Lab Quality Confab
PROCESS IMPROVEMENT INSTITUTE

# *Real Time Management of All Operational Domains and Workflows in Your Laboratory*

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PROCESS IMPROVEMENT INSTITUTE

**Objective:**

*Gain insights into achieving higher levels of productivity using Real Time Monitoring  for each lab's unique workflows*

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# Questions Pursued

- **Current State**: *How can I quickly know that my lab is running smoothly and efficiently?*

- **Capacity**: *How can I determine if our lab can take on additional work without adding new instruments or staff?*

- **Contingency Planning**: *What happens if…?*

# Preface… *Why this is important today…*

- Changing Dynamics in Healthcare
- Complexity of the Clinical Laboratory


Quest Diagnostics

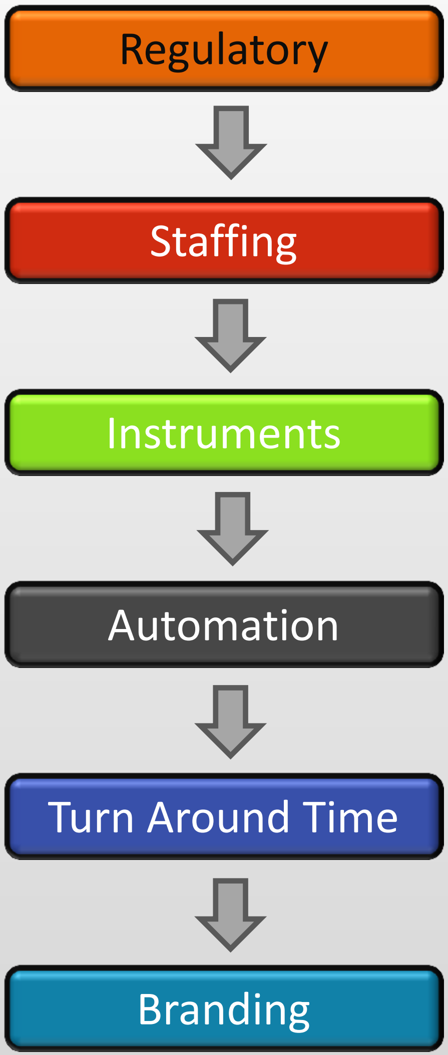
MYRIAD

ARUP LABORATORIES

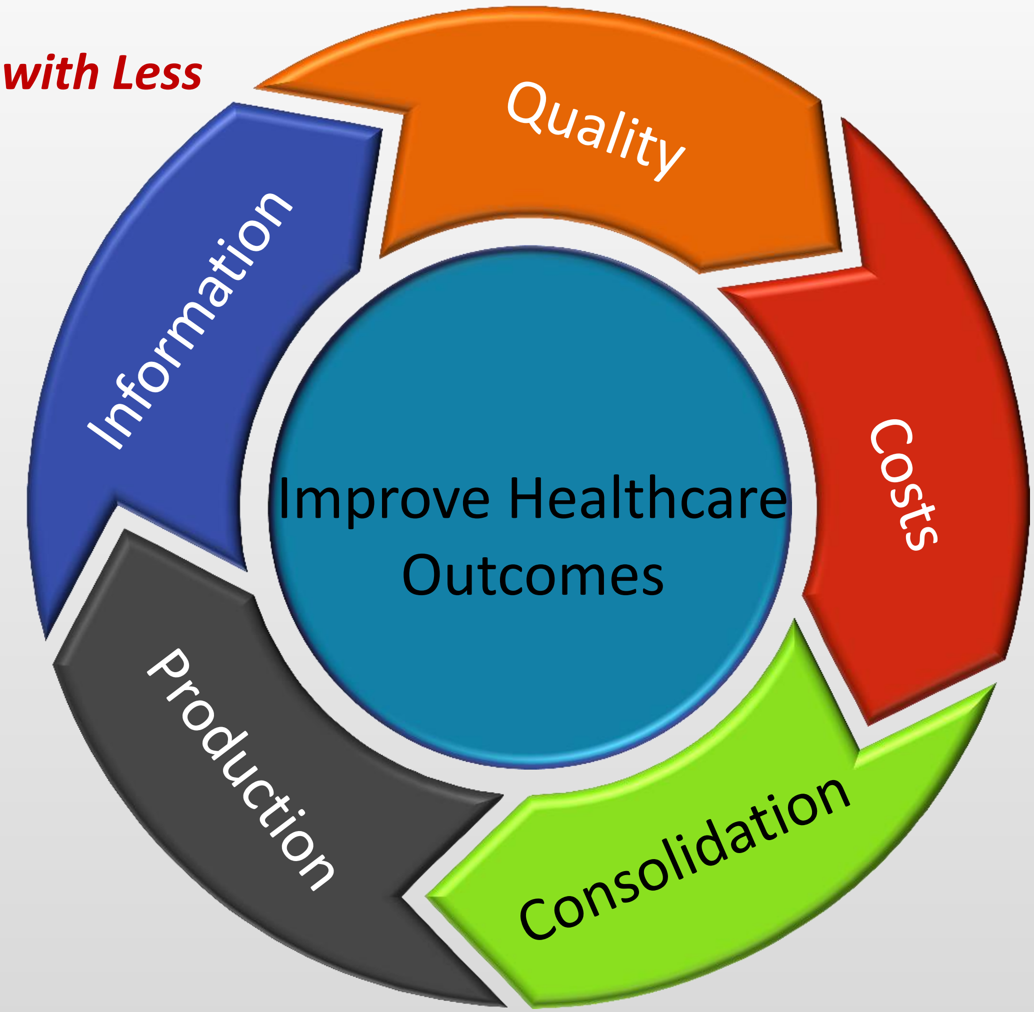
LabCorp Laboratory Corporation of America

# The Complexity of the Clinical Laboratory

> 600 Unique Tests can be Ordered by the Physician with different priorities and specimen types




