Using predictive analytics and computer simulation to improve the performance of healthcare infrastructure

Mr Ian Gibson

Founder
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**Healthcare
Delivery
Modelling**

Mr Peter Bodon
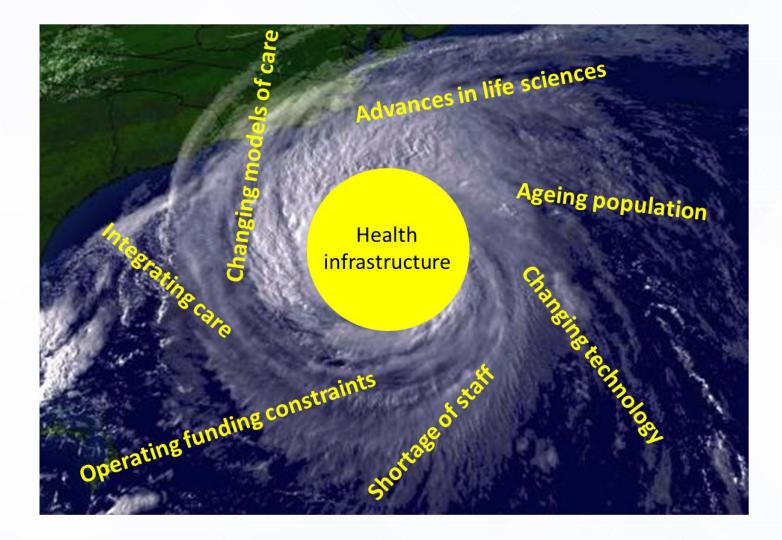
Principal
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bodon analytics

Mr David Morgareidge

Predictive Analytics Director
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Page/

MOH HOLDINGS

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Predictive analytics & simulation to improve healthcare infrastructure performance

The challenge

- When opening this conference in 2016 the Minister noted:

  "… we actively look for innovative ideas to optimise design, workflows and improve productivity in our healthcare infrastructure development …."

Strategies the Minister note include:

- *Improve productivity through care redesign, technology and workforce transformation*

- *The innovation with the greatest impact will be in new care models that better integrate care according to the patient's needs.*

- *We also need to push for practical technology use that can be scaled across the whole system and achieve significant manpower effectiveness.*

- *We can also innovate by re-imagining and redefining the practice of healthcare workers, and patients and their caregivers, so that we can achieve better healthcare outcomes more effectively, together*

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Overview

- Introduction to Predictive Analytics and Computer Simulation (PaCs)

- Contextualise the approach with Big Data
- Describe study techniques.

- US experience of using PaCs for healthcare infrastructure

Confusing simulation and computer simulation

Computer simulation is not training clinicians with manikin, that is using Simulators.
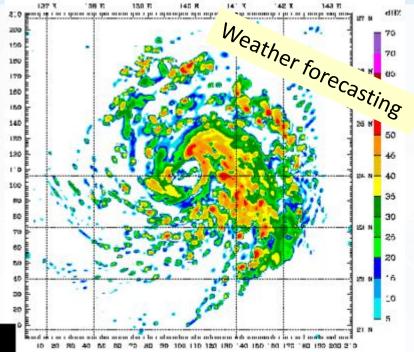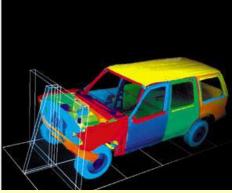
Computer simulation

Computer simulation uses mathematics and logic to construct virtual models of real systems.

The models enable understanding of the system and experiments to develop optimised systems.

Weather forecasting
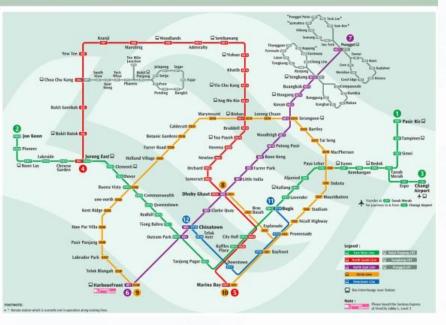
Car crash performance

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Abstraction

Basis of computer simulation.

Choosing the level of abstraction is critical
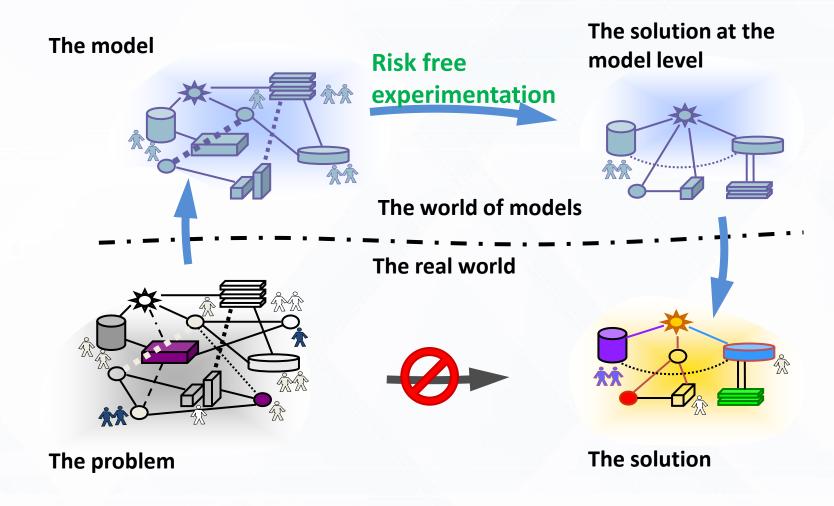
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Computer simulation – experiment in a risk free space

The model

Risk free experimentation

The solution at the model level

The world of models

The real world

The problem

The solution

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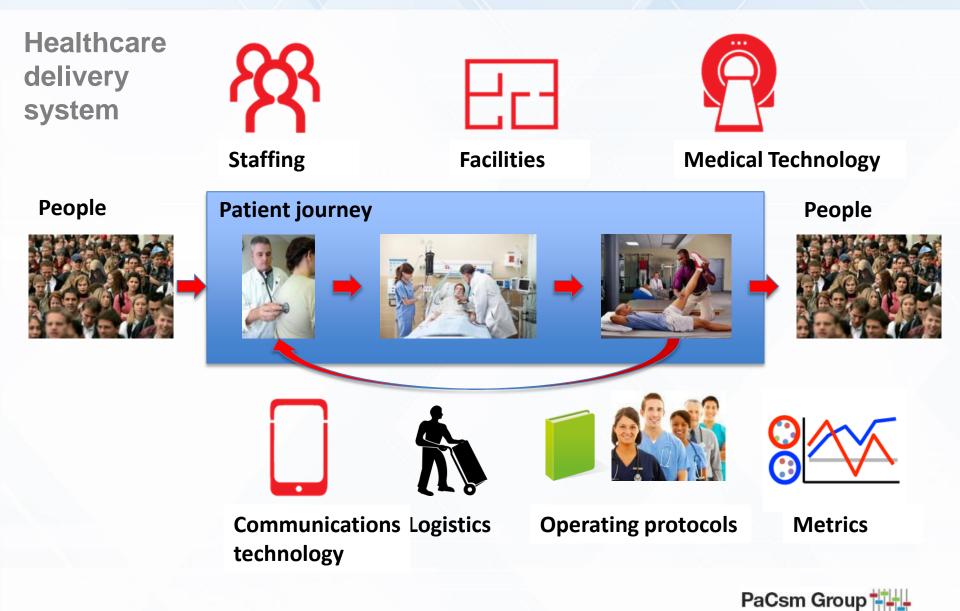
Box Hill Hospital Emergency Department Model

- $448 Million redevelopment of a major Australian metropolitan hospital.

- Scope
  - Emergency 50 patient spaces
  - Inpatient 621 beds

- Study to pressure test the proposed emergency department design.

Predictive analytics & simulation to improve healthcare infrastructure performance

Healthcare delivery system

Staffing

Facilities

Medical Technology

People

Patient journey

People

Communications technology

Logistics

Operating protocols

Metrics

Patient demand

People

- Annual throughput

- Arrival patterns

- Clinical requirements
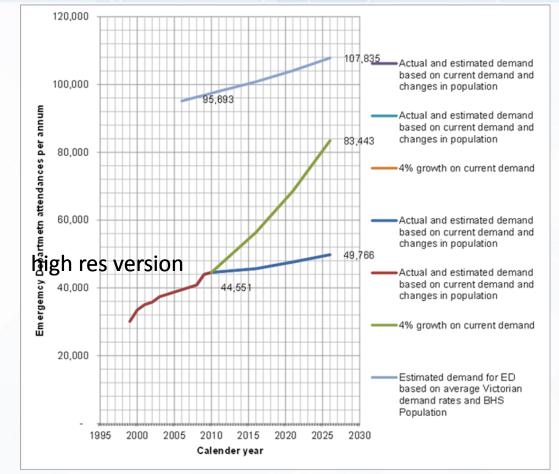
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Predictive analytics & simulation to improve healthcare infrastructure performance

Annual attendance

- Historic attendances and state wide data considered in estimating attendances 10 years after opening.

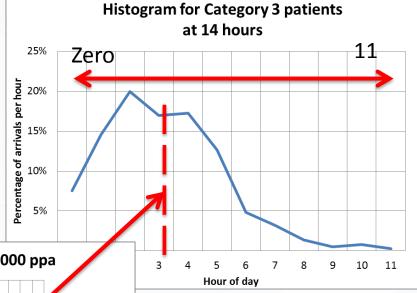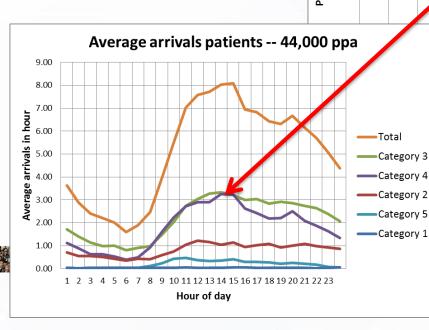- Model uses 3 scenarios 47,000, 57,000 and 87,000 attendances per annum.

Arrival patterns

- Based on data from three previous years.
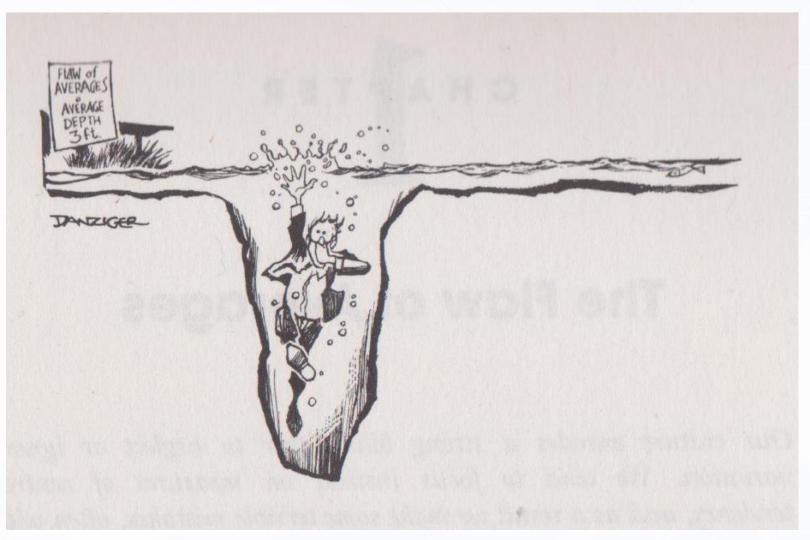
- Variation by day of week and hour of day considered.

