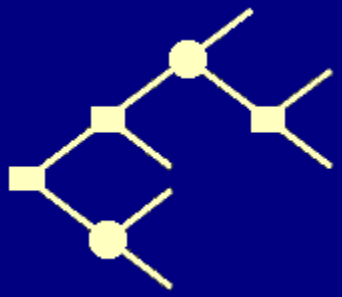

An Implementation Of Flipped Learning For OR Courses

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Quantitative Process & Decision Support/Systems Analyst

My Background

- **Past:**
  - **Ph.D. In Operations Research (Queuing Theory)**
  - **Consulting**
  - **Assistant Professor At McGill University 20 years ago**

- **Now:**
  - **Quantitative health care decision support/systems analyst**
  - **Adjunct Professor of Surgery at McGill University**
  - **Part time instructor at Continuing Studies at McGill University**

Nadia Lahrichi

- **Ph.D. Industrial Engineering**
- **Assistant Professor Ecole Polytechnique**
- **Expert in scheduling and optimization**

Lawrence Rosenberg

- **M.D.**
- **Ph.D. (experimental surgery)**
- **Professor of Surgery (A.G. Thompson Chair of Surgical Research at McGill)**
- **Chief of surgical services JGH**
- **Head of JGH transformational change effort**

The JGH's Previous Pre-Surgical Screening Clinic

- **Near the blood test center**
- **Very little space**
- **Tiny exam rooms**
- **. . .**

Challenges Facing Previous PSS Clinic

- **Insufficient space for waiting (wheel chairs), exams, training, . . .**
- **Not enough staff (i.e. nurses and admin techs)**
- **Teaching only provided to fraction of patients**
- **Inefficient flow of patient and high wait time**
- **Inconsistent medication adjustments**
- **Dealing with abnormal results**
- **Completing charts on-time and adequate follow-up**

Consequences

- **Patients weren't always properly prepared for procedures**
- **Delays in starting procedures**
- **Some cancelations**
- **Excessive patient waiting**

Literature/Analysis

- **Research literature indicates that a lack of comprehensive services increases likelihood of post-op complications**
- **Analysis of the previous PSS clinic indicated need for:**
  - **More services (ex: pharmacist, nurse training for all)**
  - **More staffing (nurses, doctors)**
  - **To move patients faster**
  - **To screen and identify patients with infection precaution or allergies (ex. MRSA exposure, latex allergies)**
  - **To better manage abnormal test results**
  - **To complete charts at least 72 hours before the day of procedure**

New Pre-Surgical Screening Clinic

- **Up to 35 patients/day would need to do some of the following:**
  - **Register for the clinic**
  - **Submit insurance information**
  - **See pharmacy technician**
  - **Change into a gown**
  - **Have ECG taken**
  - **See GP or Internist**
  - **Get dressed**
  - **Provide blood and urine samples**
  - **Watch training dvd**
  - **Receive individual training**

Management Challenges

- **Patients having differing needs**
- **Space requirements**
- **Physician idleness**
- **Staffing costs (including overtime costs)**
- **Excessive patient waiting**

Complicating Factors

- **Patient profile mix**
- **Uncertainty about times needed for each task**
- **A few patients need to see pharmacy technician before physician**
- **No shows and cancellations (not yet addressed)**
- **Making sure that staff get breaks and lunch without affecting flow**

Management Decisions

- Space
- Number of nurses
- Scheduling:
  - Staff – arrival times, break times, lunch times
  - Physicians – arrival times
  - Patients – arrival times

Tool Set

- **Discrete Event Simulation**
- **Optimization**
- **Simulation based optimization**

Simulation Model Challenges

- Different activities for different patients
- Sequence of activities
  - Patients need to be in an exam room to change into their gown
  - Patients need to be in a gown before having their ECG taken
  - . . .
- Tracking which patient had done what and still needed to do what
- How to perform the optimization

Simulation Modeling Approach

- **Animation**
  - **Normal approaches:**
    - **Flow chart**
    - **Geographic animation (i.e. in context of a floor plan)**
  - **Needed separate queues for all combinations of types of waiting**
- **Staff**
  - **Normally modeled as resources**
  - **Wanted more flexibility for simulating staff**
  - **Treated patients, staff and physical resources all as entities**

