Blending Lab Automation and Lean: Best Practices in Pairing These Powerful Tools

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PRESENTATION OUTLINE

- "LEAN"
  - Concept & Definition
  - Common solutions
  - Main Outcomes
- St Mary's Hospital Experience – 1995/96
- Evolution of Automation at St Mary's Hospital ,1998 -2009
- Benchmarking with other Hospitals
- Other Benefits
- Conclusion

St MARY' S HOSPITAL DEMOGRAPHICS

316 ACUTE CARE BED Mc GILL AFFILIATED HOSPITAL
SERVICES PROVIDED :

- **EMERGENCY (38000 VISITS /YEAR)**
- **OBSTETRIC-GYNE. (4700 DELIVERIES/YEAR)**
- **SURGERY (>13000/YEAR)**
- **MEDICINE,ONCOLOGY,DIALYSIS,MENTAL HEALTH…**

LABORATORIES: 3.1 MILLION REPORTABLE TESTS/YEAR

" LEAN "

A Structure, Methodical & systemic approach
to solve complex processes

The creation of Continuous Flow & Elimination of Waste
in order to increase the value-added portion of the process

Waste being defined as "anything that adds no value to the process, ex: Waiting ,transportation , underutilized knowledge, inventory, rework…"

Maureen Harte
Master Black Belt

A CONTINUOUS IMPROVEMENT PROCESS

6-SIGMA

REDUCING VARIABILITY

" LEAN "

SOME PUBLISHED LEAN INTERVENTIONS IN THE CLINICAL LABORATORY FIELD

- Naples Community Hospital , Naples, Florida (2004)
- Avera McKennan Hospital Center, Sioux Falls, South Dakota (2005)
- MD Anderson Cancer Center, Houston, Texas (2005)
- Shawnee Mission Medical Center , Merriam, Kansas (2006)
- Le Bonheur Children's Medical Center , Memphis, Tennessee (2006)
- Health East Laboratory Services , St Paul, MN (2007)
- Healthcare' Jackson-Madison, West Tennessee,(2007)
- Providence Healthcare's St Paul's Hospital, Vancouver, BC, Canada
- Baptist Medical Center South, Jacksonville , Florida
- Etc…

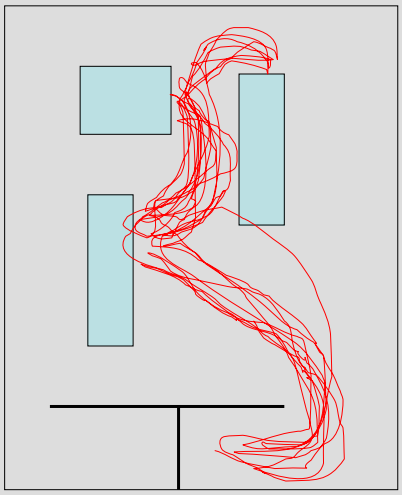
" LEAN "

Common Findings from Lean Interventions in the Clinical Laboratory

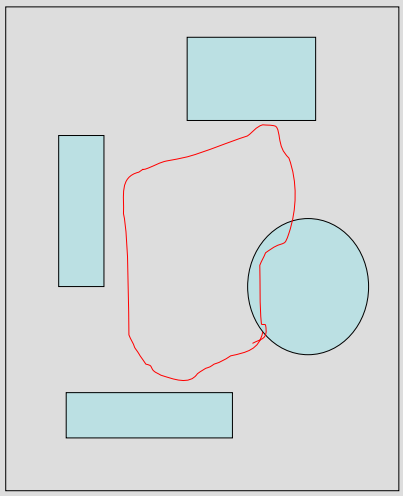
- Poor Equipment Lay Out , not matching the flow of work
- Staff unevenly allocated
- Some Process steps completely unnecessary
- Lack of Standardization
- Too many rules & exception to rules
- Batch Processing slowing down the work
- Inventory Management was time consumming
- Closets & Drawers clogged
- Etc….

"Spaghetti Diagrams"

Before Lean



After Lean



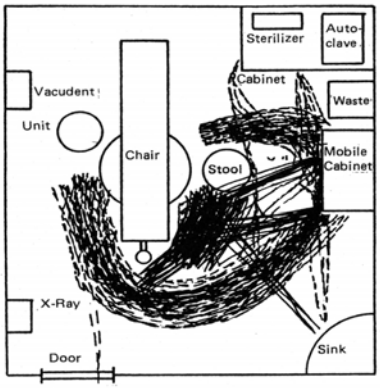


Figure 19.9. Original layout of operatory with travel paths of dentist and ass

Before

"Time & Motion Studies"
Six Edition M.Mundel- 1985

MEMOMOTION STUDIES DONE IN THE 50'S

After

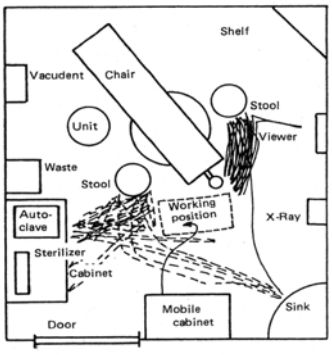


Figure 19.10. Improved layout of operatory with travel paths of dentist and assistant.

Common solutions from Lean Interventions

- Repositioning of equipment to allow 80 to 85% of testing volume to be processed in a Central Core Area.(On occasions took down walls)
- Workstation Consolidation
- Cross Training of technologists to operate many Instruments
- Redesigning the Laboratory's Equipment Layout for improved Workflow and minimizing operator's traveling.
- Process standardized to eliminate unnecessary steps
- Switching from batch processing to single piece flow (Blood Procurement)
- Introducing color coding and other visual management techniques that make it instantly apparent when a tool or supply items are out of place
- Put in place a formal supply inventory management process (yellow Card , Double bins.

"LEAN" Outcomes Summary

- Some Tangible Savings $$$
- Soft $$ Savings (Cost Avoidance)
- Improved TAT
- Saved Space
- Improved Productivity
- Reduction of Errors

St Mary's Hospital Experience 1995-96

Common solutions from Lean Interventions

PROCESS REENGINEERING

- Repositioning of equipment to allow 80 to 85% of testing volume to be processed in a Central Core Area.(On occasions took down walls)
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PARADIGM IN THE LABORATORIES IN 1995

TESTS PROCESSED BY DISCIPLINE

- Pathology
- Biochemistry
- Hematology
- Microbiology

PARADIGM CHANGE IN THE LABORATORIES- 1995

CONCEPT

Tests processed by following the Technological Platform

AUTOMATION

- Biochemistry
- Hematology
- Microbiology
- etc..

MANUAL

- Biochemistry
- Hematology
- Microbiology
- etc..

LAB CONFIGURATION (Before Changes-1995

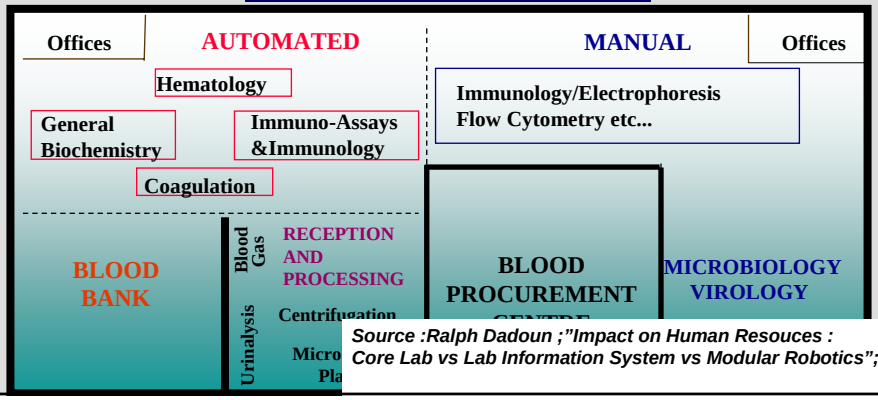
OFFICES | BIOCHEMISTRY | OFFICES | HEMATOLOGY | MICRO | OFFICES | VIRO

URINALYSIS | OFFICE | ELECTRO-PHORESIS | FILES | IMMUNOLOGY | URINE 24 HR | BANK BLOOD | HEMAT ELECT SPECIAL | PARASITOLOGY MYCOLOGY MYCOBACTERIOLOGY | OFFICES

BLOOD PROCUREMENT CENTER

- We Removed Walls
- Workstation Consolidation
- Reposition Equipment to :
  - Minimize walking & routing
  - Allow 85% of total lab volume to be processed in one area
- Staff was Cross-Trained
- Standardized Work in Processes