Histogram for Category 3 patients at 14 hours

Zero   11

At 1400 average attendances 3 range 0 to 11 arrivals per hour

Average arrivals patients -- 44,000 ppa

- Total
- Category 3
- Category 4
- Category 2
- Category 5
- Category 1

Facilities   Operating protocols   Technology

People   Patient journey   People

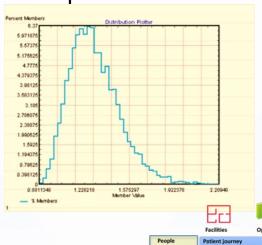Staffing   Logistics   Communications technology   Metrics

Source: The Flaw of Averages

Patient clinical requirements

42 categories based on
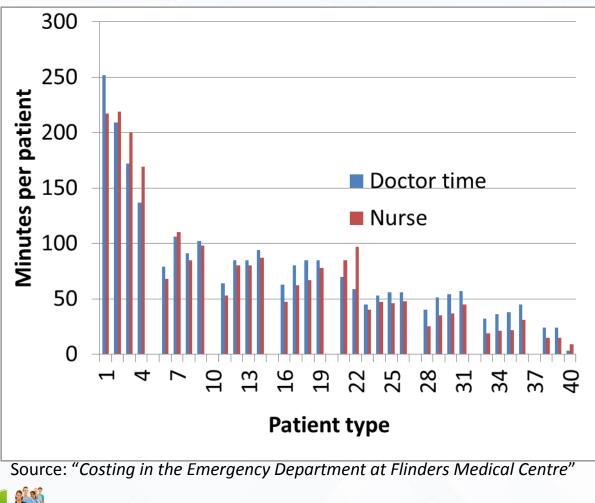
- Triage category,
- Age and
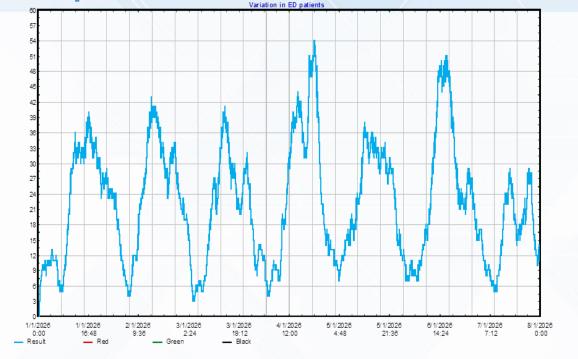- Disposition of patients

Source: *"Costing in the Emergency Department at Flinders Medical Centre"*

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Arrival patterns

42 categories based on

- Triage category,
- Age and
- Disposition of patients

Variation in ED patients

| | Result | Red | Green | Black |

	Arrival (min)	MUDAG	Urgency	Image	Lab tests	Ambulance Car
0	1/1/2026 0:00	3	1	2	1	Ambulance
1	1/1/2026 0:16:3	36	4	0	1	Car
2	1/1/2026 0:29:4	8	2	1	1	Ambulance
3	1/1/2026 0:32:0	34	4	0	1	Car
4	1/1/2026 0:38:2	11	3	1	1	Ambulance
5	1/1/2026 0:47:4	35	4	1	1	Car
6	1/1/2026 0:58:3	25	2	1	1	Ambulance
7	1/1/2026 2:42:0	34	4	1	0	Car
8	1/1/2026 3:27:2	28	3	0	0	Car

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Patient journey

Includes the activities involved in delivering care.
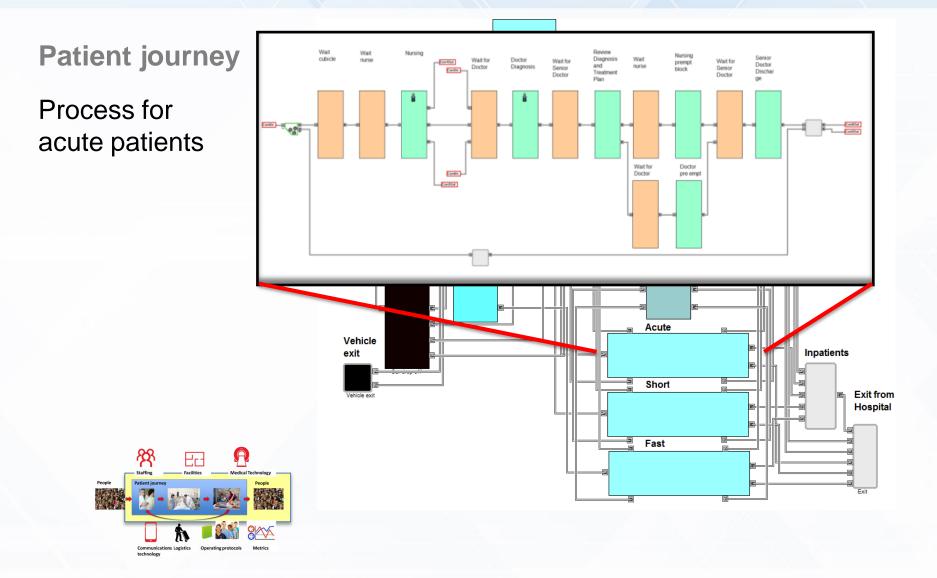Incorporates the clinical pathway, administrative and logistics involving the patient

Patient journey

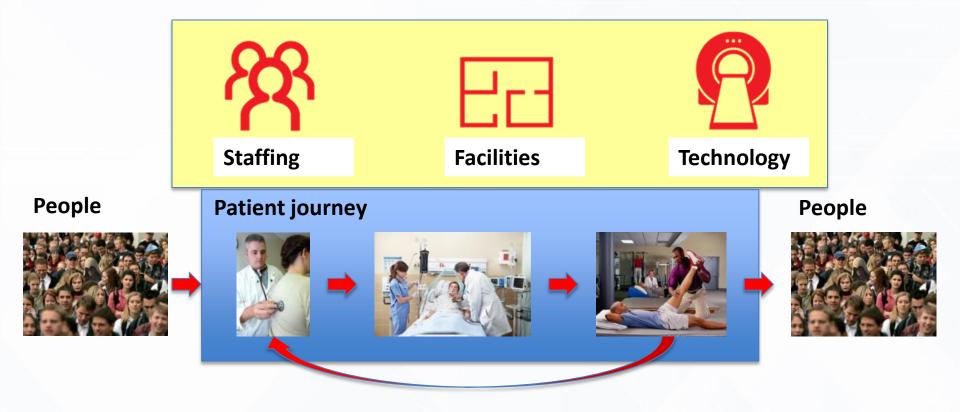Process for
acute patients

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Resources

Communications and logistics

Staffing

Facilities

Medical Technology

People

Patient journey

People

Communications technology

Logistics

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Predictive analytics & simulation to improve healthcare infrastructure performance

Healthcare delivery system

Staffing

Facilities

Medical Technology

People

Patient journey

People

Communications technology

Logistics

Operating protocols

Metrics

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Healthcare delivery system

Staffing

Facilities

Technology

People

Patient journey

People

Communications technology

Logistics

Operating protocols

Metrics

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Throughput

- Metrics can be data and graphs.

- Exportable to other programmes.

Overall performance

- Performance compared to criteria

Time to Doctors examination

Emergency department triage categories	Number of attendances	National standard - desirable treatment times (Minutes)	Target %	Model estimate of % achieving target
Resuscitation	418	Immediately	100	100
Emergency	8412	10	80	96
Urgent	21912	30	75	93
Semi Urgent	23000	60		94
Not Urgent	3607	120		98
Total	57349			

Overall performance

Percentage admitted or discharged within 4 hours	90
Patients admitted to Short term and Inpatients	22974
Patients Discharged from ED	34357

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Resource utilisation
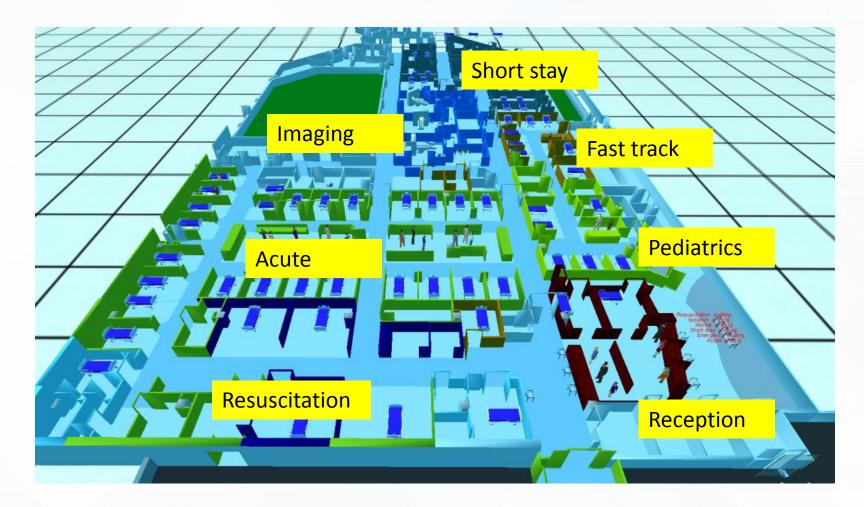
- By stream, resource and shift

Resource Utilisation		Overall Utilisation	Morning		Afternoon		Night	
			No	Utilisation	No	Utilisation	No	Utilisation
Paediatric 9962	Cubicles	42	4	53	4	54	4	20
	Nurses	30	2	41	2	40	2	13
	Doctors	26	2	32	2	33	1	12
	Senior Doctors	30	1	42	1	41	1	15

Resource Utilisation		Overall Utilisation	Morning		Afternoon		Night	
			No	Utilisation	No	Utilisation	No	Utilisation
Acute 16404	Cubicles	26	22	32	22	33	22	14
	Nurses	26	10	35	10	33	6	14
	Doctors	23	11	31	11	30	7	13
	Senior Doctors	29	3	36	4	34	1	17
	% Disposed in 4 hrs. Margin/ Loss	75	79		76		73	

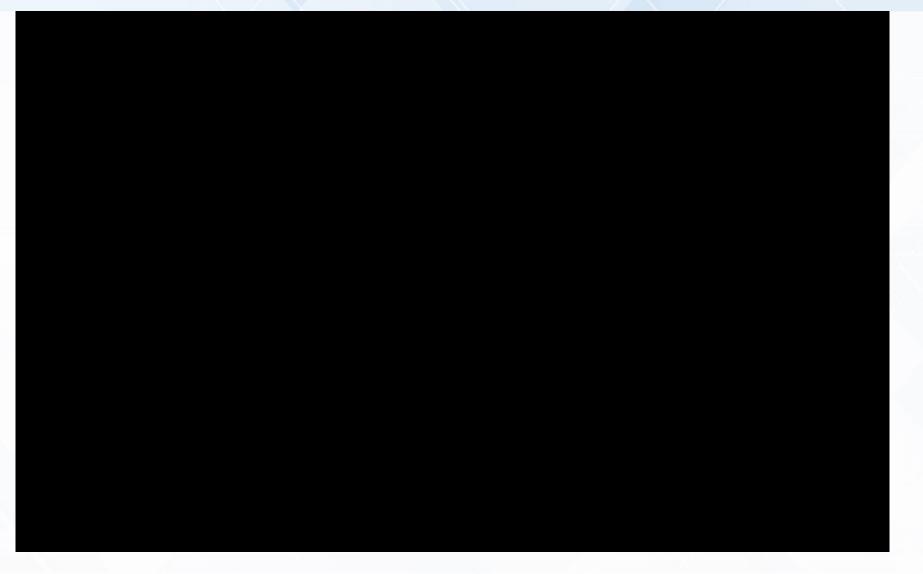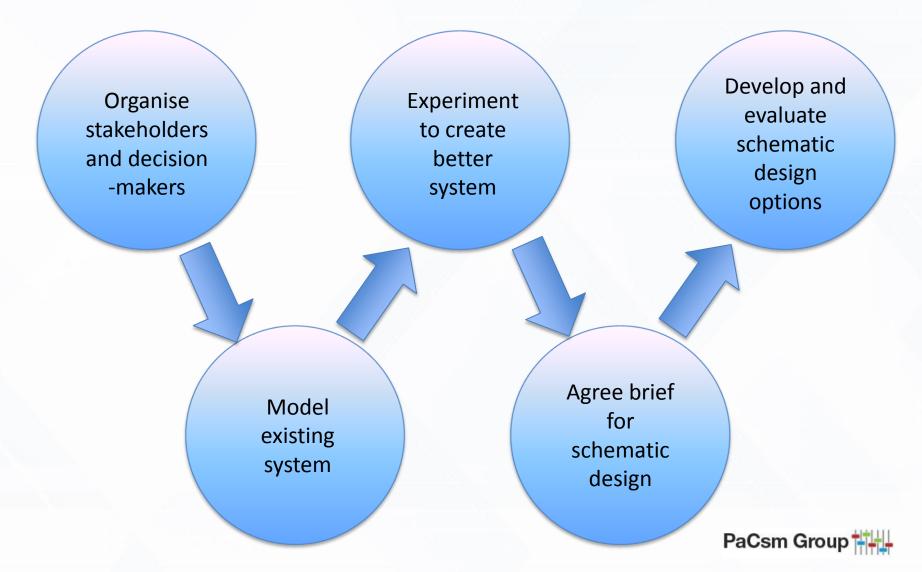|								
	Doctors	47	4	61	4	61	1	23
	Senior Doctors	26	2	33	2	33	1	15
	% Disposed in 4 hrs. Margin/ Loss	95	97		95		94	

