

# MRI Presentation

REDUCE IDLE TIME OF MRI  
MACHINES BETWEEN SCANS

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# Improving MRI Department Efficiency

Problem:

The MRI scanner sits idle 31% of the time during hours of operation (42% idle with no allotted 5-minute gap)

Goal:

If we take the steps to decrease the idle time, we can solve the wait time issue for MRI scans in Halifax

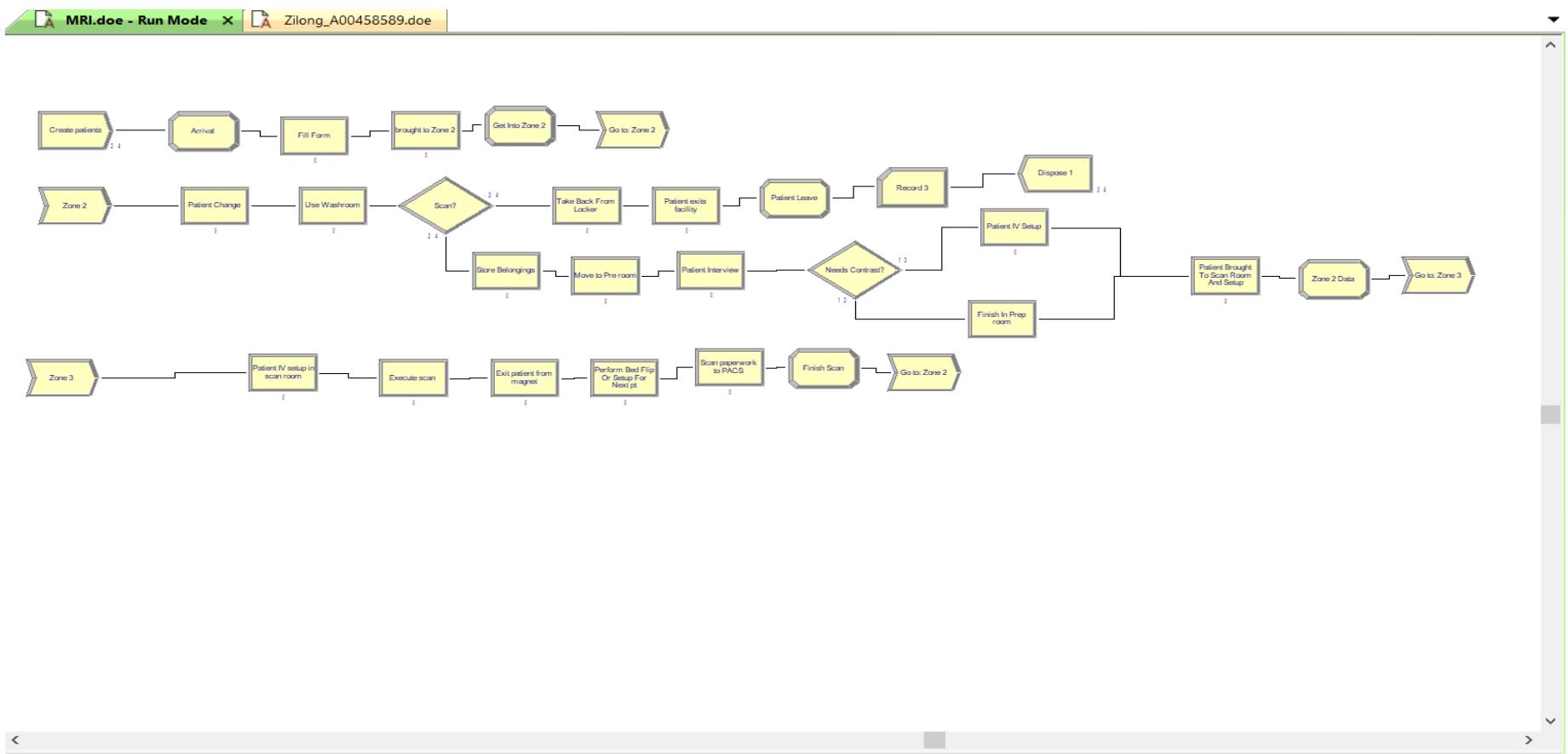


# Modeling / Optimization Steps:

- Step 1: Defining Staff Roles
  - Establish clear responsibilities for the 6-staff model
  - 2 scan techs, 2 backup techs, an administration TA, and the dedicated MRI porter.
- Step 2: Identify Idle Time Drivers
  - Lay out all steps that each staff member and patient perform
  - Tie up resources and delay patient movement/create idle time.
  - Include a backup staff member to cover breaks and low-probability events.
- Step 3: Workflow Creation
  - Create an effective workflow
  - MRI safety zones and patient movement.
- Step 4: Testing and Adjustment
  - Test out the workflow model and make adjustments based on staff comments, patient comments
  - Time it takes for staff and patients to perform each step

# Current System Modelling

- Arena Simulator:



# Modelling Results (Stats)

- Arena Simulator:

	O	P	Q	R	S	T	U	V	W	X	Y			O	P	Q	R	S	T	U	V	W	X	Y			
1	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	Average Of Replication Averages	Half-Width	StDev Of Replication Averages	Min Replication Average	Max Replication Average	Overall Min Value	Overall Max Value		1	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	Average Of Replication Averages	Half-Width	StDev Of Replication Averages	Min Replication Average	Max Replication Average	Overall Min Value	Overall Max Value	
2	Unnamed Project	Execute sca	Number Wai Queue			0.00864571	0.006175315	0.008632495	0	0.024301786	0		2	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	12.58214883	3.89925554	5.450783409	6.105528963	22.9708594	0	4		
3		Exit patient	Number Wai Queue			0	0	0	0	0	0				3	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0	0	0	0	0	0	0
4		MRI machir	Instantaneous Utilization			0.301513518	0.047642997	0.066600318	0.218368774	0.384534621	0				4	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.984969585	0.007254722	0.010141402	0.956546365	0.990542526	0	0
5			Number Bus Resource			0.301513518	0.047642997	0.066600318	0.218368774	0.384534621	0				5	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.984969585	0.007254722	0.010141402	0.956546365	0.990542526	0	0
6			Number Schi Resource			1	0	0	1	1	1				6	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.984579816	0.008857667	0.012382165	0.950080093	0.991022556	0	0
7			MRI machine 2			1	0.045809428	0.064037165	0.20683231	1	0				7	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.984579816	0.008857667	0.012382165	0.950080093	0.991022556	0	0
8			Move to Pr	Number Wai Queue		0	0	0	0	0	0				8	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.984579816	0.008857667	0.012382165	0.950080093	0.991022556	0	0