Opening of the Core Lab: 1996

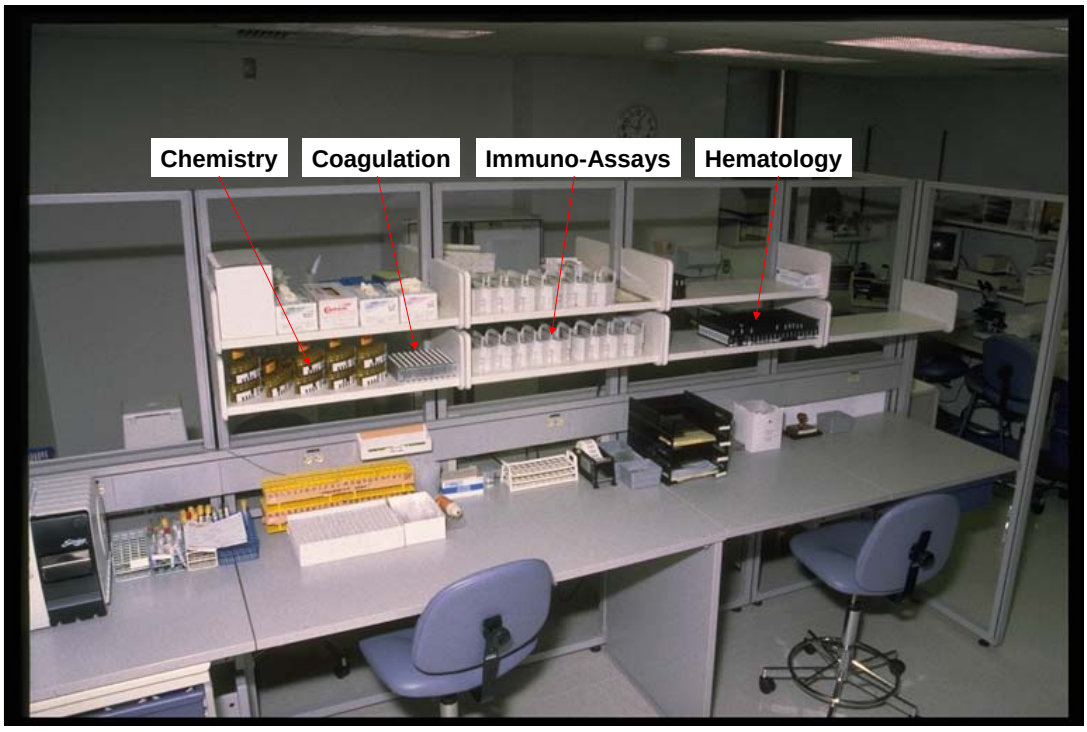


Source :Ralph Dadoun ;"Impact on Human Resouces : Core Lab vs Lab Information System vs Modular Robotics";CLMR 1998

Process in the Re-Designed St Mary's Laboratory

A SINGLE STANDADIZED PROCESS FOR :

General Chemistry, Immuno-Assay,Hematology, Coagulation




hCG
COMBO
COMPAQ


1 2

COMPUTERIZED PROCESS

ANALYSIS

↓

REFLEX-TESTING

↓

AUTO-VALIDATION

↓

AUTO-REPORTING
TO POINT OF REQUEST

St Mary's Outcomes Summary Core Lab 1996-1998

- Some $$$ Savings → 7 FTE's
- Soft $$ Savings (Cost Avoidance) → Not Accounted for
- Improved TAT → YES
  Chem Stat :37 min
  Hemat Stat:18 min
- Saved Space → YES
  Reduction of 2140 Sq/ft (23%)
- Improved Productivity → ?

METRICS	St Mary's 1998 Core Lab	CAP LMIP 1998 95 Percentile (N>700)
LMIP UNITS/ WORKED HOUR	20.6	17.25

Source :Ralph Dadoun ;"Impact on Human Resouces : Core Lab vs Lab Information System vs Modular Robotics";CLMR 1998
Ralph Dadoun ;"Implementing Pre-Analytical Automation";MLO 2000

TAT Comparison : St Mary's (Prior to Automation-1997) Vs other "Lean" Hospital Labs(2004-2007)

Average TAT Results From **Receipt** to Reported **Results**

After LEAN Implementation *(as published 2004/07)*

	Stat Chemistry	Stat Hematology	Troponin
Hospital A	35 min	18 min.	45 min.
Hospital B	55 min	25 min.	----
Hospital C	-----	33min	-----
Hospital D	45 min	15 min	-----
St Mary's Hospital 1997	**37 min**	**18 min**	**NA**

Site Visit to LEAN Laboratories (No Automation) 2008

TAT Study From **Receipt** to Reported **Results**

	Stat Chemistry	90th Percentile	Troponin	90th Percentile
Hospital 1	35 ± 17 min	57	43 ± 19 min	74
Hospital 2	44 ± 11 min	60	53 ±14 min	71
Hospital 3	39 ± 14 min	57	76 ± 20 min	107
SMH-TAT – 1997 CORE-LAB	37 ± 19 min	61	NA	

Source :Ralph Dadoun ;"Impact on Human Resouces : Core Lab vs Lab Information System vs Modular Robotics";CLMR 1998
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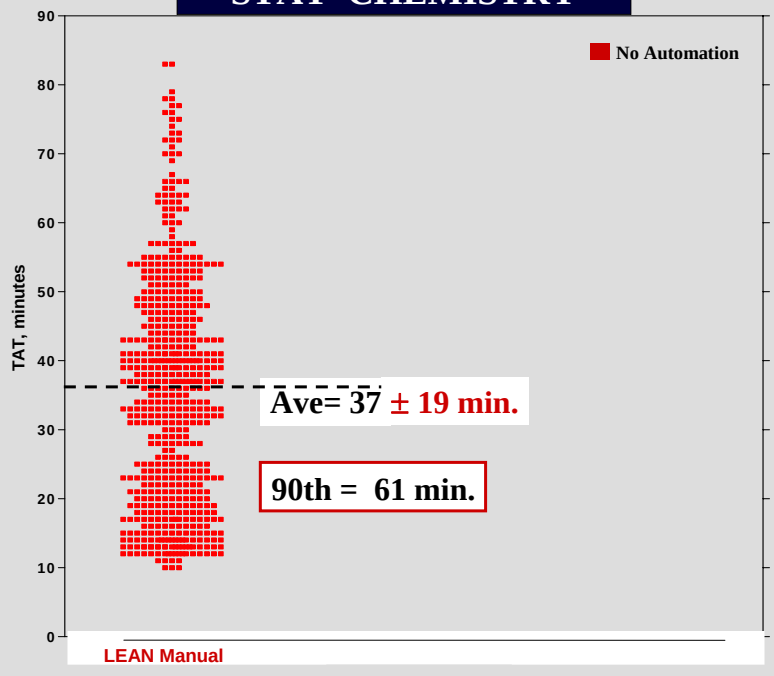
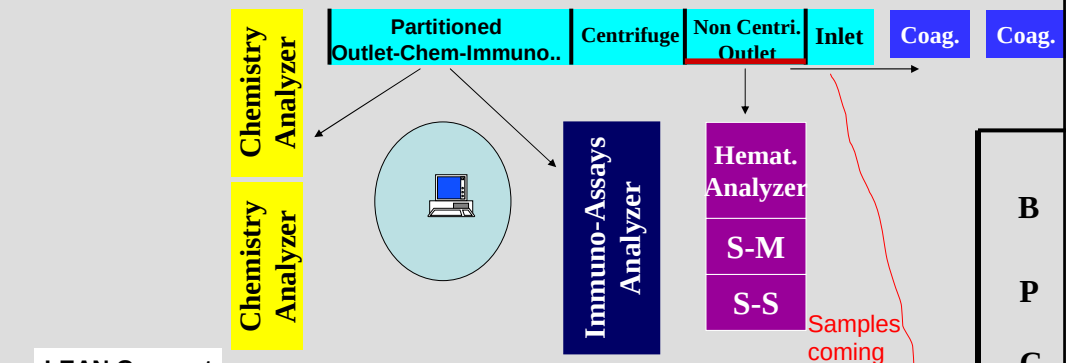
STAT CHEMISTRY