Admission Staff	AS Not In PSS 2	AS In Transition 0	AS Idle 0	AS Idle Needs Break 0	AS Idle Needs Lunch 0	AS Idle Needs To Leave 0	AS In Bathroom 0	AS On Break 0	AS At Lunch 0	AS Register 1 0	AS Register 2 0										
Nurse	RN Not In PSS 3	RN In Transition 0	RN Idle 0	RN Idle Needs Break 0	RN Idle Needs Lunch 0	RN Idle Needs To Leave 0	RN In Bathroom 0	RN On Break 0	RN At Lunch 0	RN Call Patient 0	RN Train Patient 0	RN Train Group 0	RN 1st PA Chart Review 0	RN 2nd PA Chart Review 0							
Pharmacist	PH Not In PSS 1	PH In Transition 0	PH Idle 0	PH Idle Needs Break 0	PH Idle Needs Lunch 0	PH Idle Needs To Leave 0	PH In Bathroom 0	PH On Break 0	PH At Lunch 0	PH Interview Patient 0	PH Patient Follow Up 0										
ECG Technician	ECGT Not In PSS 1	ECGT In Transition 0	ECGT Idle 0	ECGT Idle Needs Break 0	ECGT Idle Needs Lunch 0	ECGT Idle Needs To Leave 0	ECGT In Bathroom 0	ECGT On Break 0	ECGT At Lunch 0	ECGT Taking ECG 0											
Blood Taker	BT Not In PSS 1	BT In Transition 0	BT Idle 0	BT Idle Needs Break 0	BT Idle Needs Lunch 0	BT Idle Needs To Leave 0	BT In Bathroom 0	BT On Break 0	BT At Lunch 0	BT Taking Blood 0											
General Practitioner	GP Not In PSS 2	GP In Transition 0	GP Idle 0	GP Idle Needs Break 0	GP Idle Needs Lunch 0	GP Idle Needs To Leave 0	GP In Bathroom 0	GP On Break 0	GP At Lunch 0	GP Seeing Patient 0											
Internist	IN Not In PSS 1	IN In Transition 0	IN Idle 0	IN Idle Needs Break 0	IN Idle Needs Lunch 0	IN Idle Needs To Leave 0	IN In Bathroom 0	IN On Break 0	IN At Lunch 0	IN Seeing Patient 0											
Patient Changing Room		CR In Transition 0	CR Idle 2							CR In Use 0											
Exam Room		ER In Transition 0	ER Idle 6							ECGT ER In Use 0	GP ER In Use 0	IN ER In Use 0									
DVD Player		DVD Player In Transition 0	DVD Player Idle 12							DVD Player Training 0											
Patient	PA Not In PSS 23	PA Register 1 0	PA Pharmacist 0	PA Into CR And Gown 0	PA Into GP ER And Gown 0	PA Into IN ER And Gown 0	PA Into ECGT ER 0	PA ECGT 0	PA Into GP ER 0	PA GP 0	PA Into IN ER 0	PA Internist 0	PA Out Of Gown 0	PA Into CR And Out Of Gown 0	PA DVD Training 0	PA Group Training 0	PA Individual Training 0	PA Register 2 0	PA Blood Taker 0		PA PSS Process Completed 0
		PA Waits R1 12	PA Waits PH 0	PA Waits CR And Into Gown 0	PA Waits GP ER Gown 0	PA Waits IN ER Gown 0	PA Waits ECGT ER 0	PA Waits ECGT 0	PA Waits GP ER 0	PA Waits GP 0	PA Waits IN ER 0	PA Waits Internist 0		PA Waits CR And Out Of Gown 0	PA Waits DVDT 0	PA Waits GT 0	PA Waits IT 0	PA Waits R2 0	PA Waits BT 0	PA Waits Consult 0	
			PA Waits PH R2 0	PA Waits CR And Into Gown R2 0	PA Waits GP ER Gown R2 0	PA Waits IN ER Gown R2 0									PA Waits DVDT BT 0	PA Waits GT BT 0	PA Waits IT BT 0	PA Waits BT R2 0			
															PA Waits DVDT R2 0	PA Waits GT R2 0	PA Waits IT R2 0				
															PA Waits DVDT BT R2 0	PA Waits GT BT R2 0	PA Waits IT BT R2 0				