***Do More with Less***

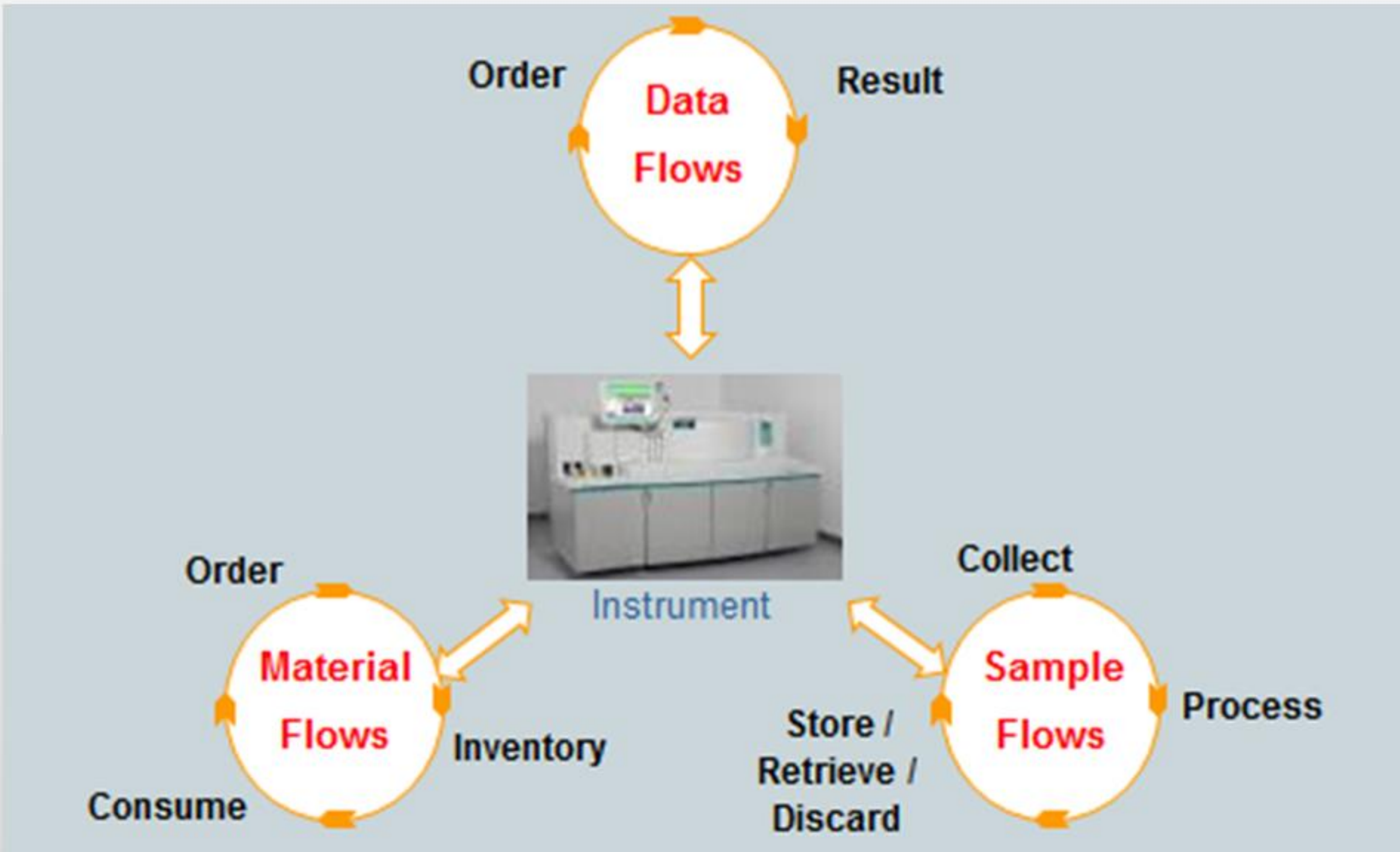



* Key Flows within the Lab
* Achieving Maximum Performance
* Theory of Constraints and Bottlenecks
* Optimizing System Performance
* Process Reviewed

# 3 Primary 'Flows' within Each Lab

**Determined by the Instrument**

**Conclusion:** **No two labs are alike!**



# Taking a Closer Look at Sample Flows from Order to Report

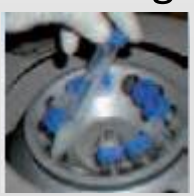
## Pre-Analytical

Collection

Sort

Label

Centrifuge



Transport

Transport

Decap

Aliquot

## Analytical

Analyze

## Post Analytical

Store / Retrieve

Transport

Seal

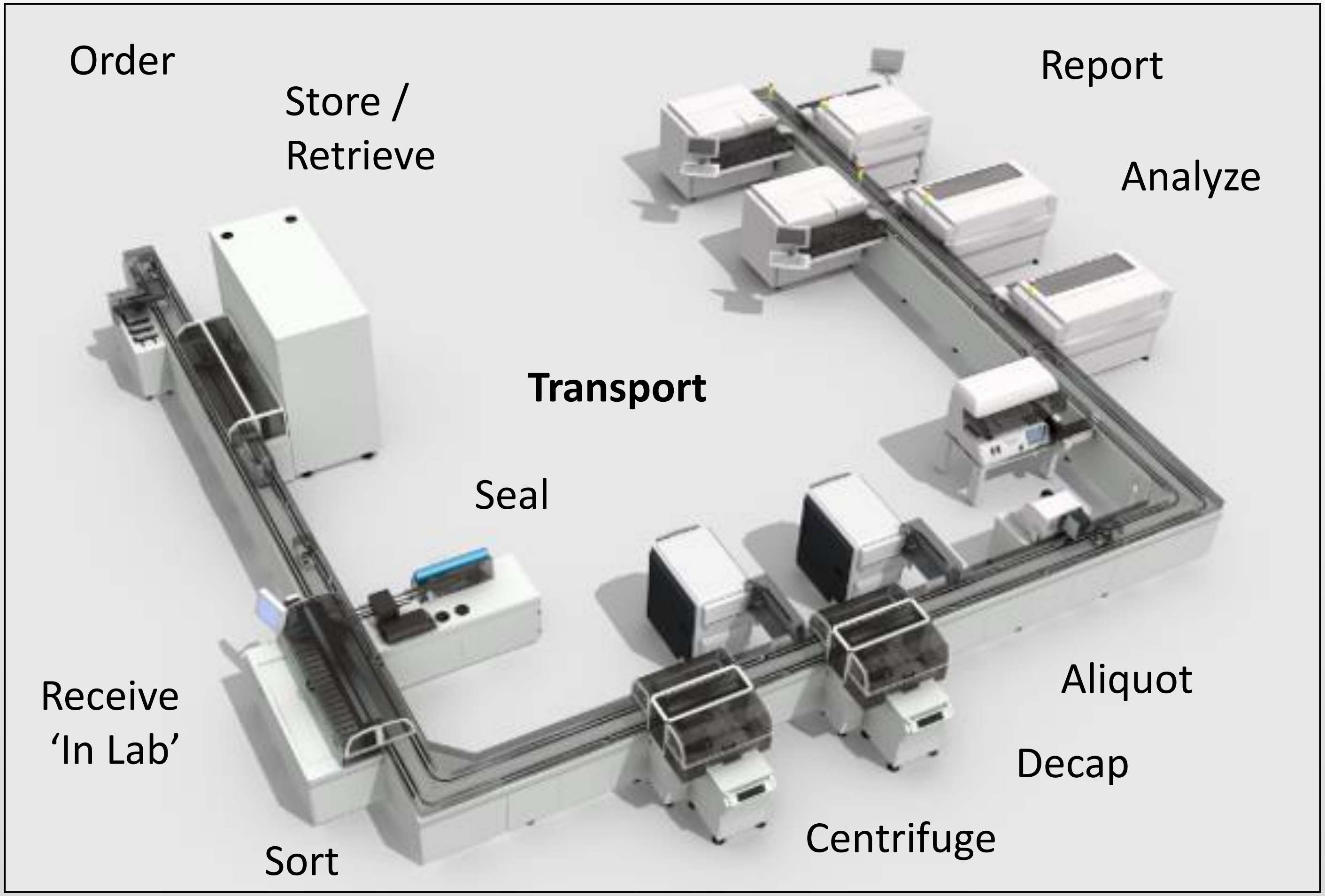
# Automating Sample Flows from Order to Report