EVOLUTION OF AUTOMATION AT ST MARY'S

1998 to 2008

AUTOMATION SYSTEM



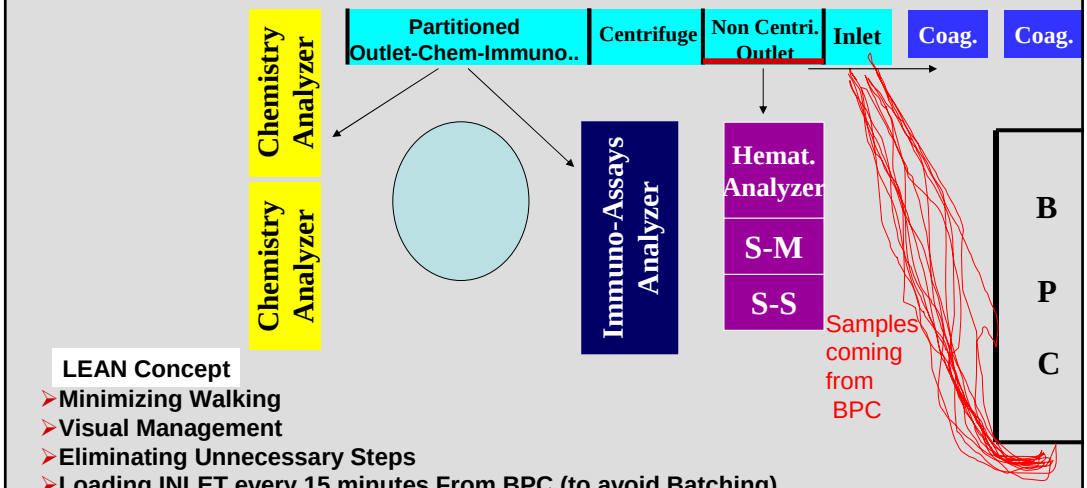
LEAN Concept

- **Minimizing Walking**
- **Visual Management**
- **Eliminating Unnecessary Steps**
- **Loading INLET every 15 minutes From BPC (to avoid Batching)**

Total Redesign of Reception & Processing

Note : **B**lood **P**rocurement **C**enter (**BPC**)

AUTOMATION SYSTEM



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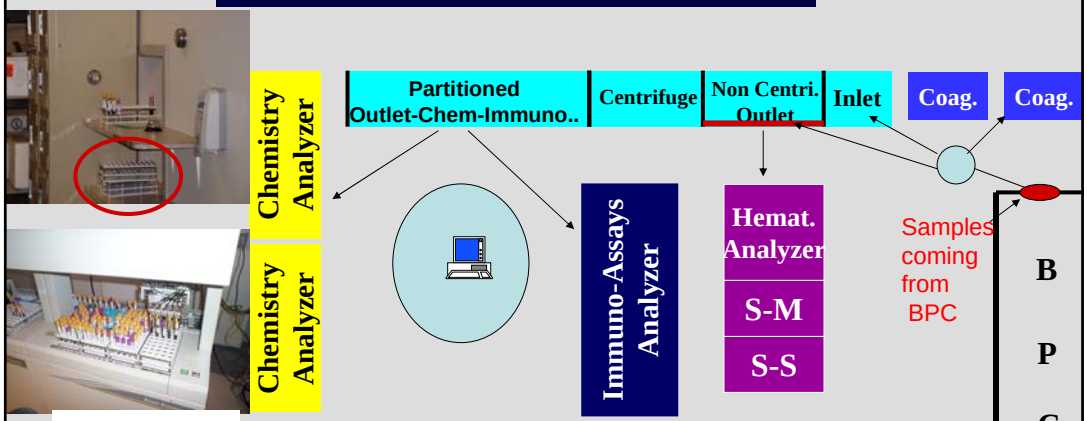