9			Patient	WIP Entity		1.159145708	0.181235985	0.253350438	0.857311559	1.531479175	0				9	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.984579816	0.008857667	0.012382165	0.950080093	0.991022556	0	0
10			Patient Bro	Number Wai Queue		0	0	0	0	0	0				10	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	1	0	0	1	1	1	1
11			Patient Cha	Number Wai Queue		0	0	0	0	0	0				11	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0	0	0	0	0	0	0
12			Patient IV s	Number Wai Queue		0.019116537	0.012788223	0.017876703	0	0.048548543	0				12	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	27.85450974	7.059901622	9.869061951	15.89566979	46.64060883	0	8
13			Patient Inte	Number Wai Queue		0	0	0	0	0	0				13	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0	0	0	0	0	0	0
14			Perform Be	Number Wai Queue		0	0	0	0	0	0				14	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.004416232	0.001961556	0.002742067	0.001342137	0.010820279	0	0
15			Perform Be	Number Wai Queue		0	0	0	0	0	0				15	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	11.51535284	3.153205366	4.407877158	6.021493742	19.91594919	0	4
16			Scan paper	Number Wai Queue		0	0	0	0	0	0				16	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.00763187	0.001796762	0.0025117	0.003690641	0.011103905	0	0
17			Use Washrc	Number Wai Queue		0.000104595	0.000236611	0.000330759	0	0.001045953	0				17	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0	0	0	0	0	0	0
18			brought to	Number Wai Queue		0	0	0	0	0	0				18	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0	0	0	0	0	0	0
19			change roo	Instantaneous Utilization		0.034445717	0.005836332	0.00815863	0.023541922	0.047181014	0				19	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	Source	0.010047002	0.002204789	0.003082082	0.006067108	0.017524335	0	0
20			change roo	Instantaneous Utilization		0.034445717	0.005836332	0.00815863	0.023541922	0.047181014	0				20	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	0	0	0	0	0	0	0	
21			change roo	Instantaneous Utilization		1	0	0	1	1	1				21	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	0.118702652	0.002346624	0.003280354	0.114128731	0.122969411	0	0	
22			change roo	Instantaneous Utilization		0.036763497	0.005883465	0.008224517	0.024517381	0.049577971	0				22	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	0.118702652	0.002346624	0.003280354	0.114128731	0.122969411	0	0	
23			change roo	Instantaneous Utilization		0.036763497	0.005883465	0.008224517	0.024517381	0.049577971	0				23	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	1	0	0	1	1	1	1	
24			change roo	Instantaneous Utilization		1	0	0	1	1	1				24	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	0.118110193	0.00249388	0.003486204	0.112838882	0.122568865	0	0	
25			change roo	Instantaneous Utilization		0.035278256	0.004553818	0.006365798	0.024784631	0.043716469	0				25	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	0.118110193	0.00249388	0.003486204	0.112838882	0.122568865	0	0	
26			change roo	Instantaneous Utilization		0.025778256	0.004553818	0.006365798	0.024784631	0.043716469	0				26	Continuous-Time Statistics (Time Persistent)	Project Name	Name	Type	1	0	0	1	1	1	1	