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Animation

Conclusions from study- Pressure testing of design

- Significant delays in imaging with 48,000 ppa

- Ambulance unloading delays at 57,000 ppa

- At 87,000 ppa system under pressure

  - Delays in ambulance unloading

  - Utilisation over 90% for extended periods

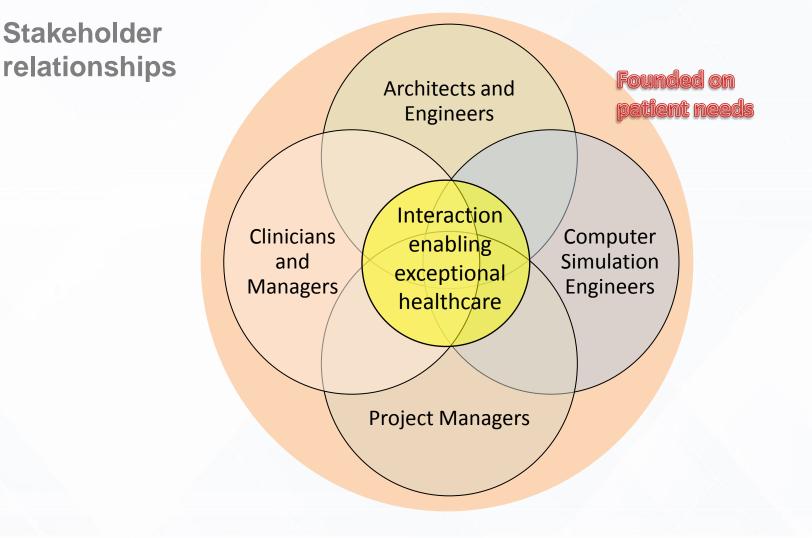- Possibility of using PaCsm in healthcare infrastructure design

Predictive analytics & simulation to improve healthcare infrastructure performance

Planning brief and schematic design process

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Stakeholder relationships

Founded on patient needs

Architects and Engineers

Clinicians and Managers

Interaction enabling exceptional healthcare

Computer Simulation Engineers

Project Managers

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Benefits in project phases

Service Plan	Design	Document, Tender & Construction	Commission	Operations
Develop shared understanding	**Integrate** facility, change & Information technology	**Plan** commissioning	**Communicate** operational proposals	**Develop** strategy plans
Evaluate healthcare delivery options	**Optimize** capital and operating cost		**Train** staff	**Match resources** to patient demand
Thorough planning brief	**Evaluate** layout options			

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Over 20 years experience:

- Simulation Modelling

- Data Analytics

- System Optimisation

Major industries

- Health

- Mining

- Transport and Logistics

- Defence

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Typical Major projects

- Project parameters:
  - Capital cost in Billions US$
  - Years to develop infrastructure
  - Optimise the system to deliver commodity
- Purpose of predictive analytics and computer simulation studies:
  - Enable robust decision-making for the project
  - Optimise the system
- Study:
  - In collaboration with stakeholders
  - Consider multiple scenarios
  - Run model 10,000s times to optimise system
  - Ongoing use of model with operational data and further development of system as it is developed and upgraded

Bendigo Hospital Development

- $1.1 bn Net present cost
- Scope
  - 372 inpatient beds
  - 72 same-day beds
  - 80-bed psychiatric inpatient unit
  - 11 new operating theatres

- Study of impact of communications technology in ED in conjunction with Cisco Systems

Importance of communications

- Communications are critical in using staff time and risk management.

    Source: The way clinicians interact in EDs Johanna Westbrook Centre for Health Systems and Safety Research

    – Inadequate communications are associated with preventable problems and adverse events in ED.
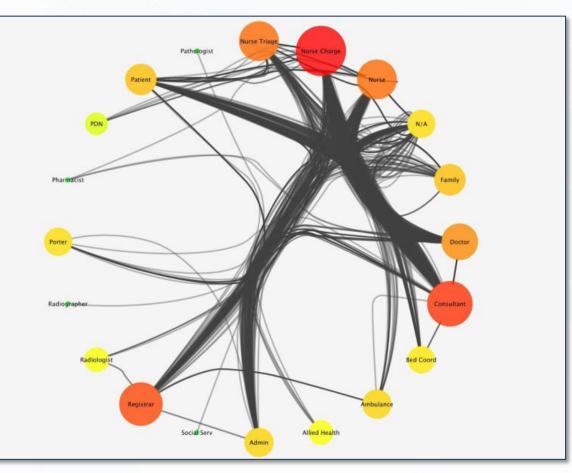
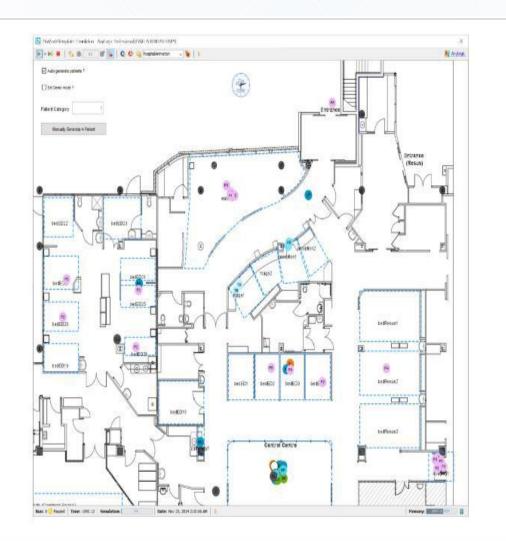   Source: Communication loads on clinical staff in the emergency department Enrico W Coiera, Rohan A Jayasuriya, Jennifer Hardy, Aiveen Bannan and Max E C Thorpe MJA Vol 176 6 May 2002

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Communications survey

- ## 95 hours of data
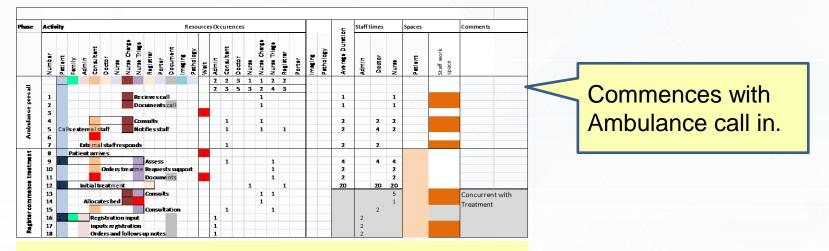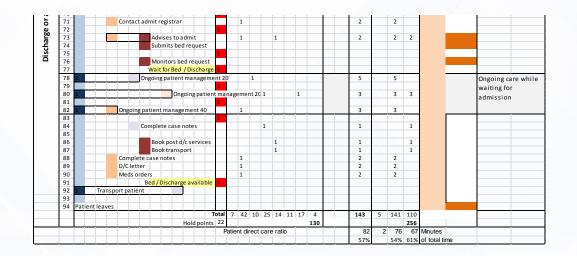
- ## Data on number of interactions and duration

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Commences with Ambulance call in.

Break in chart

Resuscitation /Emergency patients with 130 actions, 143 minutes and 256 minutes of staff resources

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Typical Metrics

Target times

- NEAT performance
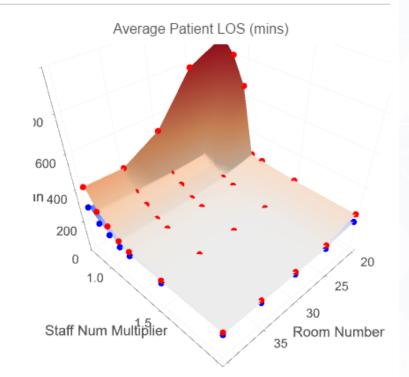- Target time to medical assessment by category

Utilisation

- Staff
- Facilities
- Major equipment

Analysis of above by:

- Patient type
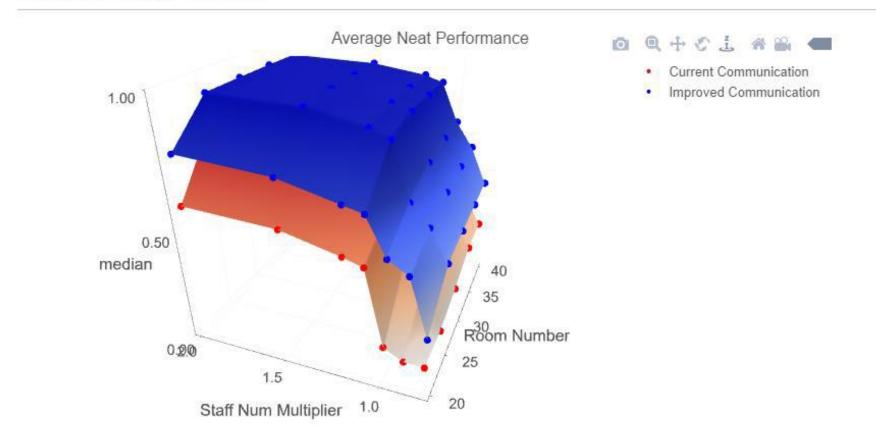- Shift time
- Arrival time (Morning, Afternoon)