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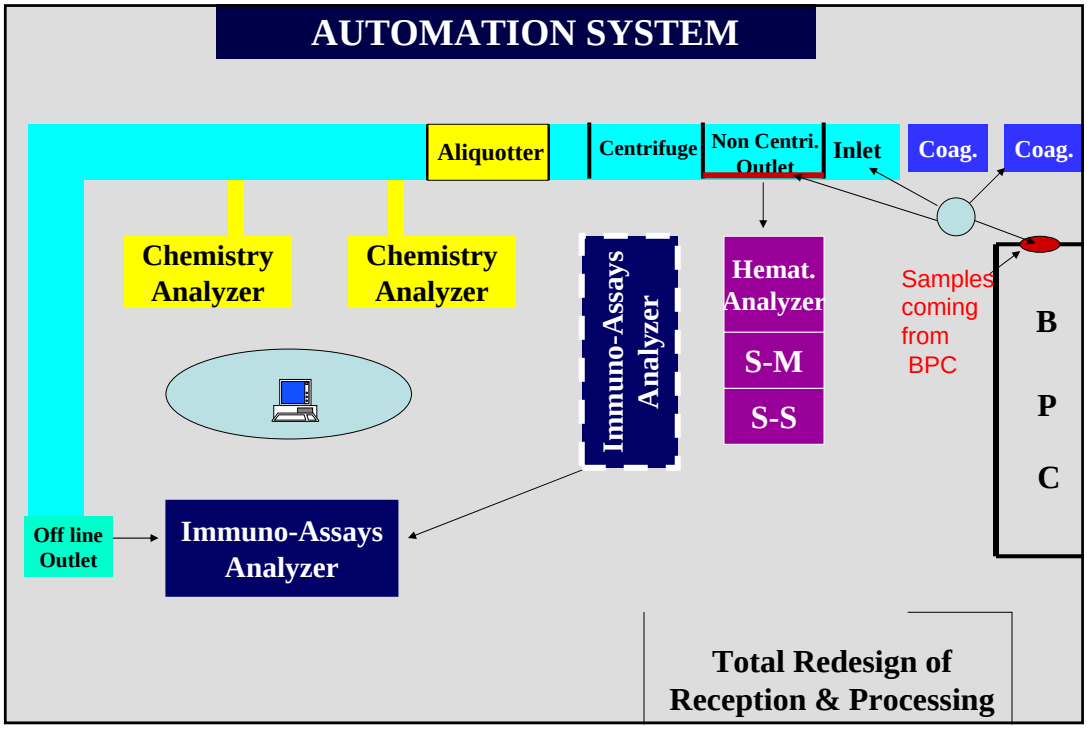
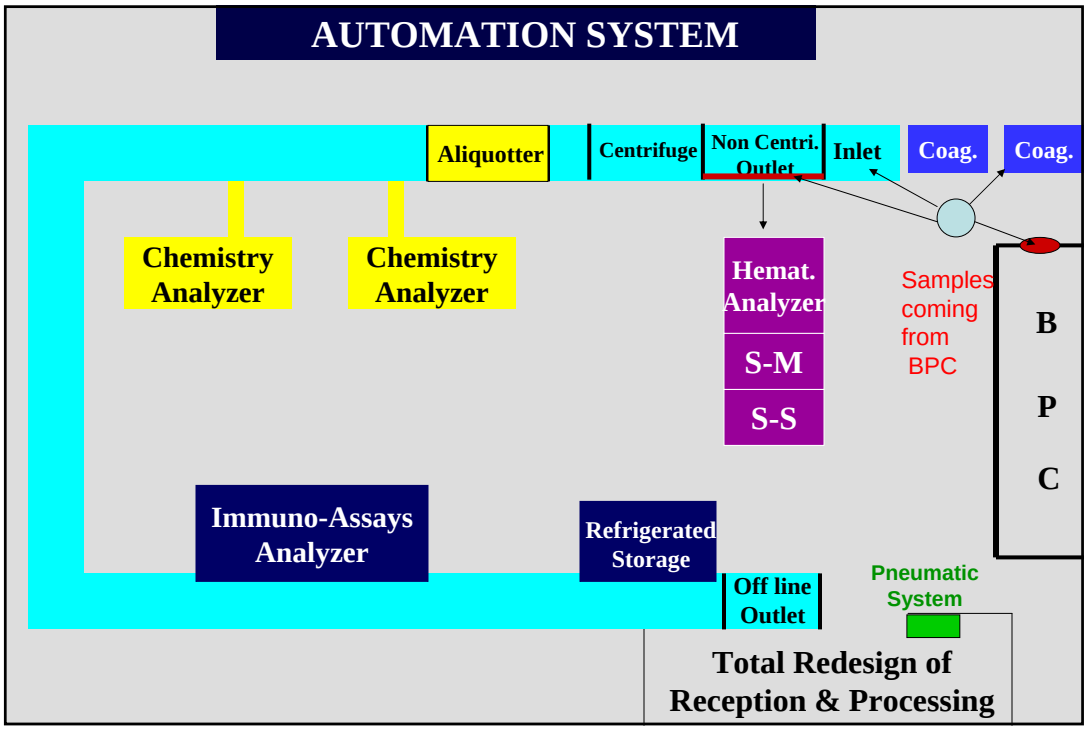
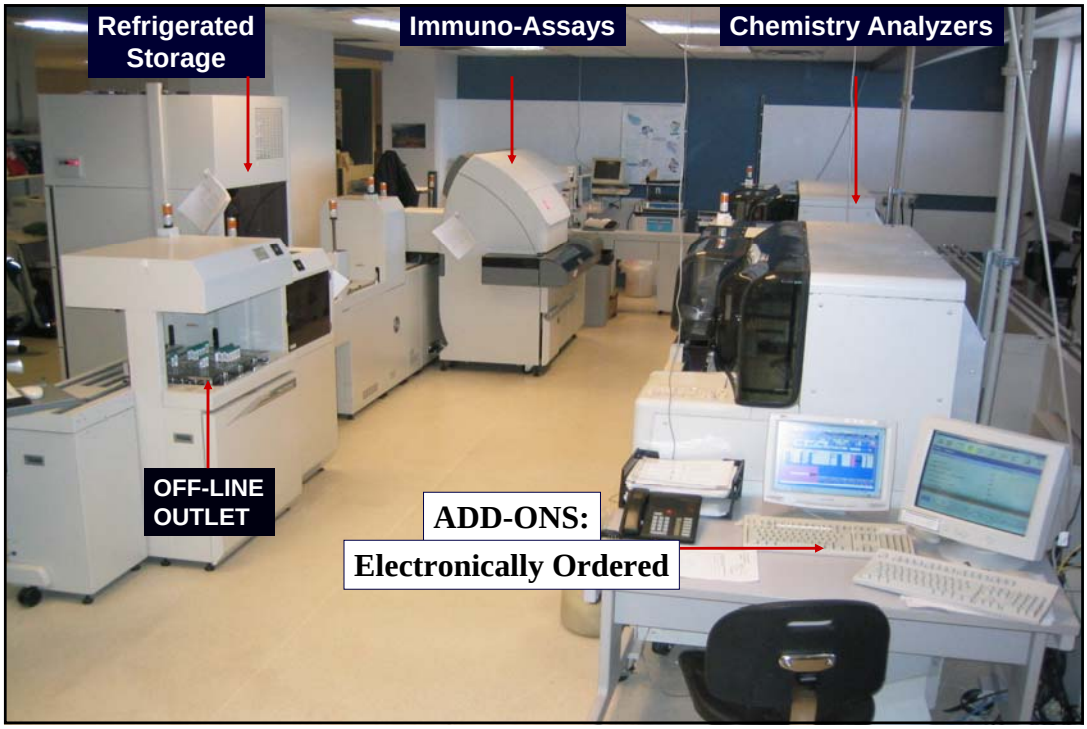
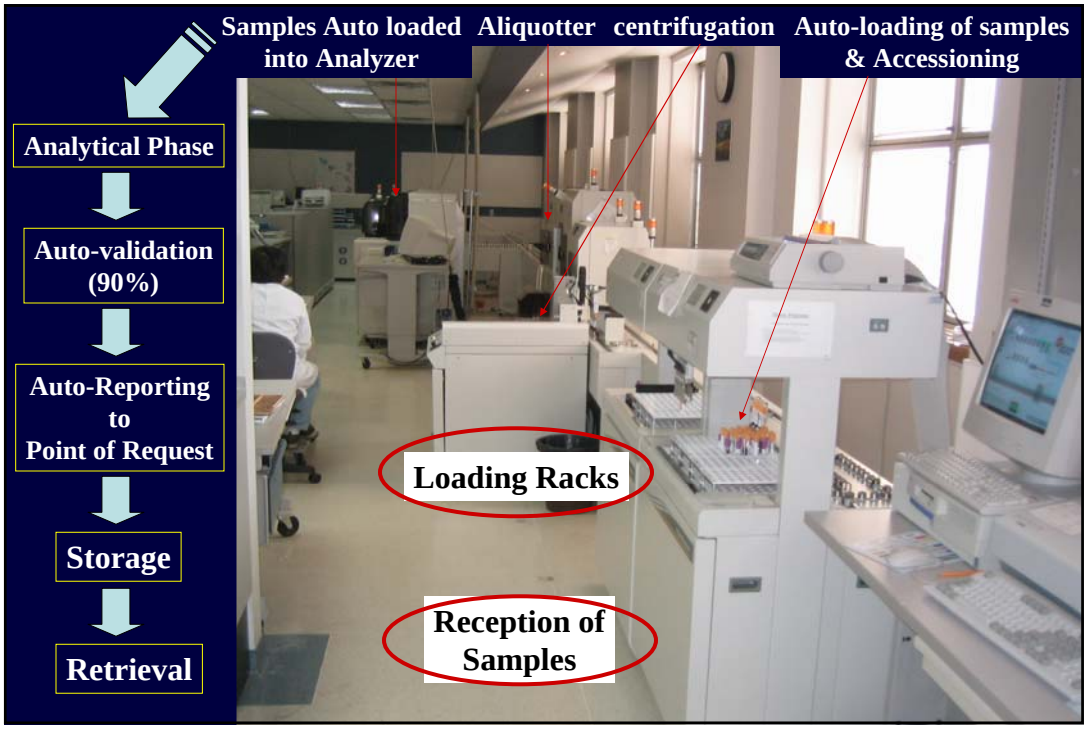

AUTOMATION SYSTEM
Aliquotter
Centrifuge
Non Centri. Outlet
Inlet
Coag.
Coag.
Chemistry Analyzer
Chemistry Analyzer
Immuno-Assays Analyzer
Hemat. Analyzer
S-M
S-S
Samples coming from BPC
B
P
C
Off line Outlet
Immuno-Assays Analyzer
Total Redesign of Reception & Processing

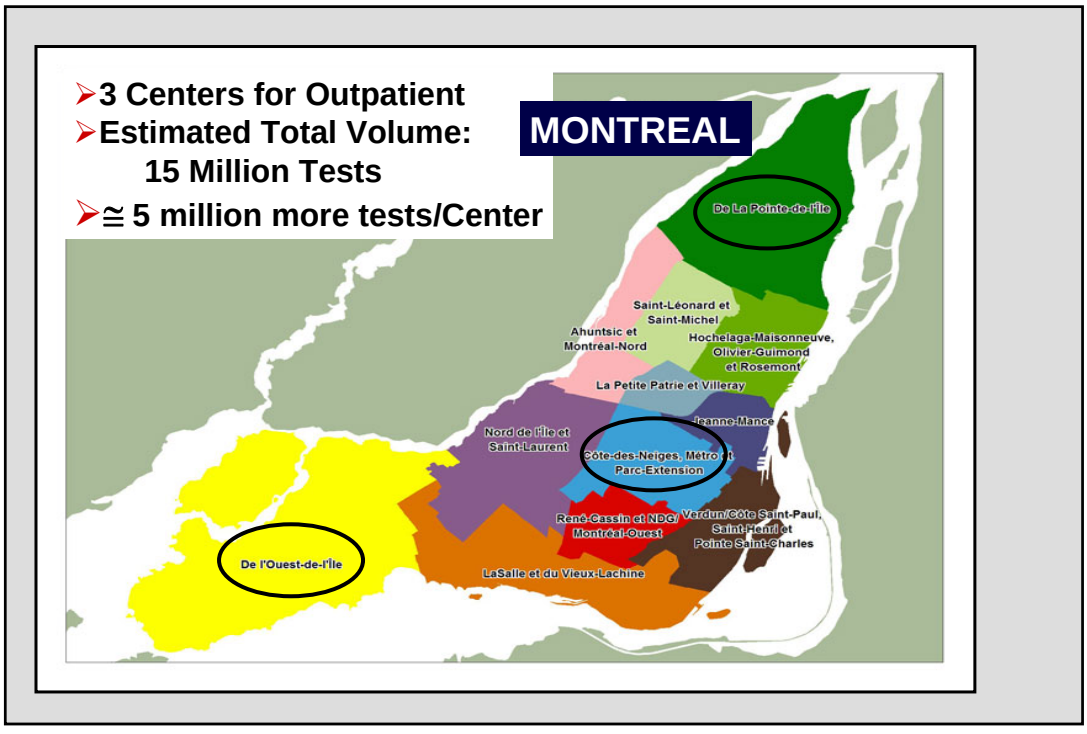

AUTOMATION SYSTEM
Aliquotter
Centrifuge
Non Centri. Outlet
Inlet
Coag.
Coag.
Chemistry Analyzer
Chemistry Analyzer
Hemat. Analyzer
S-M
S-S
Samples coming from BPC
B
P
C
Immuno-Assays Analyzer
Refrigerated Storage
Off line Outlet
Pneumatic System
Total Redesign of Reception & Processing