Collection

Label

Transport

Rack & Load



# Lab Automation

## *Achieving Maximum Performance via Process Control*

*Configuration*

*Setup*

*Workload Balance*

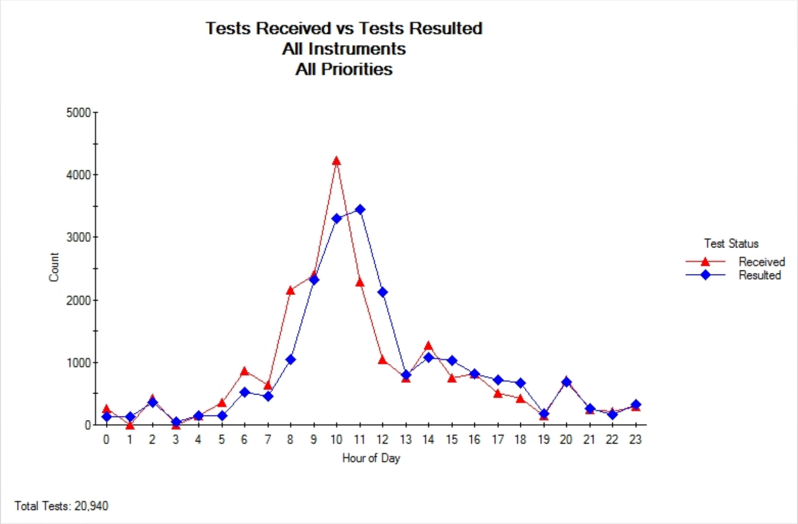
*Capacity*

# The Goal:
# Maximize System Performance

## Process

1. Forecast Demand
2. Determine Capacity
3. Exploit Constraints
4. Balance Workloads

<Repeat>

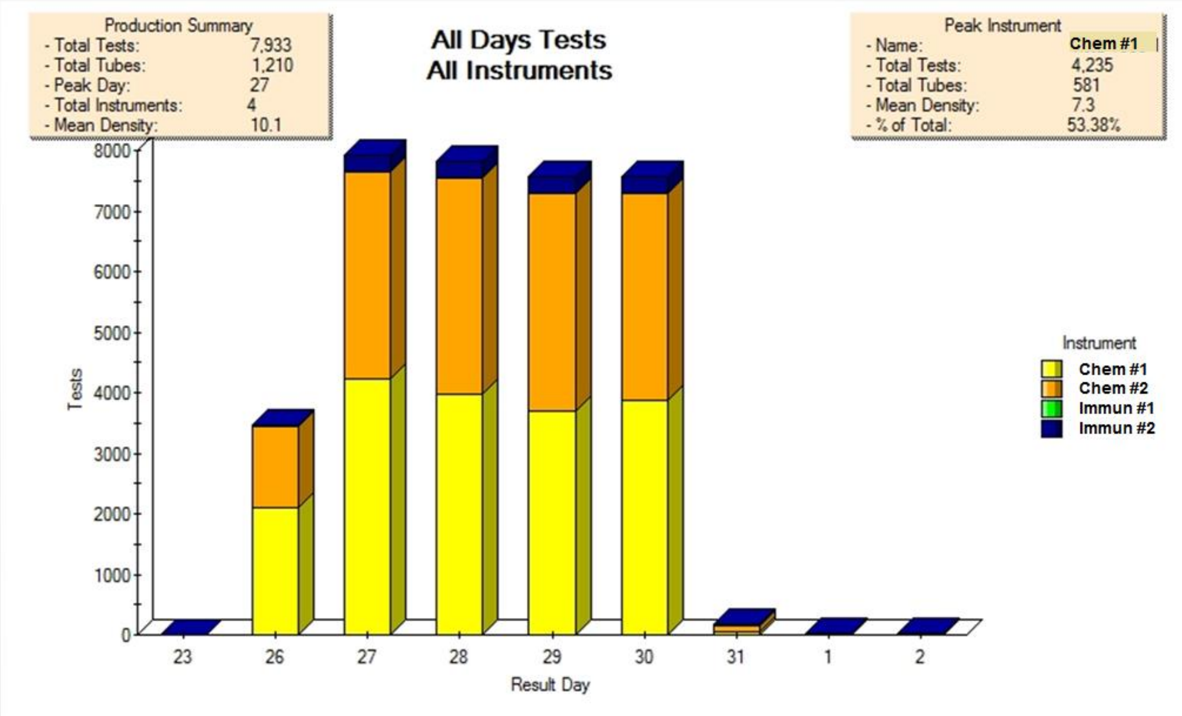


Step 1

# Forecasting Demand

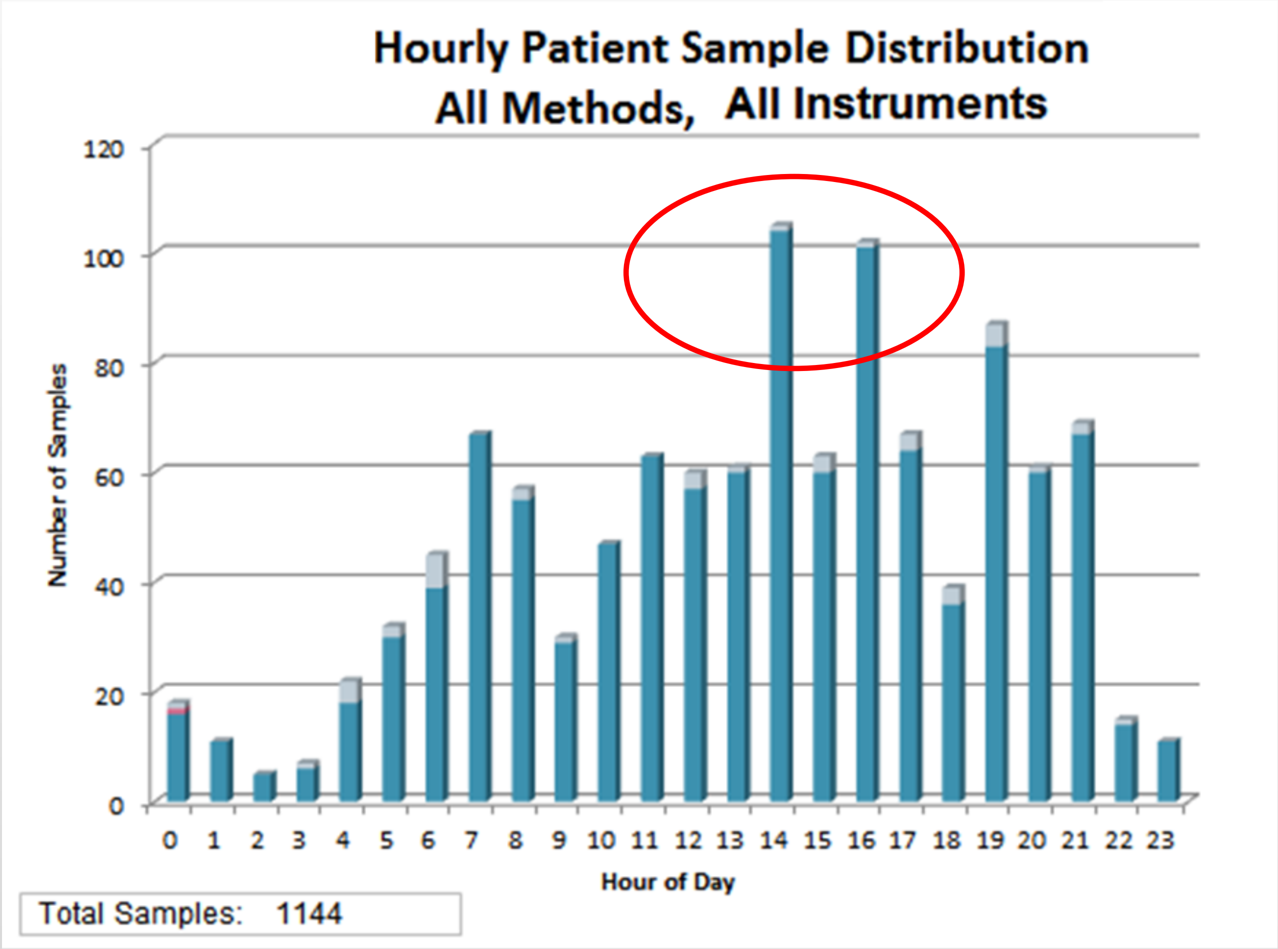
Use Historical LIS Data and Apply Assumptions for Change
(determining Peak Day of Week)

**Considerations**:
- Current Daily Workloads
- Test Density
- Seasonal Changes
- Growth Plans
- Market



# Forecasting Demand

**Consideration:** **PEAK Hours of Operation**



Step 2

# Determine Current System Capacity

*Within any given system, there is always ONE Constraint which limits the Systems overall Throughput / Capacity*

**One Approach**

- Use non-time sensitive Orders / Accessions
- Collect and Hold 3 to 6 hours of Pending Orders (# should exceed system capacity)
- Process the Pending Work using Continuous Feed
  - Observe where Queues or Bottlenecks form -- Count / Estimate the # WIP
- Quantify System Capacity by using LIS data to determine actual PEAK throughput per hour by Accession / Panel / Test

What happens if….?

Step 3

# Exploit Constraints

Eliminating Constraints will increase the Systems overall Throughput & Capacity

**<u>Common Constraints</u>**

- System Design
  - Configuration
  - Instruments
  - Processing / Track Module
- Menu / Ordering Patterns
- Test Density
- Routing (Process Control)
- Skilled Labor

# Exploiting Constraints

## Theory of Constraints (TOC)[1]

- Every system, no matter how well it performs, has at least one constraint that limits its performance described as the system's "weakest link."
- A system can have only one constraint at a time, and that other areas of weakness are "non-constraints" until they become the weakest link.
- A Constraint limits the overall throughput of other components on the line which results in longer cycle times and unused Capacity

[1] Dr Eli Goldratt “The GOAL”

# TOC / Bottleneck

- A bottleneck is a stage in a process that causes the entire process to slow down or stop resulting in a longer overall cycle time and reduced capacity.
- Chokepoint / Weak Link


Investopedia
**Definition** of '**Bottleneck**' A point of congestion in a system that occurs when workloads arrive at a given point more quickly than that point can handle them. The inefficiencies brought about by the **bottleneck** often create a queue and a longer overall cycle time.