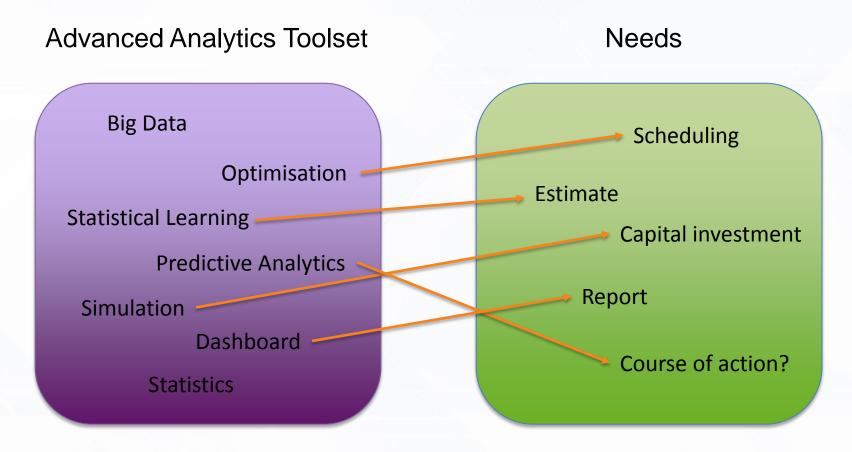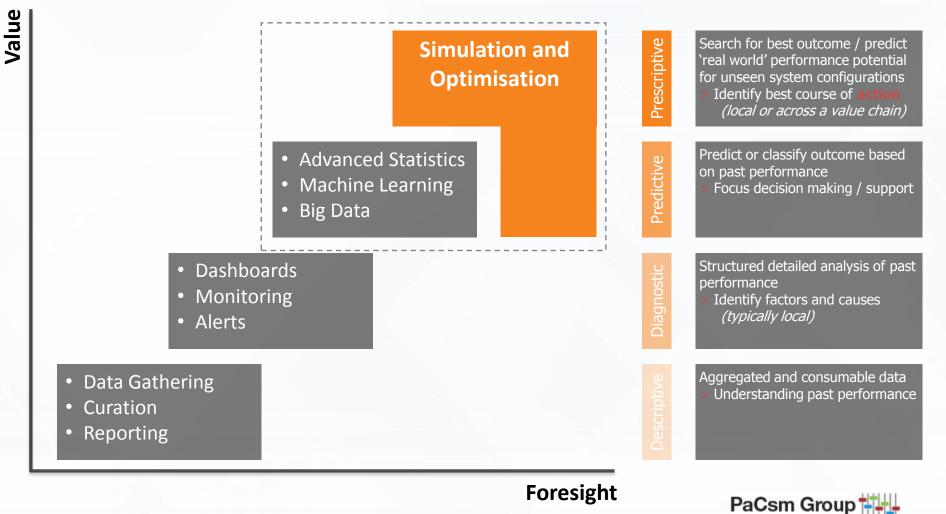Data from multiple runs can be summarised in response surfaces.

Average Patient LOS (mins)

NEAT Performance

Average Neat Performance

• Current Communication
• Improved Communication

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Analytics

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Big Data

Advanced Analytics

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Analytics Solutions Space

Advanced Analytics Toolset

Needs

Big Data
Optimisation
Statistical Learning
Predictive Analytics
Simulation
Dashboard
Statistics

Scheduling
Estimate
Capital investment
Report
Course of action?

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Analytics Horizons

Value (vertical axis)

Foresight (horizontal axis)

Simulation and Optimisation

- Advanced Statistics
- Machine Learning
- Big Data

- Dashboards
- Monitoring
- Alerts

- Data Gathering
- Curation
- Reporting

Prescriptive
Search for best outcome / predict 'real world' performance potential for unseen system configurations
> Identify best course of action *(local or across a value chain)*

Predictive
Predict or classify outcome based on past performance
> Focus decision making / support

Diagnostic
Structured detailed analysis of past performance
> Identify factors and causes *(typically local)*

Descriptive
Aggregated and consumable data
> Understanding past performance

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Unique Simulation Benefits

Identifying small gains

Predicting Future Performance
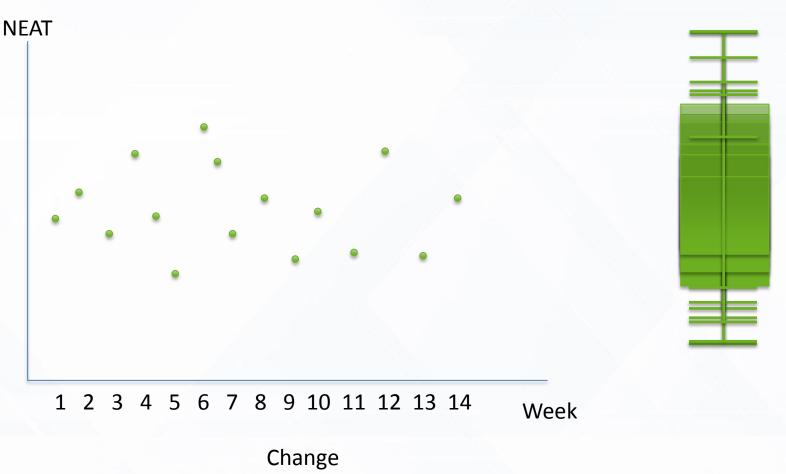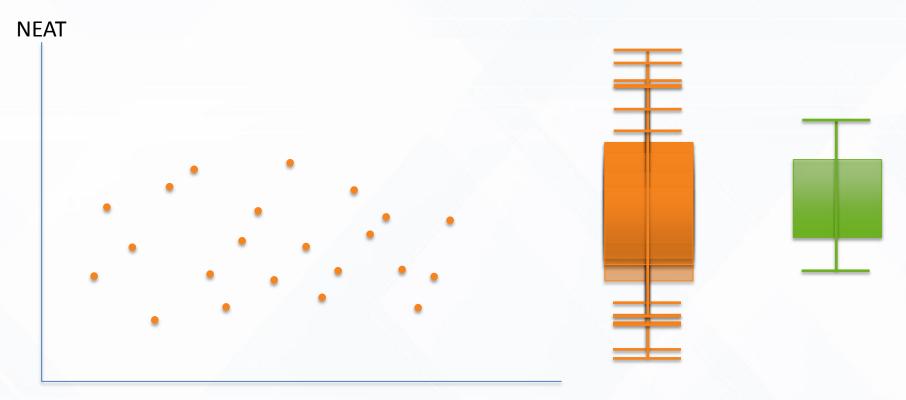
Signal vs Noise

Signal vs Noise
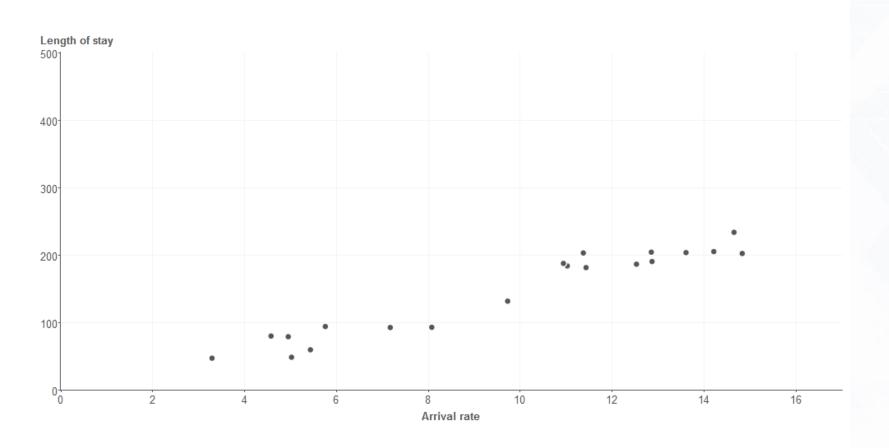
NEAT

Week

Signal vs Noise

Arrivals

Week

NEAT

Week

Prediction Horizon

Prediction Horizon

Prediction Horizon

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Prediction Horizon

Prediction Horizon

Prediction Horizon

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Architecture

Engineering

Interiors

Planning

Consulting
Commissioning
Lab Planning
Programming
Sustainability
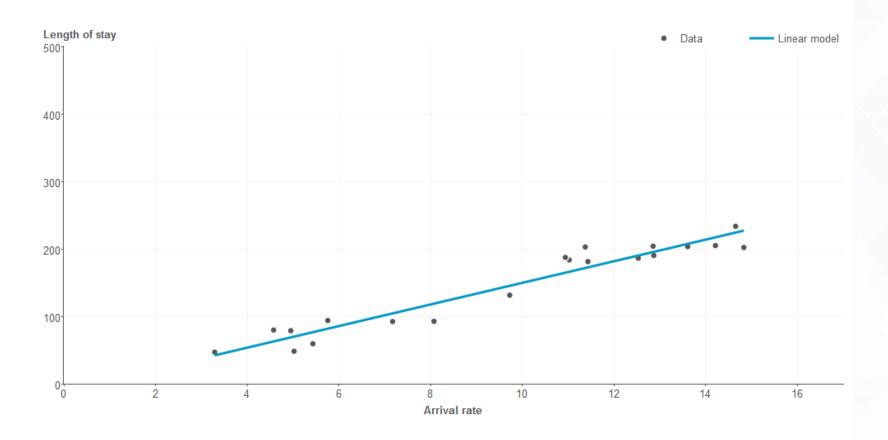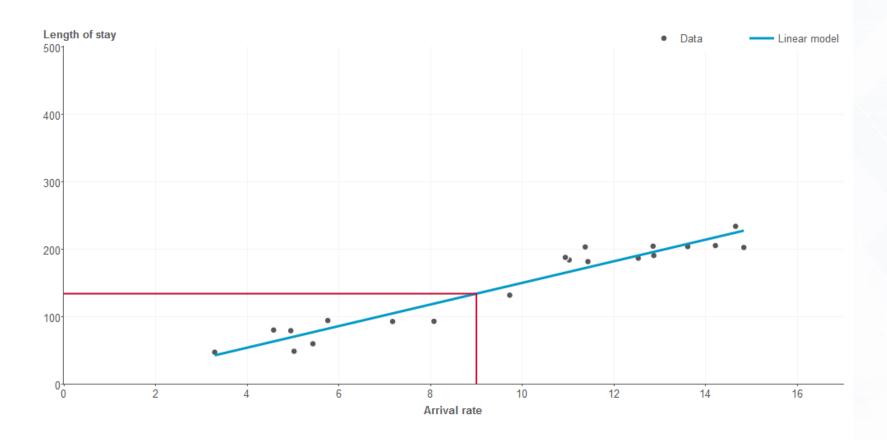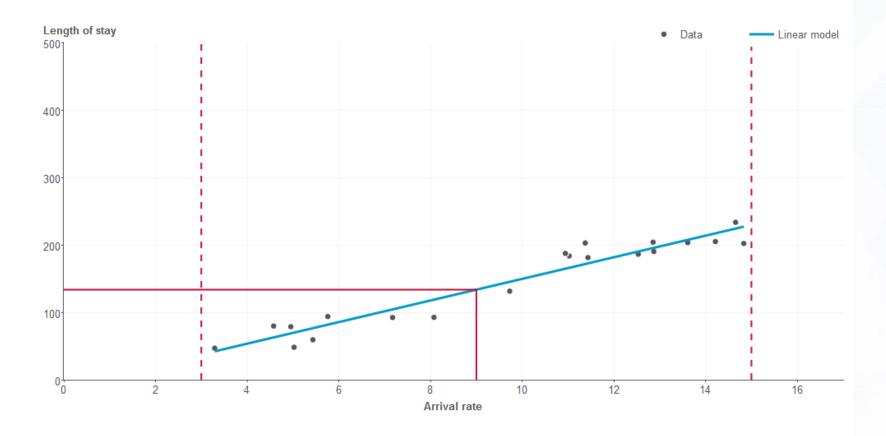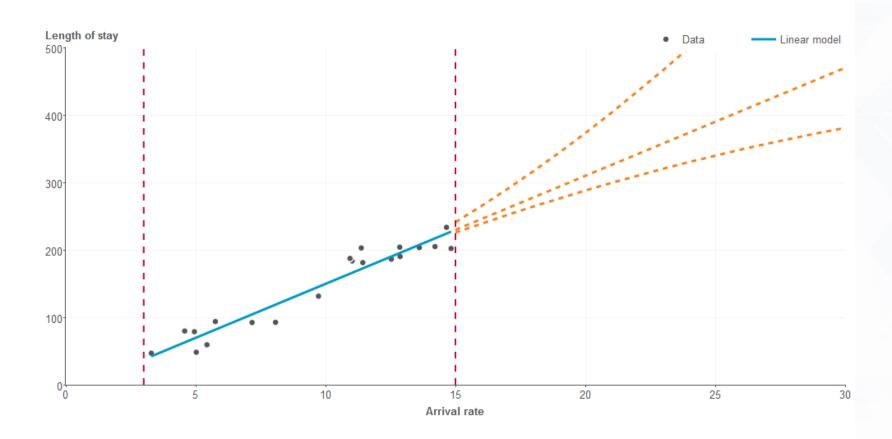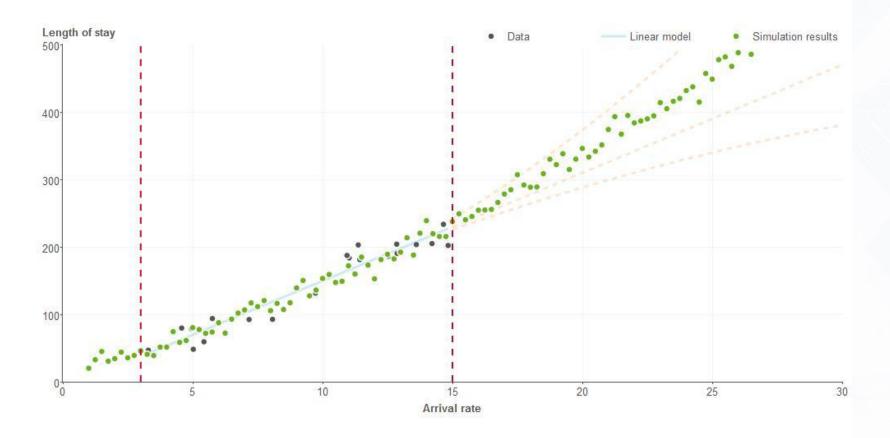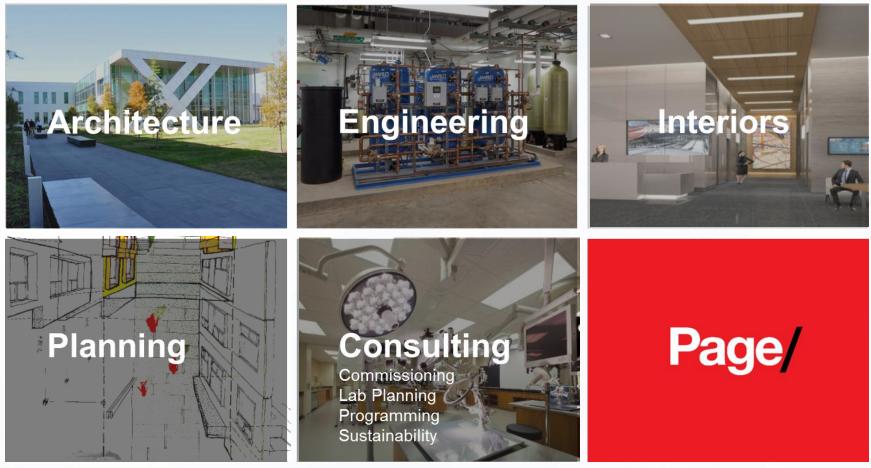
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Page is: a 450-plus-person architecture and engineering firm that works in the U.S. and abroad.