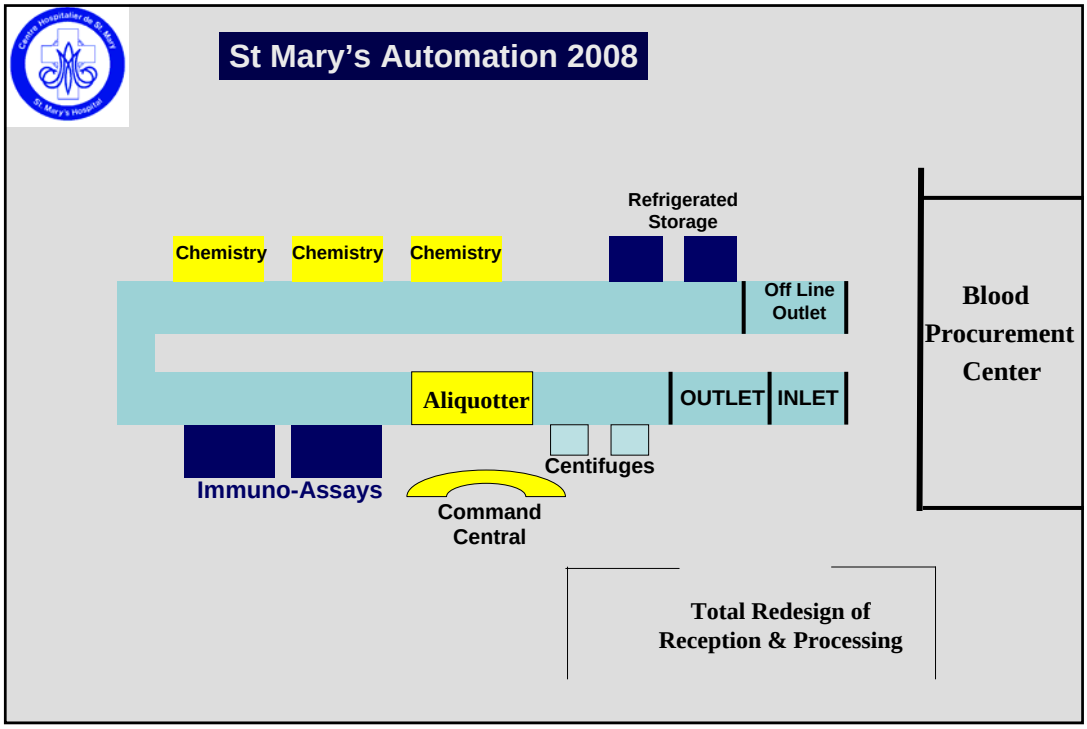


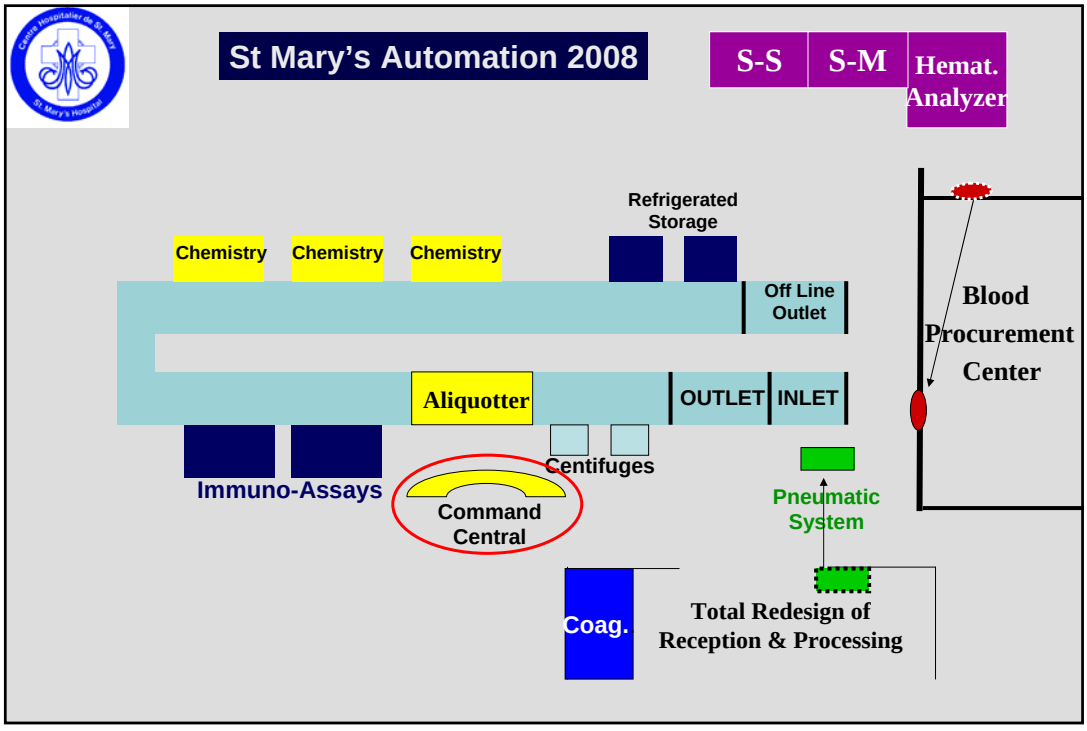
MANUAL STEPS INVOLVED IN CHEMISTRY:
Before Automation – After automation Per Sample

Process Steps	Prior to Automation	AFTER AUTOMATION		
❖RECEPTION	☑	☑	☑	☑
❖LOADING RACKS OF SAMPLES ON ROBOTICS	N/A	☑	☑	☑
❖SORTING	☑	☑	AUTOMATION	AUTOMATION
❖SCAN BAR-CODES	☑	☑		
❖TRANSPORT TUBES TO CENTRIFUGE	☑	AUTOMATION		
❖LOAD SAMPLES TO CENTRIFUGE	☑			
❖UNLOAD TUBES FROM CENTRIFUGE	☑			
❖SPLIT SAMPLES FOR SEPARATE WORKSTATION	☑			
❖VISUALIZE SERUM INDICES	☑			
❖DECAP TUBES	☑			
❖TRANSPORT RACKS TO ANALYZER	☑	☑	☑	
❖LOAD EQUIPMENT	☑	☑	☑	
❖STORE	☑	☑	☑	
Total Number of Manual Steps	12	7	5	2


Samples Auto loaded into Analyzer
Aliquotter
centrifugation
Auto-loading of samples & Accessioning
Analytical Phase
Auto-validation (90%)
Auto-Reporting to Point of Request
Storage
Retrieval
Loading Racks
Reception of Samples


3 Centers for Outpatient
Estimated Total Volume: 15 Million Tests
≅ 5 million more tests/Center
MONTREAL
De La Pointe-de-l'Île
Saint-Léonard et Saint-Michel
Ahuntsic et Montréal-Nord
Hochelaga-Maisonneuve, Olivier-Guimond et Rosemont
La Petite Patrie et Villeray
Jeanne-Mance
Nord de l'Île et Saint-Laurent
Côte-des-Neiges, Métro et Parc-Extension
René-Cassin et NDG, Montréal-Ouest
Verdun/Côte Saint-Paul, Saint-Henri et Pointe Saint-Charles
De l'Ouest-de-l'Île
LaSalle et du Vieux-Lachine


St Mary's Automation 2008
Refrigerated Storage
Chemistry
Chemistry
Chemistry
Off Line Outlet
Blood Procurement Center
Aliquotter
OUTLET
INLET
Centifuges
Immuno-Assays
Command Central
Total Redesign of Reception & Processing