## Background

# The System Constraint Can be in Any Area

### Pre-Analytical

Collection

Sort

Label

Centrifuge

Transport

Transport

Decap

Aliquot

### Analytical

Analyze

### Post Analytical

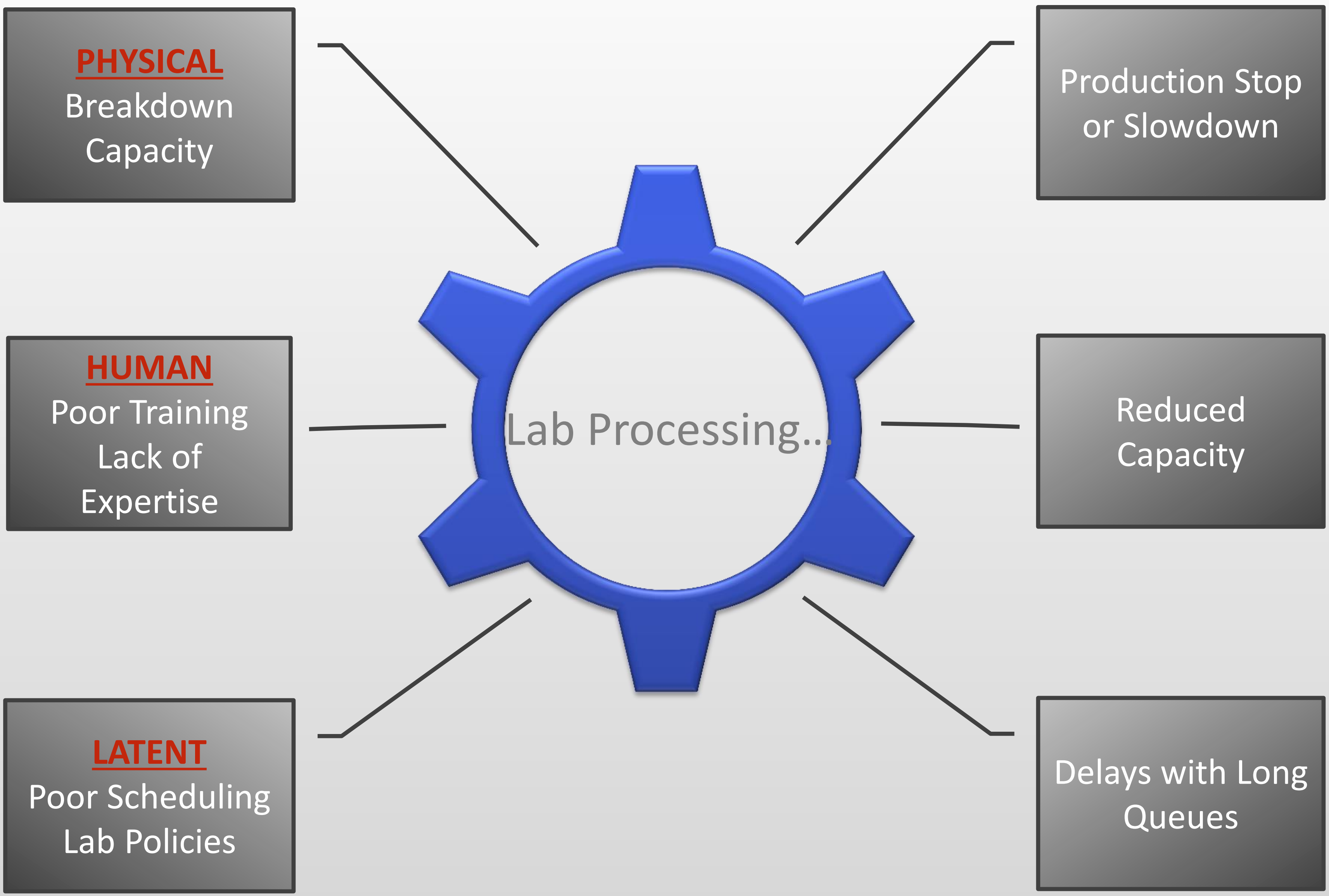
Store / Retrieve

Transport

Seal

# Constraint

# Outcomes



# Process to Identifying the System Constraint

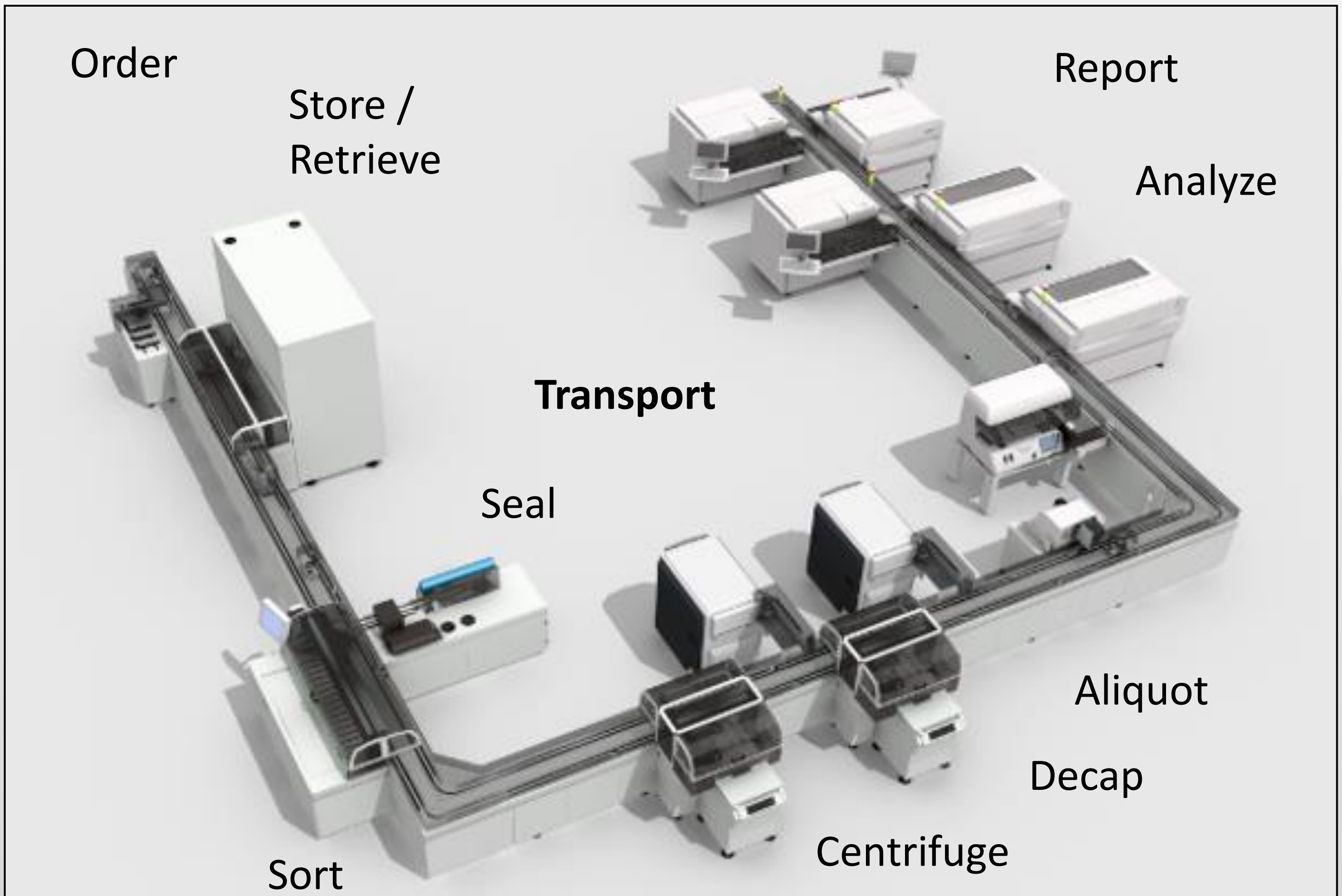
Look for the location where there is an increasing number of tubes in the queue waiting for the next step in the process (WIP)