Simulation Model Data Requirements

- **Tasks needed for each patient profile**
- **Patient profile distribution**
- **Service time distributions**
- **Count of tasks needing to be done each day**

Actual Simulation Model Data

- **Patient profiles**
  - **Guesstimates from subject matter experts in existing (PAT) clinic**
- **Service time distributions**
  - **Triangular distribution guesstimates from subject matter experts**
  - **Patient self-time studies (in progress)**
- **Count of tasks needing to be done each day**
  - **Use patient profiles and tasks associated with each profile**

Simulation Model Miscellaneous Issues

- Needed to determine rooms allocated to each type of physician
  - Can not pool rooms when GP and Internist work at same time
  - For Internist
    - When alone allocate all of the rooms
    - When with GP, allocate 2 for each Internist

Validating The Simulation Model

- **Was difficult**
  - **Plan for PSS is in flux**
  - **Incomplete data**
- **Received feedback from management**
  - **PSS Clinic Nursing Coordinator**
  - **The Chief Of Surgical Services**
  - **Associate Director Of Professional Services**
- **Tested against schedule with deterministic service times**
- **It was known that results were sensitive to service time distribution estimates which were at best guesstimates**

Optimization Issues

- **Need to start day early to get everyone done by end of day**
- **Certain staff had to arrive before other staff**
- **Breaks and lunches had to fit into 8 hour day**

Optimization Problem – Objective Function

- **Minimize sum of costs of:**
  - **Physician idle time**
  - **Staff overtime**
  - **Excessive patient waiting time**

Optimization Problem - Constraints

- **Subject to**
  - **Getting patients done by the end of the day (21:00)**
  - **Staff break and lunch times are respected**
  - **Both general practitioners work in the morning**
  - **The sole internist works in the afternoon**
  - **At least 8 people in group training sessions**
  - **Sending staff home at end of their shift if there is another staff member who can finish up for them**

Optimization

- Set initial values for each arrival time variable
- Set upper and lower bounds for each arrival time variable
- Select initial time increment
- Repeat forever
  - Loop through variables one at a time
    - Change variable positively and then negatively by time increment
    - If solution is feasible evaluate average of total simulated cost over a pre-determined number of days
    - Keep if it is an improvement
  - Gradually decrease magnitude of time increment

Optimization Challenges

- **Finishing all patients by end of day**
- **Sending staff home at end of their shift if there is another staff member who can finish up for them**
- **Determining what excessive patient waiting time is**
- **The internist in the afternoon**

Best Decision Variable Values Found To Date

- **Depends on time distributions**
- **Using preliminary esstimates (based on small study of existing PSS)**
- **Using guesstimates from ECG machine salesman**
- **Using slower dressing times**

Best Decision Variable Values Found To Date

Entity Type	Type	Count	Times				
Admissions Staff	Arrival	2	6:00	6:00			
	Break		8:55	8:55			
	Lunch		11:50	11:50			
Registered Nurse	Arrival	3	7:00	7:00	7:05		
	Break		9:55	9:55	9:50		
	Lunch		12:25	12:25	12:20		
Pharmacist	Arrival	1	7:30				
	Break		9:30				
	Lunch		12:00				
ECG Technician	Arrival	1	6:25				
	Break		8:25				
	Lunch		10:55				
Blood Taker	Arrival	1	7:55				
	Break		10:05				
	Lunch		12:40				
General Practitioner	Arrival	2	6:30	7:00			
Internist	Arrival	1	10:10				

Best Decision Variable Values Found To Date

Patient	Arrival	35	6:00	6:00	6:00	6:00	6:00
			6:00	6:00	6:05	6:05	6:05
			6:05	6:05	6:20	6:25	6:35
			6:45	7:30	7:30	7:40	7:40
			7:50	8:10	8:15	8:20	8:20
			8:25	8:40	8:50	9:00	9:05
			9:30	9:45	10:05	10:35	11:40

Challenges For Extending To Other Clinics

- **Many more queues**
- **Scheduling of different clinics**
- **Room availability**

Challenges For Extending To Other Clinics

- **Collecting data**
  - **It is very hard to get staff to track their own time**
  - **It would be very helpful to automate time tracking using two way RTLS (Real Time Location System)**
- **Implementation**
  - **It is relatively easy to do analysis**
  - **It is much harder to change processes**

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