London

San Francisco

Washington DC

Denver

Dallas

Austin   Houston

Kuwait

Doha   Abu Dhabi

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More than 10,000 Healthcare Projects Completed

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- Predictive Analytics

- a design methodology,

- not a technology application.

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MGMA
Medical Group Management Association

MGMA DataDive

Cost and Revenue: 2013 Report Based on 2012 Data

1	2	3	4	5	6	7	8	9
Internal Medicine Metrics, 2013 Report								
Metric Description	Metric Statistic							
	Count	Mean	Std Dev	10th %tile	25th %tile	Median	75th %tile	90th %tile
Metric, per Patient								
Total provider cost	12	$215.62	$86.37	$79.91	$132.86	$246.12	$280.67	$324.07
Total physician cost	20	$131.80	$63.98	$68.73	$73.36	$114.87	$202.73	$229.62
Registered Nurses	12	1.78	1.12	.56	.80	1.50	2.69	3.73
Licensed Practical Nurses	15	2.85	2.47	.41	.74	2.22	4.84	7.19
Med assistants, nurse aides	18	6.30	2.91	2.18	3.85	5.89	8.70	10.66
Total clinical support staff	22	$37.78	$24.20	$11.95	$17.81	$32.60	$54.95	$69.00
Metric, per Square Foot								
Total provider cost	15	$136.97	$36.74	$88.94	$110.52	$125.72	$172.01	$193.83
Patients	12	.90	.42	.38	.53	.84	1.23	1.60
Metric, per FTE Physician								
Total provider cost	78	$336,386	$97,615	$229,084	$268,725	$318,821	$388,429	$497,208
Total physician cost	158	$269,636	$84,999	$182,766	$220,752	$254,691	$298,296	$376,805
Patients	20	2,375	1,049	1,284	1,577	1,779	3,534	3,801
Metric, per FTE Provider								
Patients	12	1,118	677	642	725	950	1,252	2,599
Square feet	18	1,642	747	447	1,117	1,607	2,230	2,837

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Predictive Analytics

Predictive analytics & simulation to improve healthcare infrastructure performance
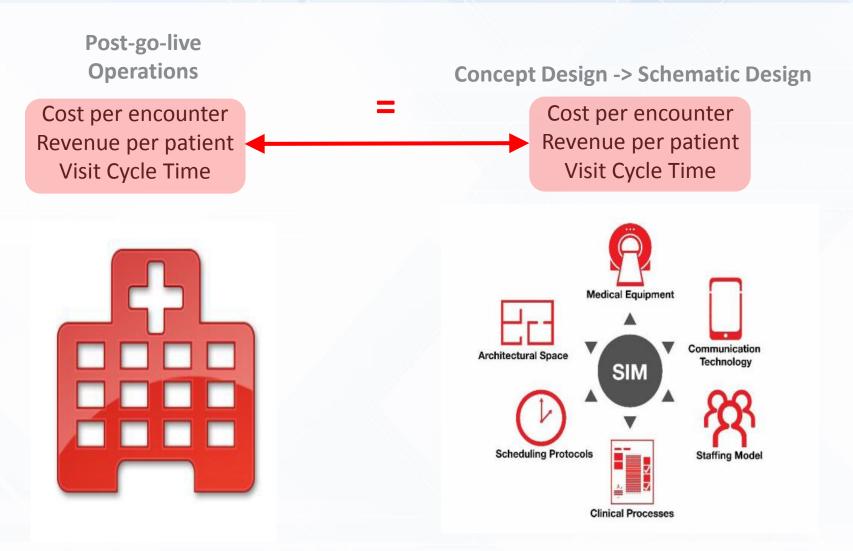
Performance Dashboard

Compares our client's current state performance against their peers in the industry.

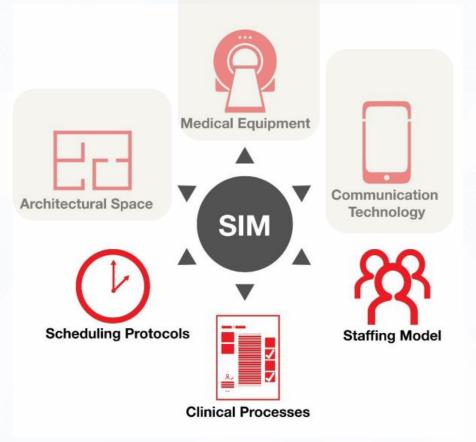We set future state targets that become "true north" for the remainder of the project.

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Post-go-live Operations

Concept Design -> Schematic Design

=

Cost per encounter
Revenue per patient
Visit Cycle Time

Cost per encounter
Revenue per patient
Visit Cycle Time

Medical Equipment

Architectural Space

Communication Technology

SIM

Scheduling Protocols

Staffing Model

Clinical Processes

Simulation

Allows the design team to weigh the benefits of **first cost** capital investments ...

Simulation

Allows the design team to weigh the benefits of **first cost** capital investments …
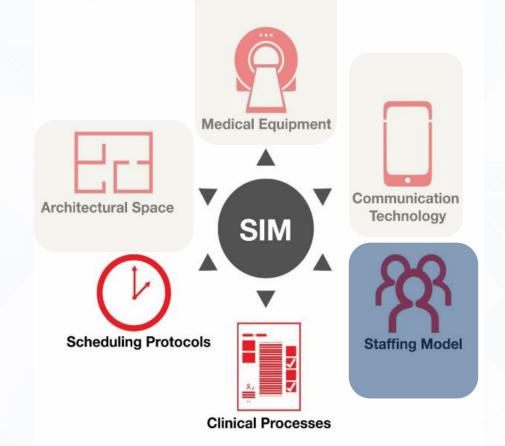
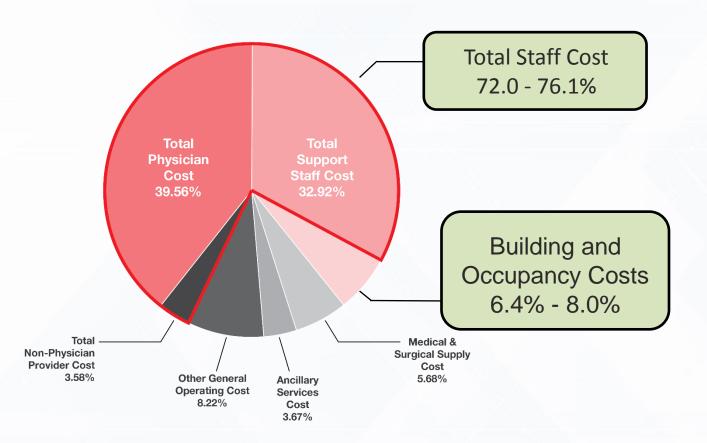with the benefits of **operational cost** reduction strategies …
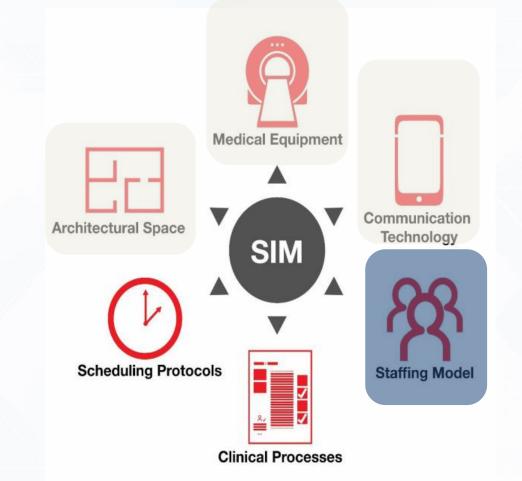
- Computer Simulation

Allows the design team to weigh the benefits of **first cost** capital investments …

with the benefits of **operational cost** reduction strategies …

to find an **optimal balance** between the two.

Facility Life Cycle Costs

Total Staff Cost
72.0 - 76.1%

Building and Occupancy Costs
6.4% - 8.0%

Total Physician Cost
39.56%

Total Support Staff Cost
32.92%

Total Non-Physician Provider Cost
3.58%

Other General Operating Cost
8.22%

Ancillary Services Cost
3.67%

Medical & Surgical Supply Cost
5.68%

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University Health System
Robert B. Green Campus Clinic
San Antonio, Texas
4th Floor

Overview

Simulate the Family Health Center.

Approximately one half of a 44,000 SF floor plate.

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Clinical Care Process Definitions

Every step of every clinical process that is a part of each patient type's care plan is defined.

A department averages 20 to 30 processes, or 200 to 400 individual steps.