Collection

Label

Transport

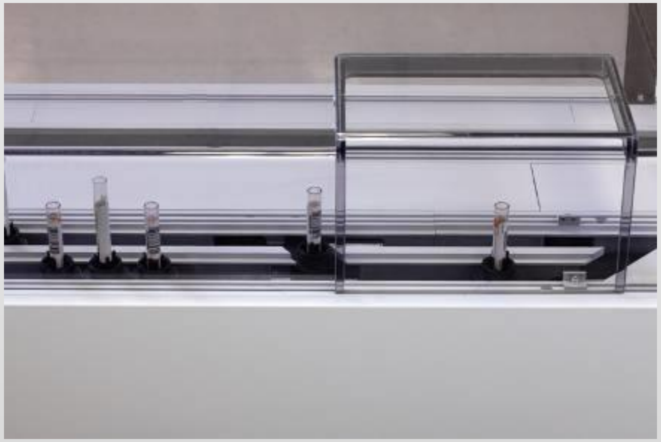
Rack & Load



# Exploit the Constraint

Understand the ‘***Why***’

- Configuration Settings not optimized for the Workload
- Demand Exceeds Capacity
- Like instruments or modules underutilized
- Rejections (barcode misreads, test not assigned)

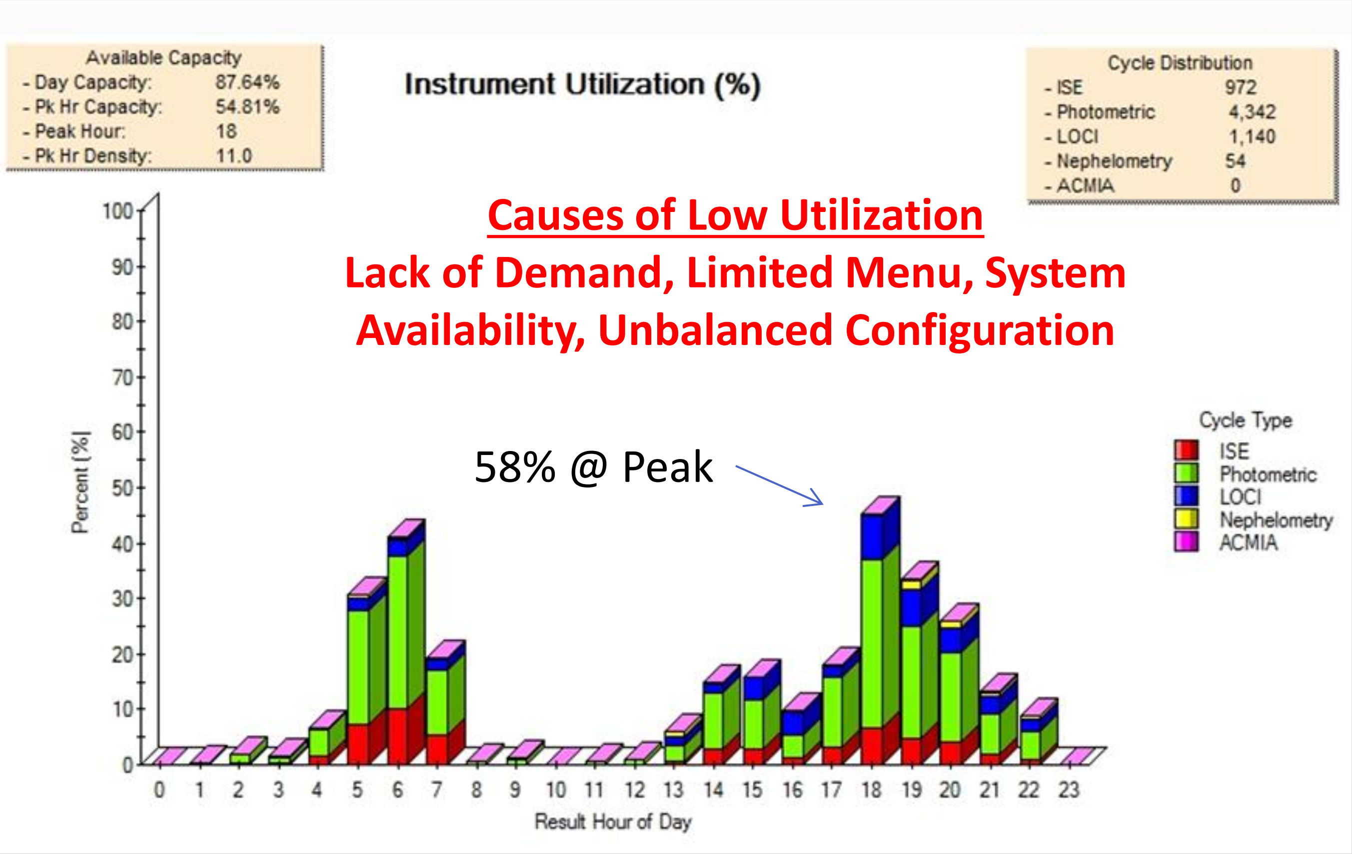


**Tubes continuous going around the track**

# Example

# Utilization

**Utilization** = the rate at which potential output levels are being met or used. Displayed as a percent of actual throughput processed based against known performance of a given component or module.