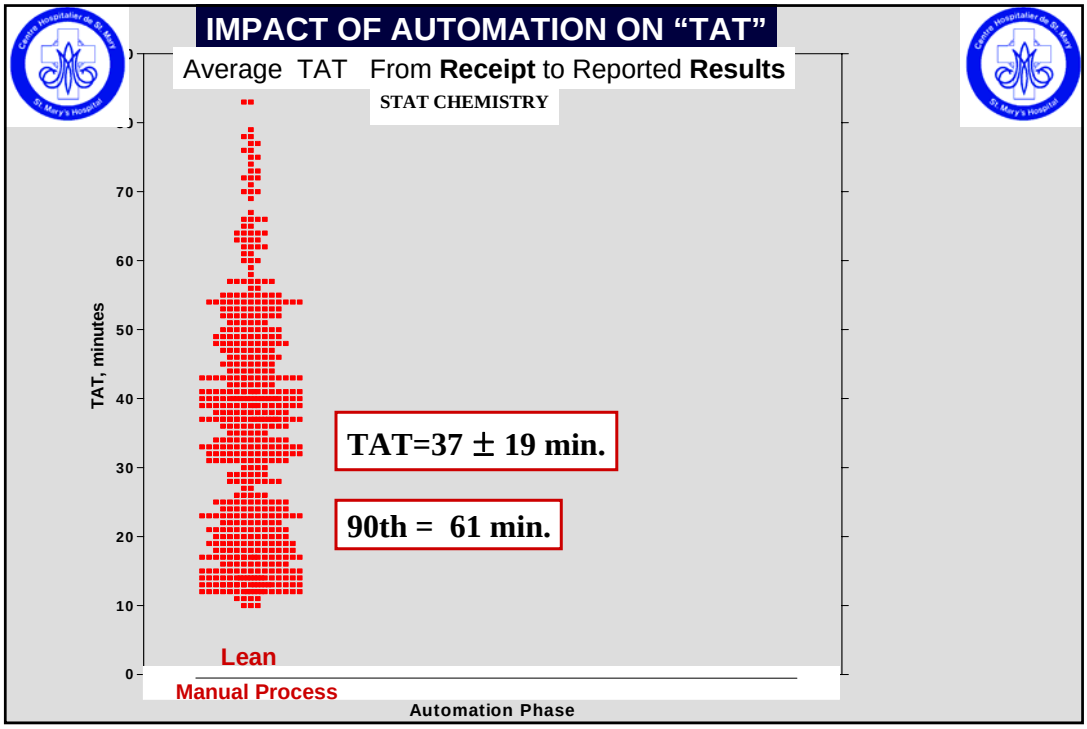

St Mary's Automation 2008
S-S
S-M
Hemat. Analyzer
Refrigerated Storage
Chemistry
Chemistry
Chemistry
Off Line Outlet
Blood Procurement Center
Aliquotter
OUTLET
INLET
Centifuges
Immuno-Assays
Command Central
Pneumatic System
Coag.
Total Redesign of Reception & Processing

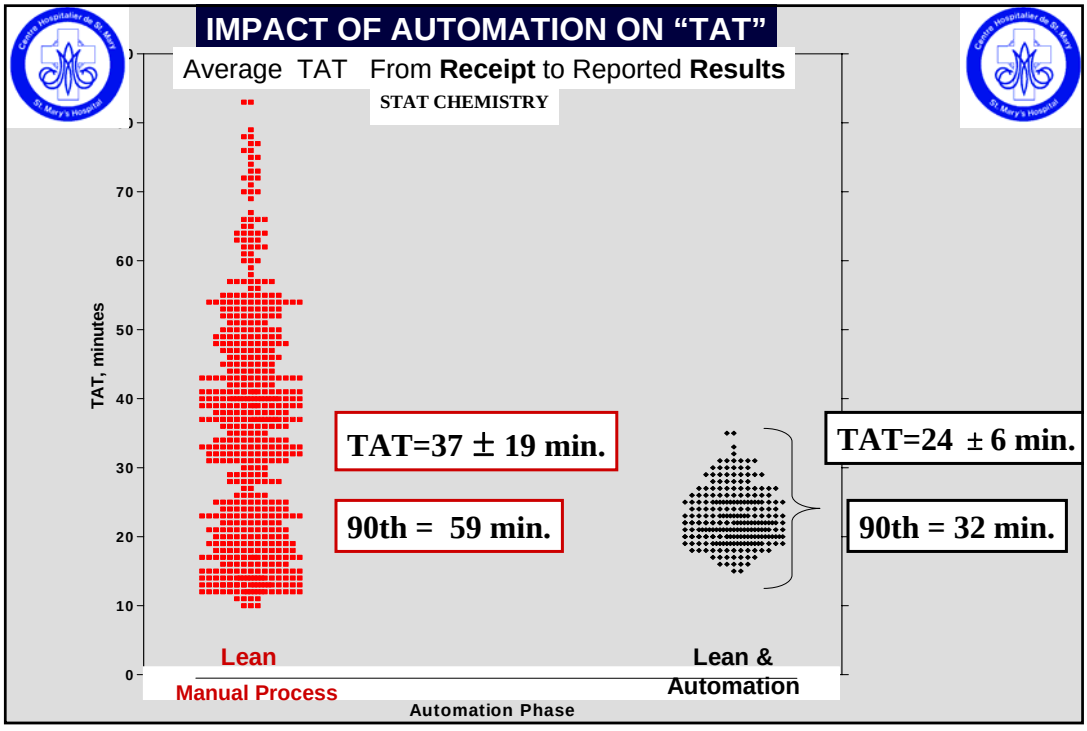
Site Visit to LEAN Laboratories (With Automation) 2008

Average TAT From **Receipt** to Reported **Results**

N > 200

	Stat Chemistry	90th Percentile	Troponin	90th Percentile
Hospital A (Automation System 1)	47 ± 20 min	76	70 min	NA
Hospital B (Automation System 2)	43 ± 9 min	55	52± 10 min	66
Hospital C (Automation System 3)	36 ± 11 min	50	NA	
Hospital C (ED STAT LAB)	25 ± 7 min	35	28 ± 10 min	42
St Mary's (Automation system 4**)**	24 ± 6 min	32	29 ± 6 min	38


IMPACT OF AUTOMATION ON "TAT"
Average TAT From Receipt to Reported Results
STAT CHEMISTRY
TAT, minutes
0
10
20
30
40
50
60
70
TAT=37 ± 19 min.
90th = 61 min.
Lean
Manual Process
Automation Phase


IMPACT OF AUTOMATION ON "TAT"
Average TAT From Receipt to Reported Results
STAT CHEMISTRY
TAT, minutes
0
10
20
30
40
50
60
70
TAT=37 ± 19 min.
90th = 59 min.
TAT=24 ± 6 min.
90th = 32 min.
Lean
Manual Process
Lean &
Automation
Automation Phase

BENEFITS OF AUTOMATION OUTSIDE THE WALLS OF THE LABORATORY

EMERGENCY DEPARTEMENT

- Test ordering at triage
- Lab Technician in ED 16hrs/day – 7 days/week

TAT FROM :

Time of Collection → **Reported results**

	Chemistry	Hematology	Cardiac panel (Troponin)
Ave :	31 ± 7 min.	15 ± 9 min.	36 ± 7 min
90th	43 min. n=573	28 min. n=569	48 min. n=205

- ADD-ONS : 6 to 10 minutes

ADD-ONS

Brigham and Women's Hospital , Massachusetts General Hospital, Boston,MA

Requests for Add-ons (n>500)	**: 70% within 4 hours >90% within 8 hours**
Origin of Requests	**: 70% Inpatient 20% ED**
Average TAT	**: 2.7 hrs ± 2.6hrs 3.7 hrs ± 3.4hrs**

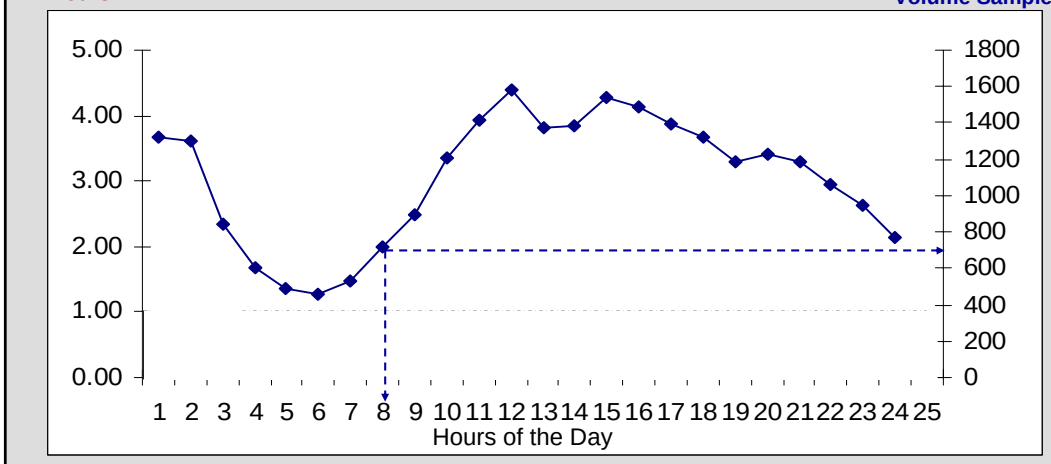
Resources : 1 to 2 FTEs

"Add-on Testing in the clinical laboratory :Observations From 2 Large Academic Medical Center " LABMEDICINE , November 2006,vol. 37