A clinic with 8 service lines would have between 500 and 800 individual steps.

| Step	Staff Type	Physical Location		Action	Duration (minutes)		
		Start	Stop		Low	Mean	High
1		Vestibule	Main Reception	Travel		(1)	
2	Recp_LR1	Main Reception	Main Reception	Receive directions to appropriate Reception / Check location.		1.0	
3		Main Reception	Reception / Check Out - LR2	Travel		(1)	
4	Recp_LR2	Reception / Check Out - LR2	Reception / Check Out - LR2	Complete registration forms, make payment.		5.0	
5		Reception / Check Out - LR2	Waiting - LRS3	Travel		(1)	
6		Waiting - LRS3	Waiting - LRS3	Wait for procedure room to become available.		(1)	
7	Nurse	Waiting - LRS3	Pre CT (1-2)	Travel		(1)	
8	Nurse	Pre CT (1-2)	Pre CT (1-2)	Prep for procedure.		15.0	
9	Nurse	Pre CT (1-2)	CT 1	Travel		(1)	
10	Nurse	CT1	CT 1	Patient reports to procedure room 30 minutes prior to the start of the procedure.		30.0	
11	Dr_CT	CT 1	CT 1	Procedure.		20.0	
12		CT 1	Holding (1-3)	Travel		(1)	
13	Ckout_LR3	Holding (1-3)	Holding (1-3)	Post procedure care.		15.0	
14		Holding (1-3)	Reception / Check Out - LRC3	Travel		(1)	
15		Reception / Check Out - LRC3	Vestibule	Travel and Exit		(1)	

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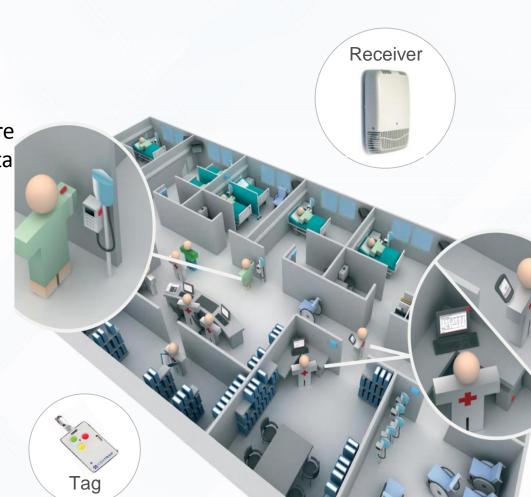
Input: Automated Tracking

Use ultrasound technology to capture real time current state clinic visit data

Manual methods, as were tested on the Med/Med clinic, were judged to be ineffective.
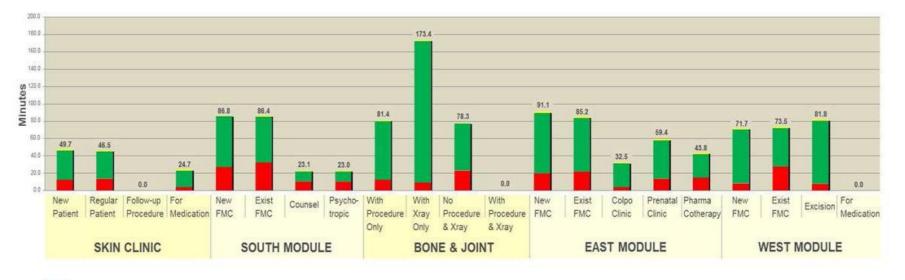
Receiver

Tag

Database

Store the streaming data coming from each Tag every 3 seconds into a comma-delimited log file.

2010,3,8,0,0,30,593,11779,0.0.0.0,0,0,0.1,0,0,-1,-1,-1,-1,0
2010,3,8,0,0,32,687,11773,HDR-2191,1,7.75799,1,0,0,-1,-1,-1,-1,0
2010,3,8,0,0,32,703,11773,HDR-2292,1,1.08288,1,0,0,-1,-1,-1,-1,0
2010,3,8,0,0,32,703,11773,HDR-2256,3,0.217024,1,0,0,-1,-1,-1,-1,0
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8
2010,3,8,0,0,54,780,11816,HDR-2292,1,0.67393,1,0,0,-1,-1,-1,-1,0
2010,3,8,0,0,54,812,11805,HDR-2255,1,3.63336,1,0,0,-1,-1,-1,-1,1
2010,3,8,0,1,1,484,11812,HDR-2261,1,5.36469,1,0,0,-1,-1,-1,-1,0
2010,3,8,0,1,1,484,11812,HDR-872,1,0.277526,1,0,0,-1,-1,-1,-1,0

Data Processed	
Quantity	**Description**
15	Tags active on average
8	Hours per day
60	Minutes per hour
6	10-second intervals per minute
22	Days
950,400	Rows of data collected
19	Data fields per row
18,057,600	**Total number of data points**

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Predictive analytics & simulation to improve healthcare infrastructure performance

Visit Cycle Time by Patient Type

Evaluate Spatial Design

Use the captured current state data to drive the simulation of the new clinic.

Floor plan of the Family Medicine portion of the 4th floor

36 exam rooms are available.

Skin Clinic and Bone & Joint Clinic will not be housed in this space, as originally thought.
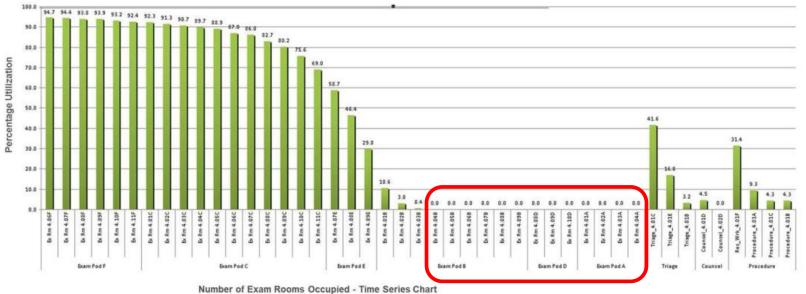

EXAM	= 36
TRIAGE	= 3
COUNSEL	= 2
PROC	= 4

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Base Case Results - Average Volume

Simulate "average" patient volumes in new clinic.

SD design has adequate capacity.

Utilization of Exam Rooms

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Base Case Results – Peak Volume

Simulate "peak" patient volumes in new CSB.

SD design has 25% greater capacity than is required to support the 3 clinics.

Utilization of Exam Rooms
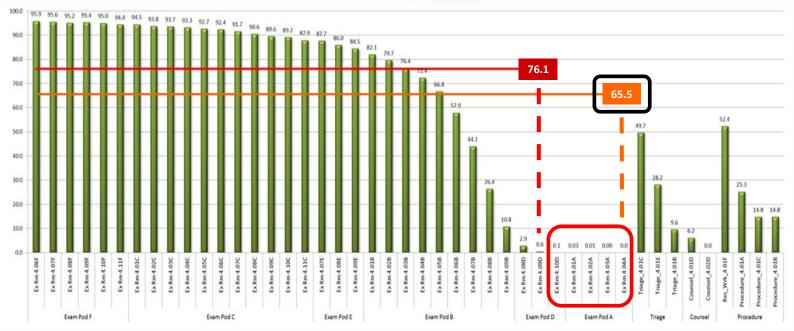
5C Results - Peak Volume, +10%

Simulation results for "peak" patient volumes for the original 3 clinics, plus the Skin and Bone & Joint clinics, with 10% growth in all 5 clinics. The design has adequate capacity.

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Predictive analytics & simulation to improve healthcare infrastructure performance

University Health System
Robert B. Green Campus Clinic
San Antonio, Texas
5th Floor

ASC Shell Space

OMS, ENDO and ENT initially requested more space than would fit on a single floor.

Successive efforts at better defining processes and their durations allowed simulation to demonstrate that all three services could fit on a single floor, with spare capacity in the fitted out space, and with 3,277 SF converted to shell space

Saved $623,000 in construction cost.

SHELL SPACE - 3,277 SF

CONFERENCE CENTER - 1,666 SF

SCALE: 1/8" = 1'-0"

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**Duke Realty Baylor Gaston Medical Office Building
Dallas, Texas**

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Performance Dashboard

Compares our client's current state performance against their peers in the industry.

Medical Group Management Association database

MedProvider Objective: Reduce the total operational expense per physician per year by at least $5,000 in order to make the move to a new facility attractive.
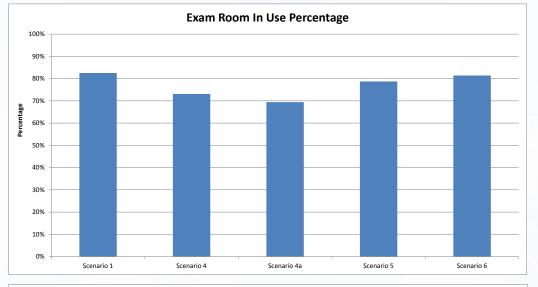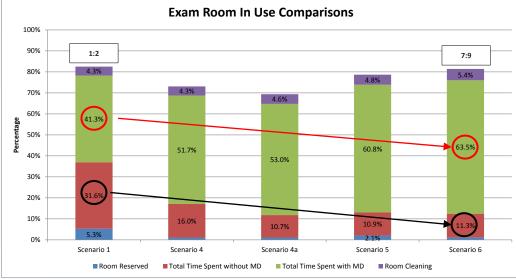
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Sensitivity Analysis:
Exam Room in Use

- **Increased value added time** in the exam room by **49%** (41% to 64%)

- **Decreased patient waiting** in the exam room by **66%** (32% to 11%)
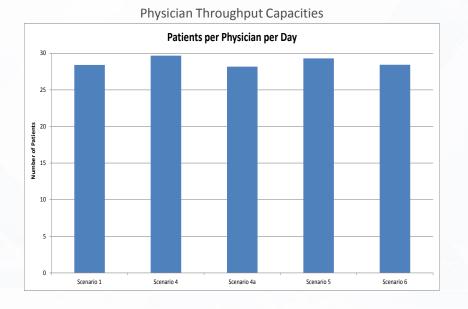
Exam Room In Use Percentage

Exam Room In Use Comparisons

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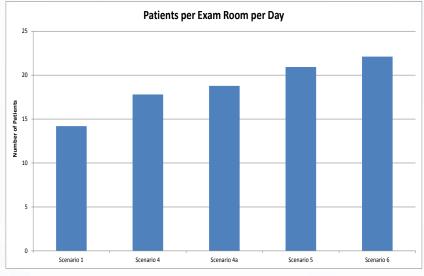
Sensitivity Analysis: Throughput

The number of patients seen per exam room increases by 56%, which increases the revenue per SF and the overall profitability of the clinic.

Scenario	The simulation model consists of:	Patients per day	Patients per physician/day	Patients per exam room /day
Scenario 1	10 Physicians, 20 Exam Rooms	284	28.4	14.2
Scenario 4	9 Physicians, 15 Exam and 5 Triage Rooms	267	29.7	17.8
Scenario 4a	6 Physicians, 9 Exam and 3 Triage Rooms	169	28.2	18.8
Scenario 5	10 Physicians, 14 Exam and 5 Triage Rooms	293	29.3	20.9
Scenario 6	7 Physicians, 9 Exam and 3 Triage Rooms	199	28.4	22.1

Physician Throughput Capacities

Exam Room Throughput Capacities

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Recommendations

Resulting annual savings per physician:

33 Physicians:

$16,351 per physician/year
$540,000 for the practice/year
and

50 Physicians:

$19,964 per physician/year
$998,000 for the practice/year.

Reduced Check-in/out FTE's.

Eliminated private offices.

Improved physician to exam room ratio.

