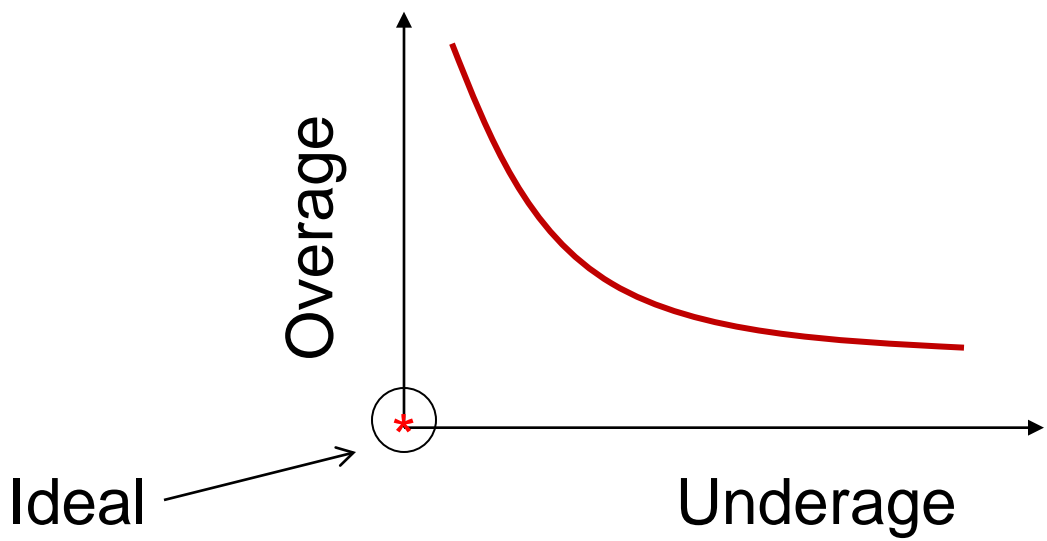
$$E_N[\text{Max}(0, I - B \cdot N)]$$

Target
↗

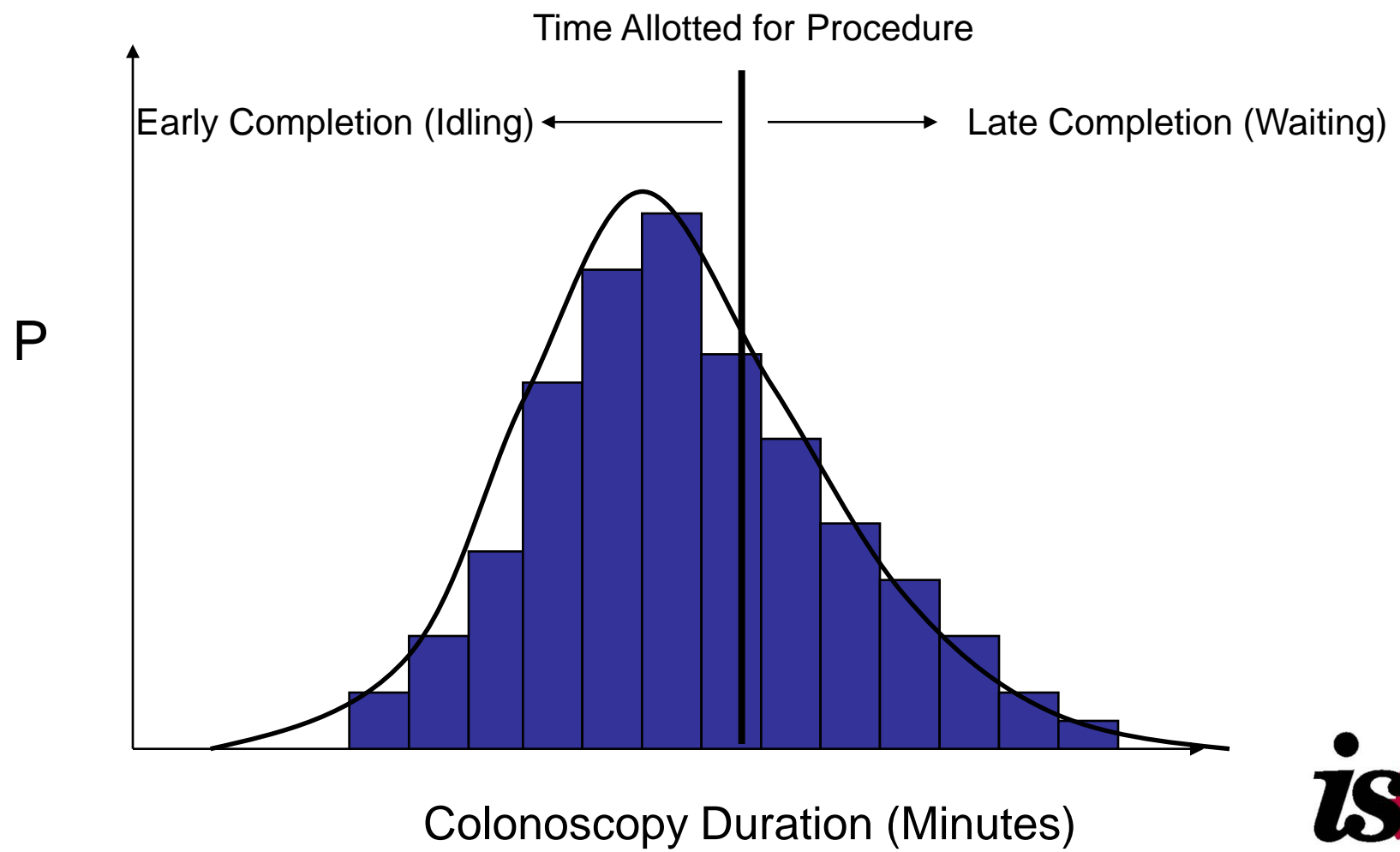
↖
Actual

Average Overage:

$$E_N[\text{Max}(0, B \cdot N - I)]$$



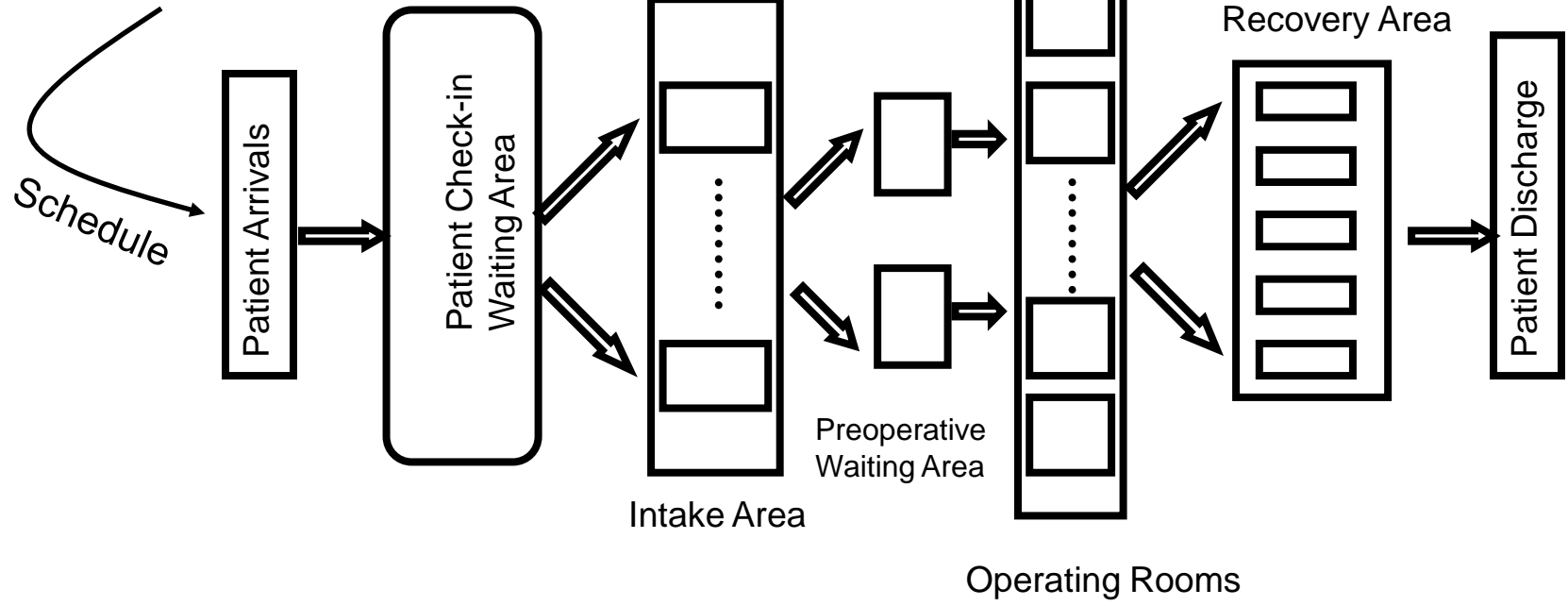
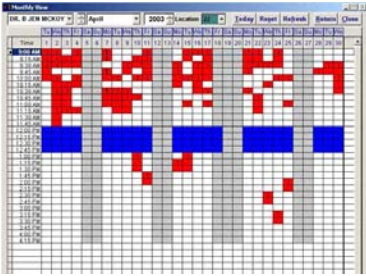
Appointment Scheduling