ER-TAT: Collection to Reported Results

THE MACKENZIE STUDY

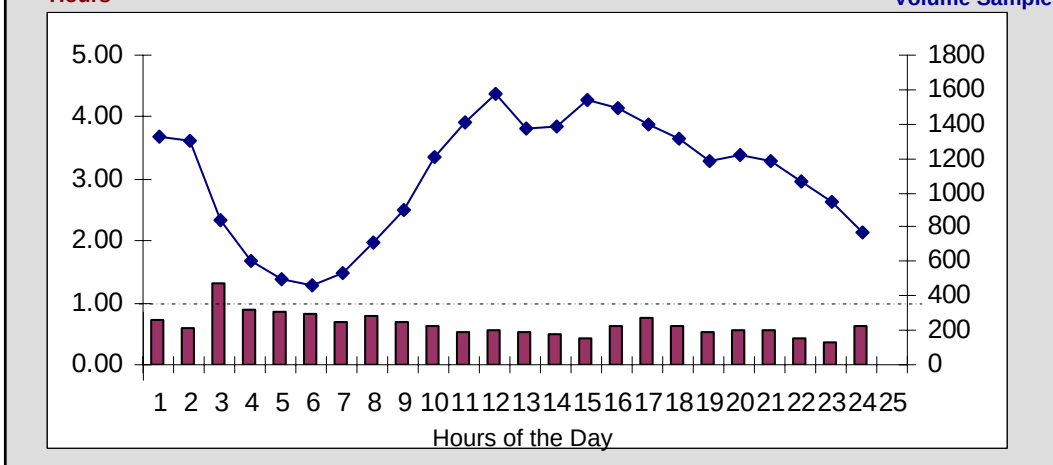
ER-TAT: Collection to Reported Results



Number of blood specimens per hour for the year 2007

TAT

ER-TAT: Collection to Reported Results



Number of blood specimens per hour for the year 2007

TAT

OTHER BENEFITS FROM AUTOMATION

IMPACT OF AUTOMATION ON "WASTE"

Waste being defined as "anything that adds no value to the process, ex: Waiting ,transportation , underutilized knowledge, inventory, rework…"

Maureen Harte
Master Black Belt

Value Added Steps

Monitoring of:

- **reagents & supply levels**
- **Controls & Calibrations**
- **Stat TAT in Real Time**
- **Odd events: (QNS,Clots..Dilutions…**
- **Critical Results review**
- **Decisions**
  - **Re run**
  - **Reflex**

Non Value Added Steps

- Waiting Time
- Transport Time
- Routine Steps
  - Reception of Specimen
  - Sorting to work areas

Automation : Staffing & Management Plan

➢**OPEN A MOLECULAR BIOLOGY LABORATORY**

➢**Brought back in house more than 20 tests performed outside, making results available to physicians more rapidly.**

(Ex.:Thyroglobulin, Toxoplasmosis, Anti-Transglutimase, alfa-feto-protein, etc…)

➢**Provide ongoing continuing education for all the technologists :**
10 Hours/Per Month

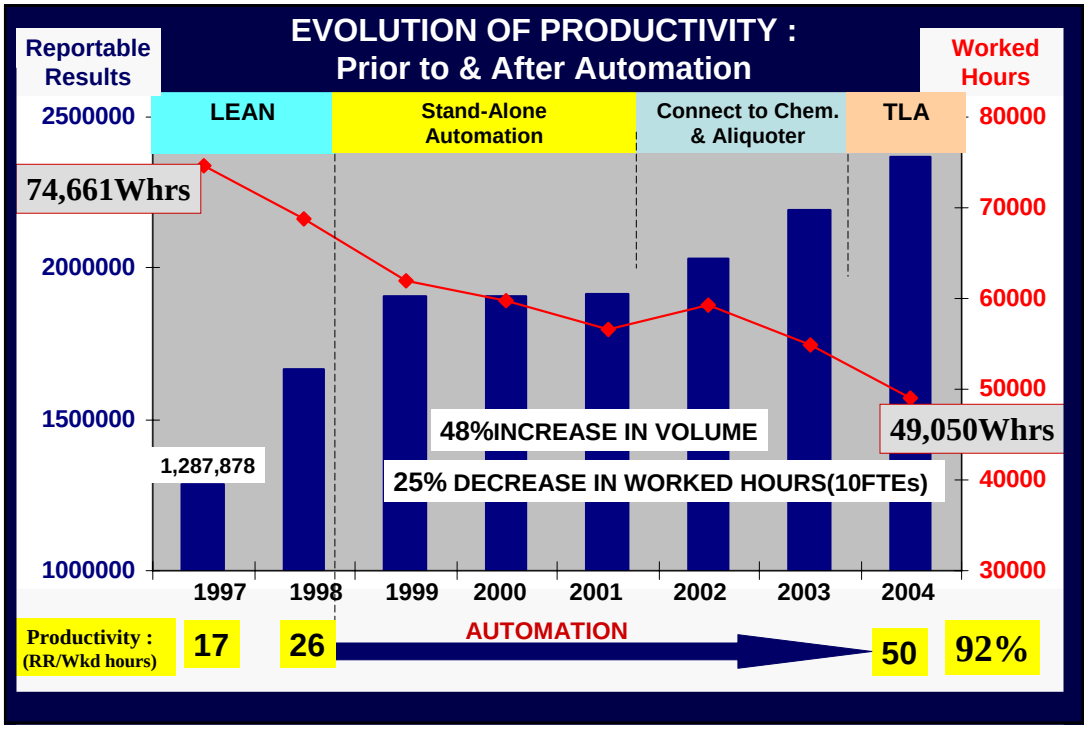
➢**One full time employee dedicated to:**
- ❖**Update Policies, Procedures & Processes**
- ❖**Maintain accreditation standards (CAP & Accreditation Canada ISO 15189)**
- ❖**Quality Control**

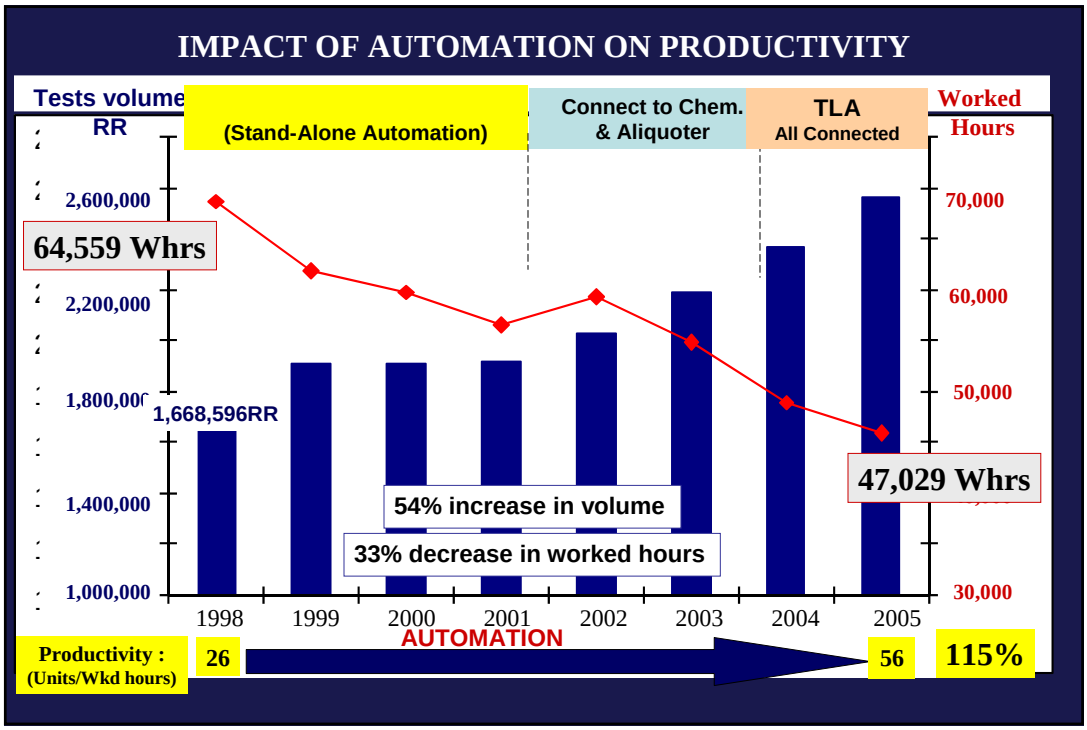
➢ **2.5 full time Employees dedicated for the Laboratory Information System**