MedProvider Lease Option Analysis
Issue Date: August 9, 2012

	New Gaston Avenue MOB Efficient Space Plan		New Gaston Avenue MOB Current Space Plan		Existing Swiss Avenue MOB Current Space Plan
	Initial	Future	Initial	Future	Current
Lease Term (Yrs)	15	15	15	15	---
Total Space Lease Premises (RSF)	38,700	49,600	48,000	61,700	50,474
Ancillary Space Lease Premises (RSF)	14,000	14,000	14,000	14,000	12,233
Clinical Space Lease Premises (RSF)	24,700	35,600	34,000	47,700	38,241
NNN Rental Rate ($/RSF)	$22.00	$22.00	$22.00	$22.00	$24.57
Building and Occupancy Operating Expenses ($/RSF)	$10.50	$10.50	$10.50	$10.50	$8.57
Gross Rent ($/RSF)	$32.50	$32.50	$32.50	$32.50	$33.14
Full Service Rent ($)	$802,750	$1,157,000	$1,105,000	$1,550,250	$1,267,292
Physicians (#)	33	50	33	50	33
Clinical Space Plan Efficiency (SF/Physician)	748	712	1,030	954	1,159
Clinical Space Unit Rent (Annual $/Physician)	**$24,326**	**$23,140**	**$33,485**	**$31,005**	**$38,403**
Clinical Space Unit Rent (Monthly $/Physician)	$2,027	$1,928	$2,790	$2,584	$3,200
New MOB vs Existing MOB (SF/Physician)	**35%**	**39%**	**11%**	**18%**	
New MOB vs Existing MOB ($/Physician)	37%	40%	13%	19%	

Predictive analytics & simulation to improve healthcare infrastructure performance

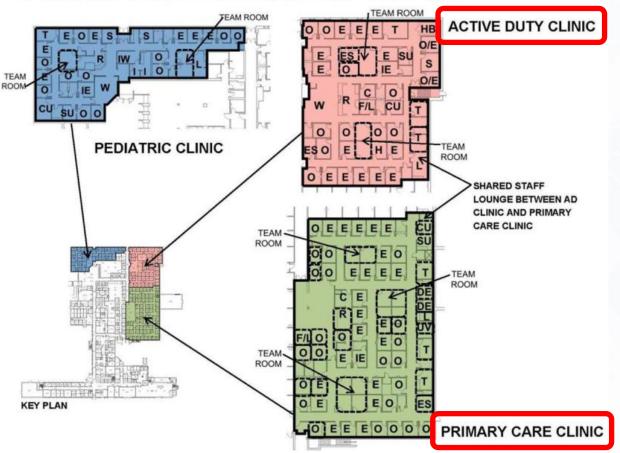**Kenner Army Health Clinic**
Fort Lee, Virginia

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Kenner Army Health Clinic

Simulation Pilot for the US Army.

Scope of work: Active Duty Clinic, Primary Care Clinic .

KENNER ARMY HEALTH CLINIC- BUILDING 8130 – FIRST FLOOR

PEDIATRIC CLINIC

ACTIVE DUTY CLINIC

SHARED STAFF LOUNGE BETWEEN AD CLINIC AND PRIMARY CARE CLINIC

PRIMARY CARE CLINIC

KEY PLAN

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Data Collection:
Manual Tracking

Use manual forms that providers complete to track the patient journey through the clinic.

Form Region overview: areas 1 through 5.

Provides more detail and process definition than does AHLTA.

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ADC - PATIENT VISIT TIME FOR PROVIDERS PATIENTS ONLY

1.a.   Current state

2.a.   New layout without using spare capacity of 5 Specialty Exam Rooms and 3 Treatment Rooms. Number of patient care rooms does not increase, but the workload in them does; screening is now performed there, too. Shared offices not available for consults. **Degrades performance by -1.3 min. or -4.3%.** Effective use of, and physical adjacency to Providers' other rooms, is paramount.

3.a.   Layout change + 2:1 Screener to Provider ratio. **Improves performance by 1.4 min. or 4.7%.**

4.a.   Layout change + 2:1 Screener to Provider ratio + 5% Screener and Provider efficiency. **Improves performance by 3.6 min. or 12.0%.**

5.a.   Layout change + 2:1 Screener to Provider ratio + 5% Screener and Provider efficiency + use of Treatment Rooms for backed up exams. **Improves performance by 5.7 min. or 18.9%.**

6.a.   Layout change + 2:1 Screener to Provider ratio + 5% Screener and Provider efficiency + use of Treatment Rooms and 5 Specialty Exam Rooms for backed-up exams. **Improves performance by 7.8 min. or 25.9%.**
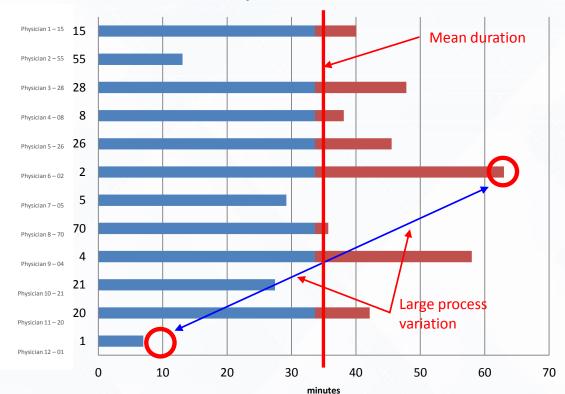
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Visit Cycle Times by Provider

Data collection just completed.

Process improvement opportunities can lead to reduced spatial demands.

Clients now want process analysis and improvement first, then want to discuss architecture.
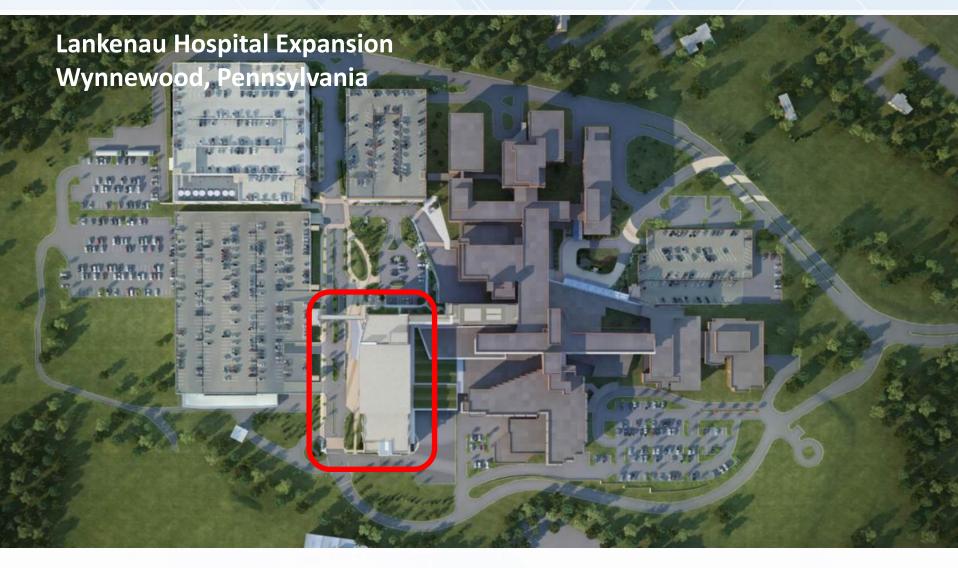
- Critique of traditional design process

ADC / Physical Exam - 255

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Lankenau Hospital Expansion
Wynnewood, Pennsylvania

Predictive analytics & simulation to improve healthcare infrastructure performance

Lankenau Hospital Expansion

Service: Simulate non-invasive cardiac care delivery process.

Objective: Identify inadequate or excessive space in program .

Take-away: Increased the number of Echo rooms by 50% and increased the number of holding bays by 67% to accommodate projected volumes and to keep office hours between 8:00 AM and 5:00 PM without overtime.

Avoided $450,000 renovation

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Simulation Results
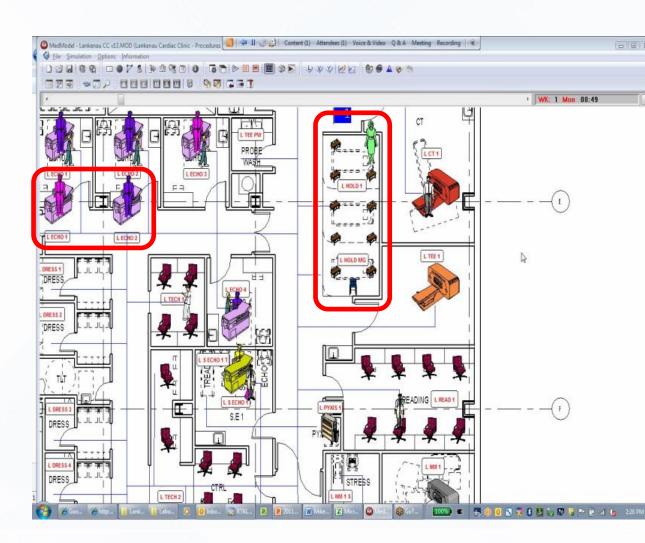
Original Design

Takes 12 hours to process patients instead of the 8 that was desired.

Final Design

Takes 8 hours to process patients.

The design team had to
- add 2 Echo Rooms
- add 2 Holding Bays
to achieve these results.

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Research – Traditional vs. PACT Clinic Design

VA Austin

VA Reno

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Clinic Design and Operations Research

VA traditional clinic layout.

VA Austin Clinic

Clinic Design and Operations Research

VA new PACT model (Patient Aligned Care Team).

VA Reno Clinic

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UT Southwestern
Medical Center

Simulation Projects

Medical/Surgical Floor
Surgical Suite
Central Pharmacy
Materials Management
Vertical Transportation
Food Court

Dr. John Warner
Dr. Bruce Meyer
Ms. Becky McCulley

Dallas, Texas

PaCsm Group

HI·TEC 2017
HEALTHCARE INFRASTRUCTURE
TECHNOLOGY & ENGINEERING CONFERENCE

Med/Surg

64 beds per floor.

16 beds per unit.

4:1 staffing ratio.

Reduce travel time.

Reduce travel distance.

Increase nursing contact with the patient.

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Med/Surg

What level of decentralization is most efficient for:
-nursing staff
-techs/patient care supplies
-techs/linen
-techs/pharmacy

Nurses planned to use 56 clinical interventions to care for the patients

Many of these involved trips to the Clean Supply/Meds rooms

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Med/Surg

Nurse server

One per patient room

Opens to hall, not to patient room

Eliminated 21,900 hours per year of non-value-added nursing walking time

BAYLOR
REGIONAL MEDICAL CENTER
OR SUITE
PLANO, TX

PaCsm Group

Baylor OR Suite

Service: Simulate the existing OR suite of 12 rooms.

Objective: Identify throughput constraints and determine if 1,500 new ortho cases, 300 new spine cases, and 6% annual organic growth can be accommodated without any additional ORs.

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Analysis of Every Case in Every OR

Optimize each room's use based on size and equipment.