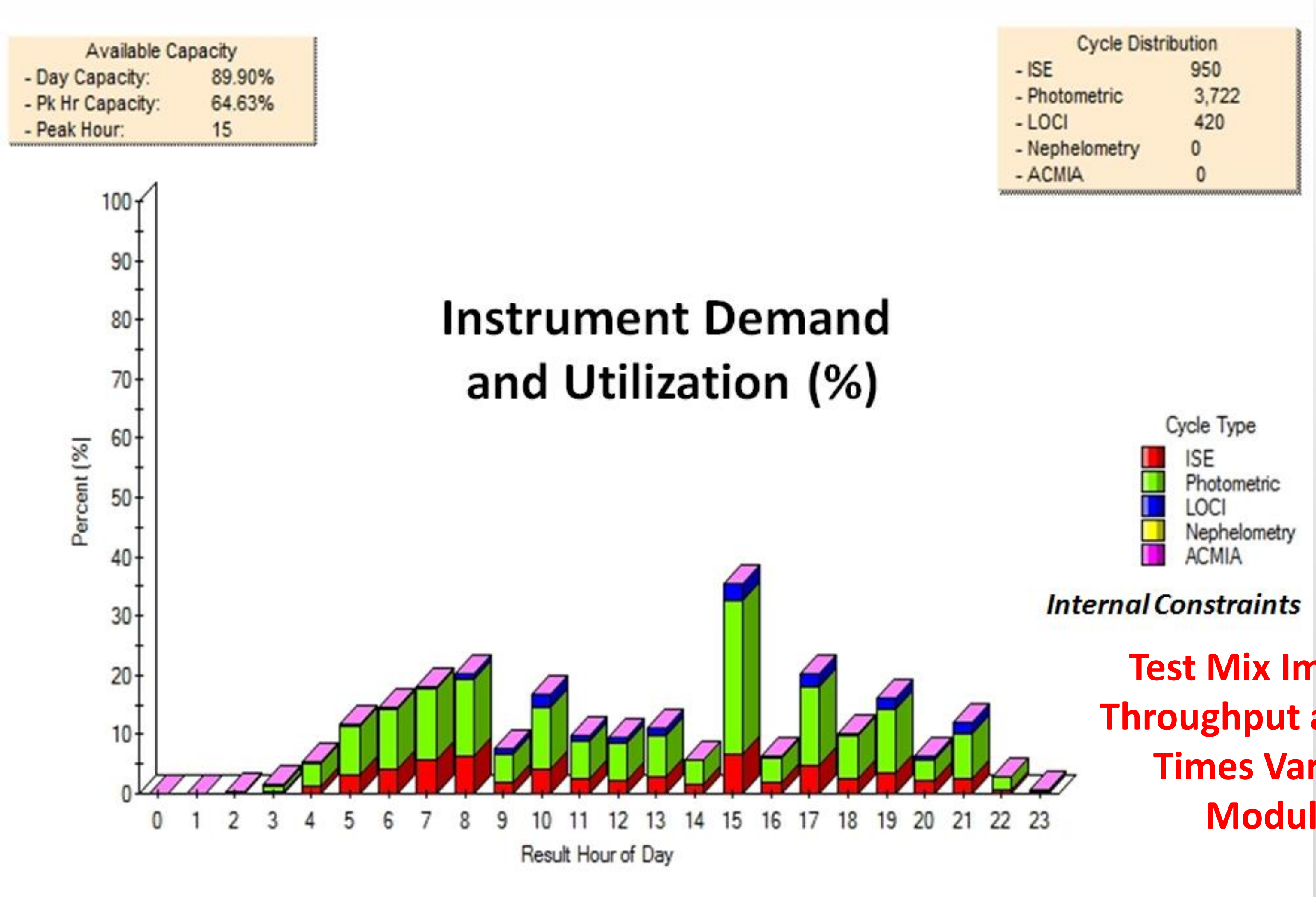



**NOTE**: **Theoretical Claims ≠ Actual Throughput**

Example

# Capacity / Utilization

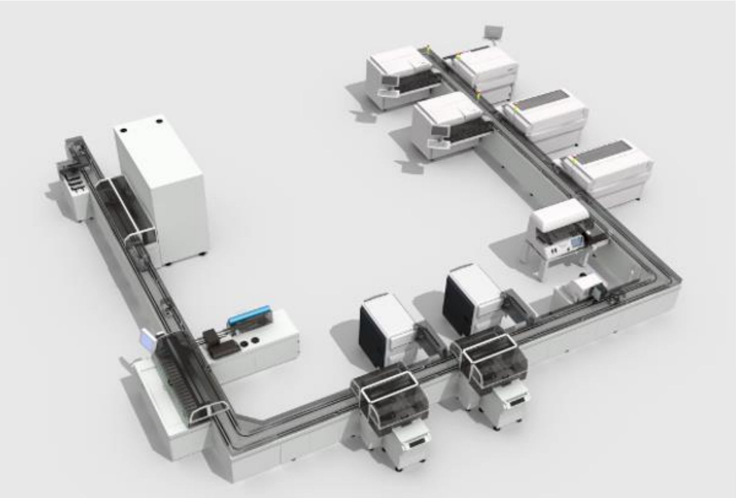
Limited to the Overall System's Constraint which can Change based upon Demand




**Test Mix Impacts Throughput as Cycle Times Vary by Module**

# Lab Automation Constraints

## Cycle Times Vary ≠ Demand



| | Max. Sample Throughput per Hour |
|---|---|
| Input / Output | 800 |
| Centrifuge | 300 |
| Decapper | 800 |
| Bulk Input Module | 1000 |
| Track U Turn | 2100 |
| Track T Turn | 3600 |
| Rack Input Module | 800 |
| Aliquot | 500 |
| Recapper | 800 |
| Refrigerator Storage | 800 |