At No Extra Cost

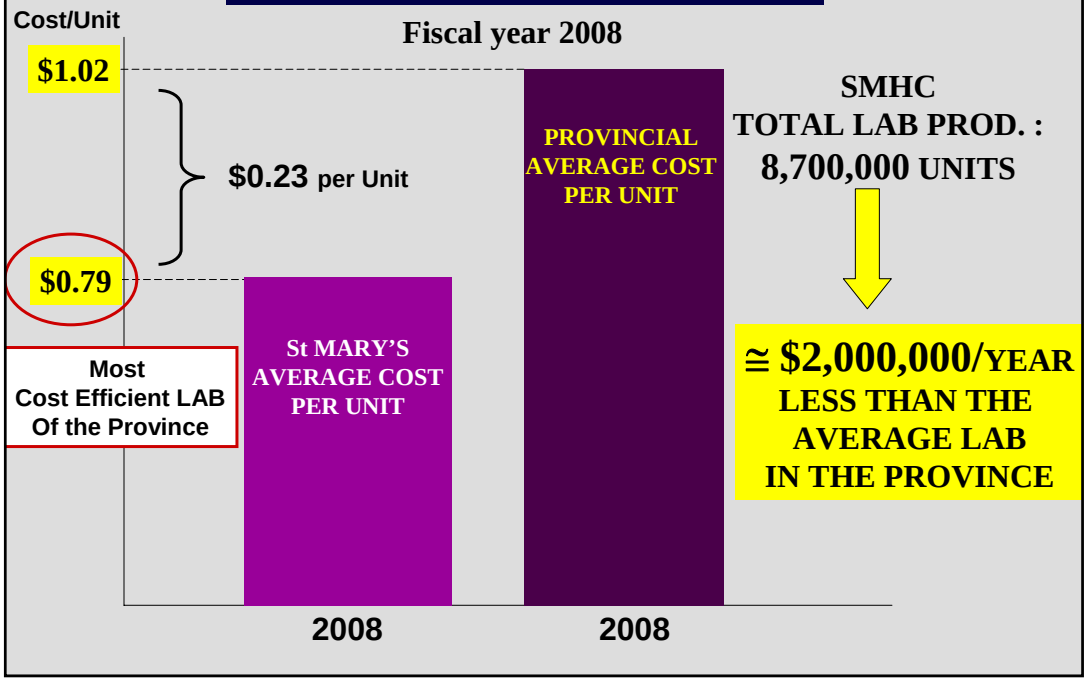
Non Value Added Steps
- Waiting Time
- Transport Time
- Routine Steps
  - Reception of Specimen
  - Sorting to work areas
  - Loading Centrifuge
  - Unloading Centrifuge
  - Remove Caps
  - Sample Integrity
  - Aliquotting
  - Loading Analyzers
  - Sorting for Storage
  - Store in fridge
  - Retrieve Specimens

PRODUCTIVITY


EVOLUTION OF PRODUCTIVITY :
Prior to & After Automation
Reportable Results
Worked Hours
LEAN
Stand-Alone Automation
Connect to Chem. & Aliquoter
TLA
2500000
2000000
1500000
1000000
80000
70000
60000
50000
40000
30000
74,661Whrs
1,287,878
48%INCREASE IN VOLUME
25% DECREASE IN WORKED HOURS(10FTEs)
49,050Whrs
1997
1998
1999
2000
2001
2002
2003
2004
Productivity : (RR/Wkd hours)
17
26
AUTOMATION
50
92%


IMPACT OF AUTOMATION ON PRODUCTIVITY
Tests volume
RR
(Stand-Alone Automation)
Connect to Chem. & Aliquoter
TLA
All Connected
Worked Hours
2,600,000
2,200,000
1,800,000
1,400,000
1,000,000
70,000
60,000
50,000
30,000
64,559 Whrs
1,668,596RR
54% increase in volume
33% decrease in worked hours
47,029 Whrs
1998
1999
2000
2001
2002
2003
2004
2005
AUTOMATION
Productivity : (Units/Wkd hours)
26
56
115%

COST EFFICIENCY BENCHMARKING



BENCHMARKING SUMMARY

Site Visit to " LEAN" Laboratories - 2008

TAT Study From **Receipt** to Reported **Results**

	Stat Chemistry	90th Percentile	Troponin	90th Percentile
Hospital 1	35± 17 min	57	43 ± 19 min	74
Hospital 2	44 ± 11 min	60	53 ±14 min	71
Hospital 3	39 ± 14 min	57	76 ± 20 min	107
Hospital 4	36 ± 11 min	50	ED Stat-lab	42
Hospital 5	47 ± 20 min	76	70 min	NA
Hospital 6	43 ± 9 min	55	52± 10 min	66
St Mary's	24 ± 6 min	32	29 ± 6 min	38

TAT From **Collection** to Reported **Results**

St Mary's	32 ± 7 min	43	36 ± 7 min	48

LEAN or AUTOMATION?

LEAN or AUTOMATION?

Hospital SHH

TAT Chemistry – N>500

Reception to Reported Results

	NO Automation NO LEAN	Automation Only	Automation + LEAN
Ave ± SD	61 ± 32 min.	39 ± 15 min.	28 ± 8 min.
90th	106 minutes	62 minutes	39 minutes

LEAN or AUTOMATION?

	Hospital SHH NO Automation NO LEAN	Hospital SHH Automation Only	Hospital SMH LEAN Only
Ave ± SD	61 ± 32 min.	39 ± 15 min.	37 ± 19 min.
90th	106 minutes	62 minutes	59 minutes

LEAN or AUTOMATION?

	Hospital SHH	Hospital SHH	Hospital SMH
	NO Automation NO LEAN	Automation Only	LEAN Only
Ave ± SD	61 ± 32 min.	39 ± 15 min.	37 ± 19 min.
90th	106 minutes	62 minutes	59 minutes

Automation + LEAN

	Hospital SHH	Hospital SMH
Ave ± SD	28 ± 8 min.	24 ± 6 min.
90th	39 minutes	32 minutes

CONCLUSION

LEAN

- Some Tangible Savings $$$
- Improves TAT
- Saves Space
- Improves Productivity
- Reduces number of Errors

AUTOMATION

LEAN

→ To a much higher level

"LEAN" CANNOT REPLACE AUTOMATION

LEAN is a Continuous Improvement Process

AUTOMATION is just a Piece of Equipment which drastically reduces variability

An Automation System is to the Pre/Post Analytical phase
What an Analyzer is to the Analytical Phase

THANK YOU

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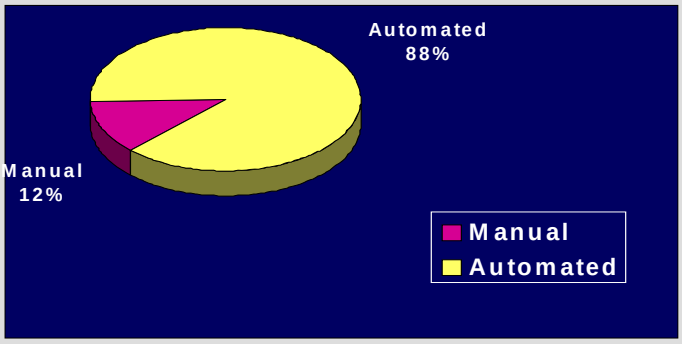
St Mary's Workflow Analysis- 1995

PERCENTAGE OF TESTS
AUTOMATED VS MANUAL

Manual: 366/3155 = 12%
Automated : 2789/3155 = 88%



IMPLEMENTATION PROCESS

- Meet with laboratory physicians
- Set up work team of 10 employees (8 technicians)
- Analyze results of workflow study
- Review all actual processes in each discipline
- Restructuring of laboratories in two sections (Automated & Manual)
  - Establish new operational processes (with & without computerization) & optimize standardization
  - Impact on personnel