Factors that Influence Scheduling

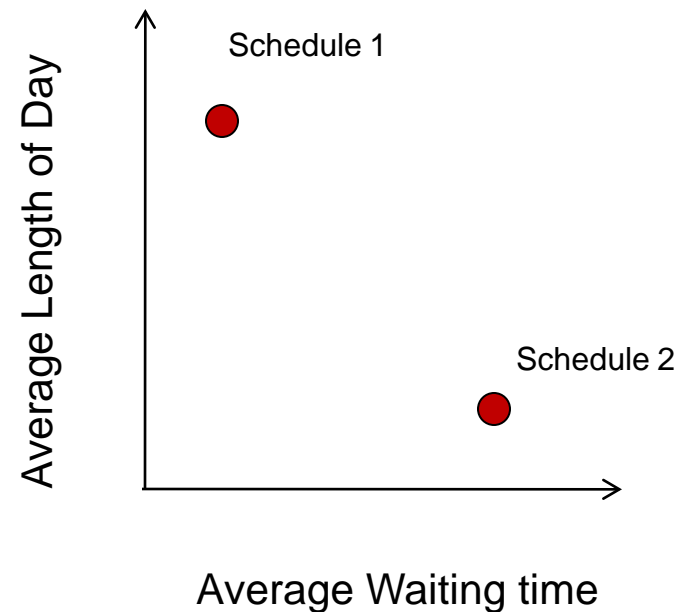
- Resource availability
- Room turnovers
- On-time starts
- No-shows

Endoscopy Simulator



Competing Criteria

- Patient Waiting Time:
 - negatively correlated with patient inter-arrival times
- Length of Day:
 - positively correlated with inter-arrival times

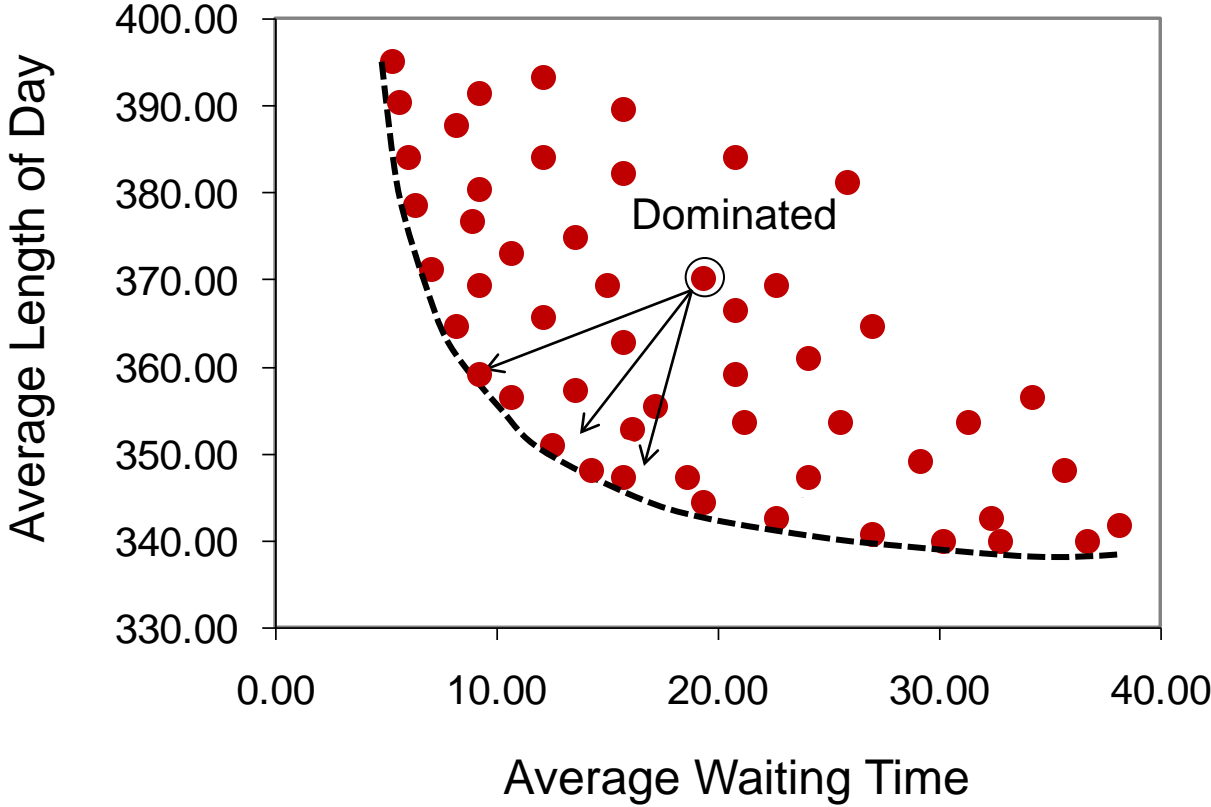


Searching for the Optimal Schedule

- Decision variables: scheduled start times to be assigned to patients each day
- Example Schedule:
 - Patient 1: 8am Patient 2: 8am Patient 3: 8:30 am
Patient 4: 8:30 am,, Patient 15: 3pm, Patient 16: 3:30pm
- Goal: understand tradeoffs between waiting and length of day



Schedule Optimization



Key Points

- There is a science to health care delivery
- Variation detracts from operational efficiency
- Collecting data is necessary to understand variation
- Planning for variation can reduce its impact



Questions?



Simple Example

- Comparison of endoscopy time allocations given random procedure time between 10 and 20 minutes