I guess the utilization of MRI machine is around 30%



# Optimization Techniques

- Spatial and Flow Optimization (Zones)
- Structural Optimization (Roles)



# Spatial and Flow Optimization (Zones)

- Use Zone 1 to your advantage -
  - Patients can take their time filling out the screening form here, as they do not need to be supervised.
  - This prevents them from taking up resources in the main department.
- Utilize the Prep Room (Zone 2) as the Ideal Wait Area -
  - The patient is screened here to ensure they are fully prepared for their scan or ready to switch magnets if needed.
  - Limit Patients in Zone 2
  - Maintain a maximum of 3 patients in Zone 2: 2 patients being prepped and 1 exiting the magnet, to manage flow without creating bottlenecks.
- Focus on High-Time Tasks:
  - Time for patient preparation ~ 16 mins,
  - Time to complete scan ~ 30 mins.



# Structural Optimization (Roles)

- Scan Tech
  - Follows the current patient through their care until scanning is complete.
- Backup Tech
  - Priority is to prep the next patient.
  - Assists with patient set up, finishes paperwork [~ is available for administration questions?]
- Administrative TA
  - Manages the clinical calendar, handles inpatient appointments, outpatient fluctuations
  - Facility calls, freeing up technologists for clinical tasks.
- Dedicated Porter
  - Communicates with the administrative TA to transport patients to and from the MRI department.
  - Handles stocking, cleaning, and initial patient instructions (should be allocated some more TA tasks post scan)
- Staffing Model:
  - Ensure patients are not waiting for resources [change rooms, bathrooms, lockers, and prep rooms]
  - Prepped for the scan before it is ready for them.



# Key Takeaways for Efficiency

- Spatial (Zone) optimization and Structural Optimization
- Especially in a 2-bay suite which handles double the patients and staff
- Operational Success Factors
  - Consistency in data collection is vital for successful workflow improvement
- Workflow improvements must account for the fact that the type of exam changes the workflow
- MRI Staff Scheduling Optimization and MRI Patient Scheduling Optimization



# Alternative Technology to run Simulation

- SimPy – For Simulation
  - Environment
  - Entity - Events - States
  - Processes (wait, interrupt)
  - Resources (allocation, release) – Resources Container
- Streamlit – For FE/Visualization and Deploy
- Statistics Collection – Warm Up Period (To avoid Bias)
  - KPIs – Cycle time, Wait time, Throughput Rate
  - Mean, SD for various Simulation



# Thank you!

Any Questions?!