Histogram of OR 7 Current State-Cases to Be approximated

		Simulation Parameters - Case Type, Duration and Number / Staff Required / Instruments Required						
		Procedure						
Type by Frequency	**No.**	**Name**	**Average Duration**	**Count**	**Total Duration**	**N**	**T**	**Instrument Sets**
Cases Occurring More Than Once per Month	1	ARTHROPLASTY,TOTAL KNEE	2.52	68	171.6			
	2	ARTHROSCOPY,KNEE, W/WO MENISCECTOMY/MENISCAL REPAIR/TRANSPLANT	1.14	37	42.1			
	3	SPINAL FUSION,LUMBAR,POST.INTERBODY,W/WO LAMINECTOMY/DISKECTOMY/GRAFT/INT.FIX.	5.78	23	133.0			
	4	SPINAL FUSION,CERVICAL,ANT.INTERBODY,W/WO DISKECTOMY/GRAFT/INT.FIX.	3.27	22	72.0			
	5	ARTHROSCOPY,SHOULDER,W/WO ACROMIOPLASTY/EXC.DISTAL CLAV./ROTATOR CUFF REPAIR	2.45	22	53.9			
	6	SPINAL FUSION,LUMBAR,ANT.INTERBODY,W/WO DISKECTOMY/GRAFT/INT.FIX	6.28	15	94.2			
	7	ARTHROPLASTY,TOTAL HIP	2.68	14	37.6			
	8	ORIF,HIP DISLOCATION W/ACETABULAR WALL/FEMORAL HEAD FX.	1.32	13	17.1			
	9	ESWL(LITHOTRIPSY EXTRACORPOREAL SHOCK WAVE)	1.00	12	12.1			
	10	ORIF,ANKLE/FOOT(CALCANEAL/METATARSAL/TALUS/TARSAL/TRIMALLEOLAR/),W/WO GRAFT/FIXATION	1.62	12	19.5			
Repre-sentative Cases for Cases Occurring Less Than Once per Month	42	Group A	0.60	10	6.0			
	78	Group B, C, D	1.52	156	236.6			
	23	Group E, F, G, H	3.08	65	200.2			
	128	Group I , J, K	4.55	12	54.6			
	69	Group L, M, N, O, P	7.28	7	51.0			
Totals		TOTAL, Actual, Per ORIS Data supplied by Jeremiah Johnson		488	1201.5			
		TOTAL, as Represented in Current State Simulation Model		488	1201.2			
		VARIANCE, Actual vs Simulation		0	-0.3			

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Baylor Scott & White Medical Center Plano

$100M Master Plan Expansion

Yuma Regional Medical Center

3-Phase effort:
- Master plan
- Existing ED re-engineering
- New ED design

Simulation sited the ED and reduced annual labor costs by $100,000 relative to other possible locations.

A ground-breaking RTLS (Real Time Location-based Service) implementation delivered detailed and highly accurate current-state performance data.

Yuma RMC Master Plan

The existing 14,000-SF ED was too small for its 76,000 annual visits, so a new ED needed to be designed. The existing ED also created challenges for optimal space utilization and staffing due to wide seasonal fluctuations in volume, caused by the influx of retirees from northern states.
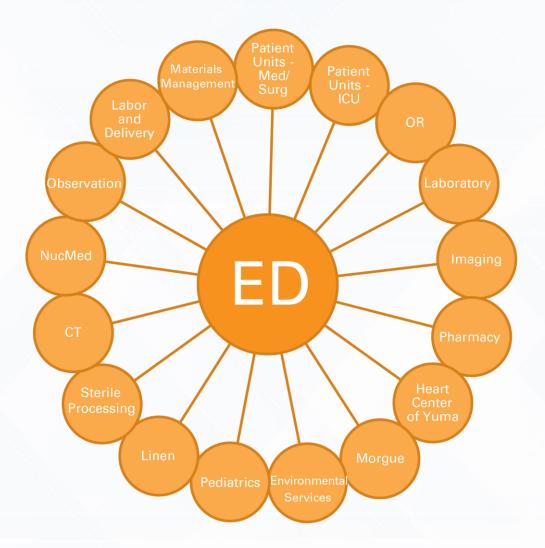

REDUCED ANNUAL LABOR COSTS BY **$100,000**

Transactional Relationships

Use simulation to study the transactional relationships between the ED and 12 departments related to patient care, and 5 departments providing support services.

Optimize location in part based on lowest cost operational expense.

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HI·TEC 2017
HEALTHCARE INFRASTRUCTURE
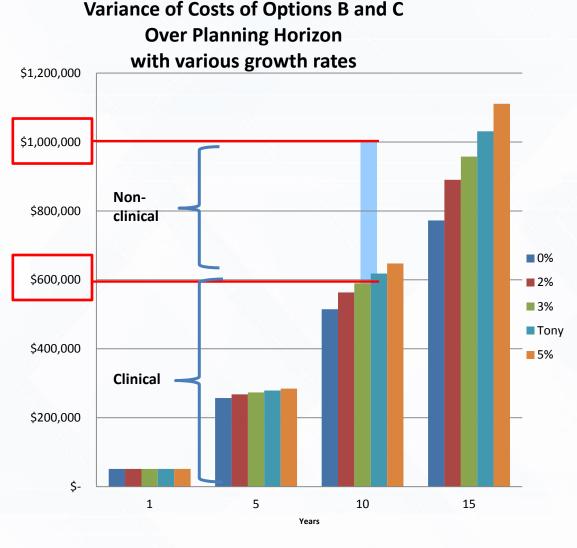TECHNOLOGY & ENGINEERING CONFERENCE

Simulation Results

Variances in annual operating costs between Options B and C.

1, 5, 10, and 15 year intervals.

0%, 2%, 3%, 3.88%/CFO Tony, and 5% annual rates of growth.

Variance of Costs of Options B and C Over Planning Horizon with various growth rates

Legend:
- 0%
- 2%
- 3%
- Tony
- 5%

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Lancaster General Medical Center Lancaster, Pennsylvania

Evaluate multiple operational and spatial planning concepts for the ED's expansion and renovation to determine the optimal solution that supports the expected patient volume growth, while minimizing interim relocations and operational disruptions and also minimizing capital costs.
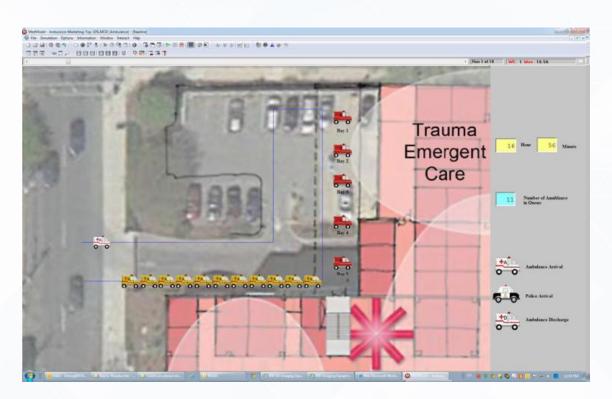
ELIMINATED
6
HOURS
OF QUEUING

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Simulation Model

Ambulance queuing situation in the late afternoon 10% of the year, when traffic volumes peak, as modeled in the simulation software.

This caused the ED project to be paused while the initial master plan was discarded and an entirely new one developed.

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UT Southwestern Medical Center
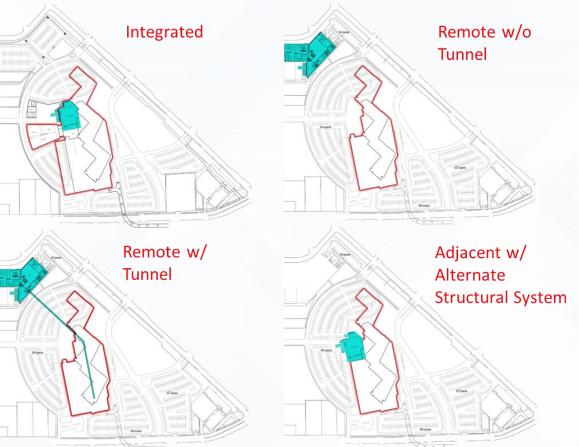## Clements University Hospital
Dallas, Texas

Materials Management - Optimal Location

Integrated – high chassis cost, minimal travel distance.

Remote w/o Tunnel – less expensive chassis, combined with CUP, access difficult.

Remote w/ Tunnel – less expensive chassis, combined with CUP, reasonable access, high tunnel cost.

Adjacent w/ Alternate Structural System – low cost structure, minimal travel distance, best solution.

Integrated

Remote w/o Tunnel

Remote w/ Tunnel

Adjacent w/ Alternate Structural System

Materials Management AGV vs. VAC vs. Manual

AGV:

- 7/24 operation

- 99% effectiveness vs. 70% for FTE

- Reduction of 20-40 FTE

- Sensitivity analysis on ROI key variables
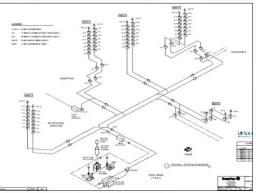
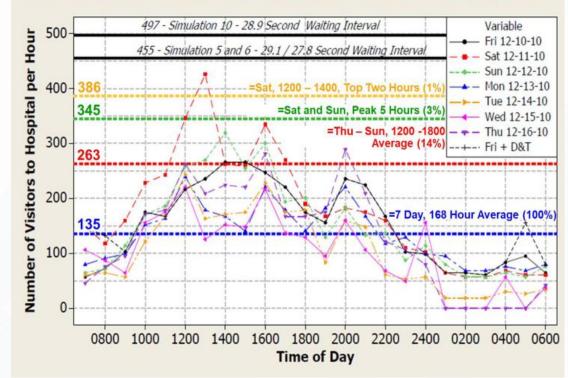- ROI insufficient; AGVs not implemented

VAC:

- Good ROI, system implemented

Visitor Elevators

Saved $3M in construction cost and reduced construction schedule by 1 month.

- 2-hour, 2025 peak (1.2%)
  HR = 29 visitors (6.8%) w/o G
  HR = 71 visitors (16.7%) w G

- 5-hour, 2025 peak (3.0%)
  HR = 69 visitors (17.9%) w/o G HR = 111 visitors (28.8%) w G

- 20-hour, 2025 peak (11.9%)
  HR = 110 visitors (31.9%) w/o G
  HR = 152 visitors (44.1%) w G

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Predictive analytics & simulation to improve healthcare infrastructure performance

NIBS-DHA Task Order 27

I. Simulation definition

II. Task Order 27 deliverables:

1. Industry Current State Overview
2. Why implement simulation
3. Expected benefits
4. Data requirements
5. Time requirements
6. Schedule requirements
7. Costs
8. Facility life cycle management
9. Implementation decision framework

Military Health System

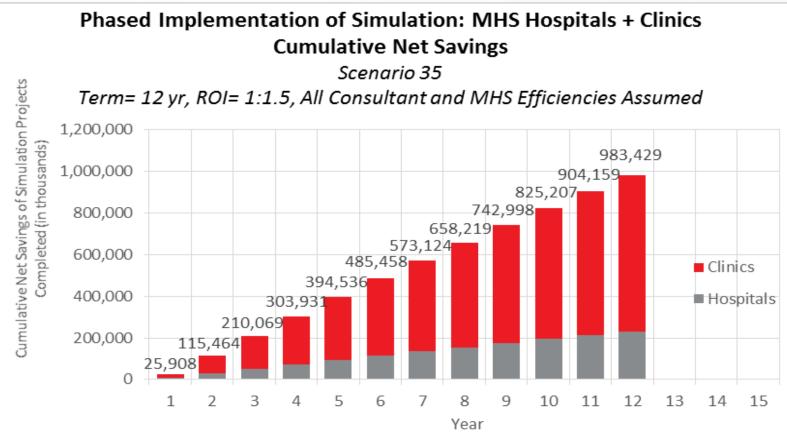- 56 Hospitals
- 360 Clinics

DHA
Defense Health Agency

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Predictive analytics & simulation to improve healthcare infrastructure performance

Simulation Implementation – Scenario 35 – Net Savings

Phased Implementation of Simulation: MHS Hospitals + Clinics
Cumulative Net Savings
Scenario 35
Term= 12 yr, ROI= 1:1.5, All Consultant and MHS Efficiencies Assumed
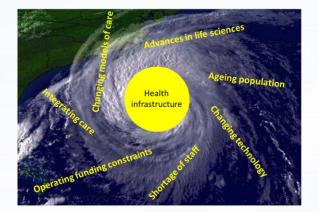
Summary

- When opening this conference in 2016 the Minister noted:

  "… we actively look for innovative ideas to optimise design, workflows and improve productivity in our healthcare infrastructure development …."

- PaCsm provides a viable method to address the cyclone of issues health faces.

- Best used for planning facility requirements and schematic design.

  - Translating models of care into facility requirements.

  - Considering models of care, capital and operating costs.

Thank You

Mr Ian Gibson

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Page/

MOH HOLDINGS

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