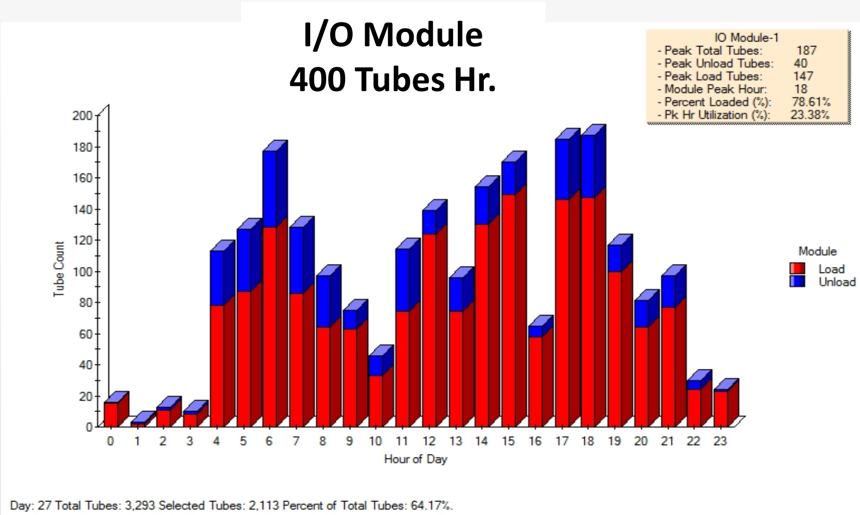
| Instrument Name | Tubes/Hour | Tests/Hour | Sampling Type | Instrument Category | Details |
|---|---|---|---|---|---|
| Tosoh G8 | 37 | 37 | Point of Space | Chemistry | Hemaglobin A1C - HPLC |
| ADVIA 1800 | 200 | 1800 | Point of Space | Chemistry | 18 sec ISE, 3 sec photo |
| ADVIA 2400 | 200 | 2400 | Point of Space | Chemistry | 18 sec ISE, 2 sec photo |
| Alifax Jo Plus | 20 | 20 | Point of Space | Hematology | Automate ESR |
| ADVIA 2120i | 120 | 120 | Pick & Place | Hematology | 2 cycle type CBC, Reticulocyte |
| ACL Top LAS | 100 | 120 | Point of Space | Hemostasis | 2 cycle type |
| CS-5100 | 100 | 400 | Point of Space | Hemostasis | 2 cycle types |
| Liaison XL | 57 | 121 | Point of Space | Immunoassay | 1 cycle type |
| Immulite 2000 | 200 | 200 | Pick & Place | Immunoassay | 5 cycle types 1-Pass, 2-Pass No Pretreat, 2-Pass Pretreat, 3-Pass, 4-Pass |
| Centaur | 240 | 240 | Point of Space | Immunoassay | 4 cycle type, 1 Pass, 1 Pass Extended, 2 Pass, 2 Pass Extended |
| EXL 200 | 67 | 624 | Point of Space | Integrated | 3 cycle type |
| Vista 1500 | 200 | 2000 | Point of Space | Integrated | 3 servers, 5 cycle types |

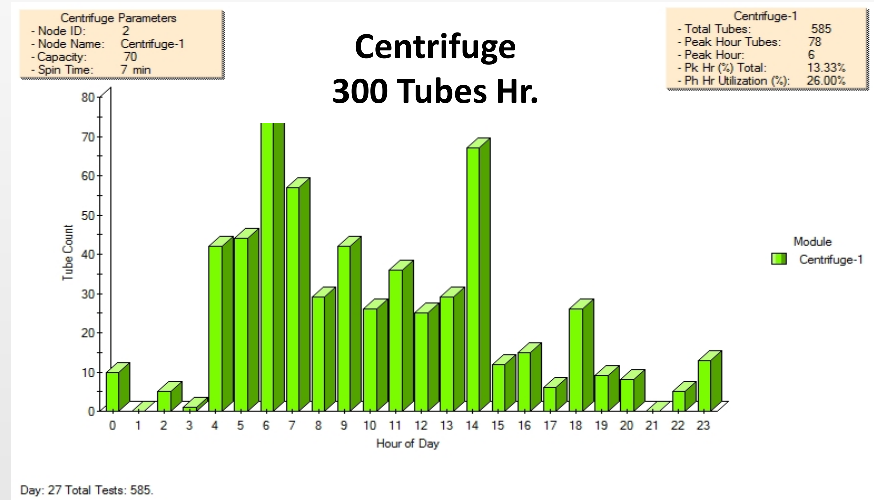
Sources: CAP Today - Inpeco

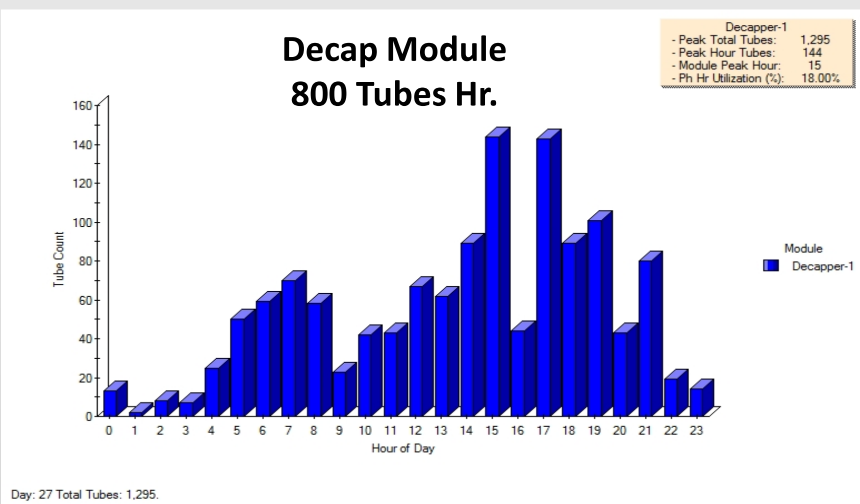
Example

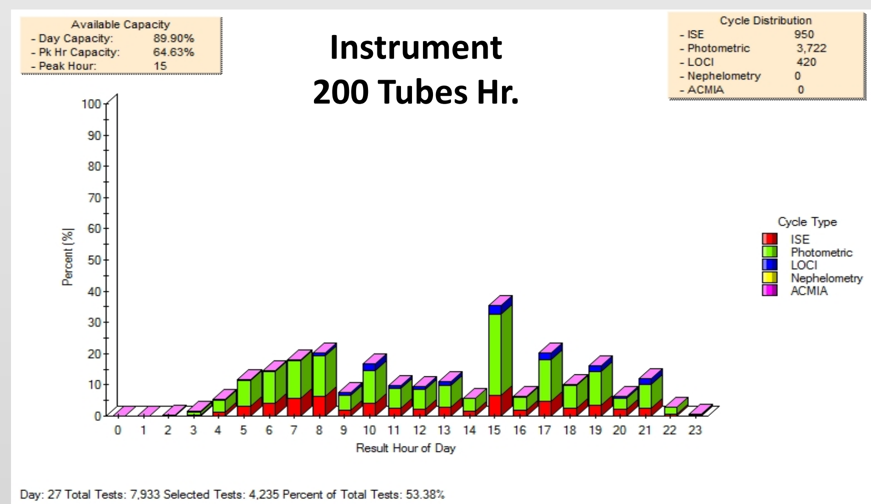
# Module Capacity

## Dependencies: System Design, Configuration and Workloads



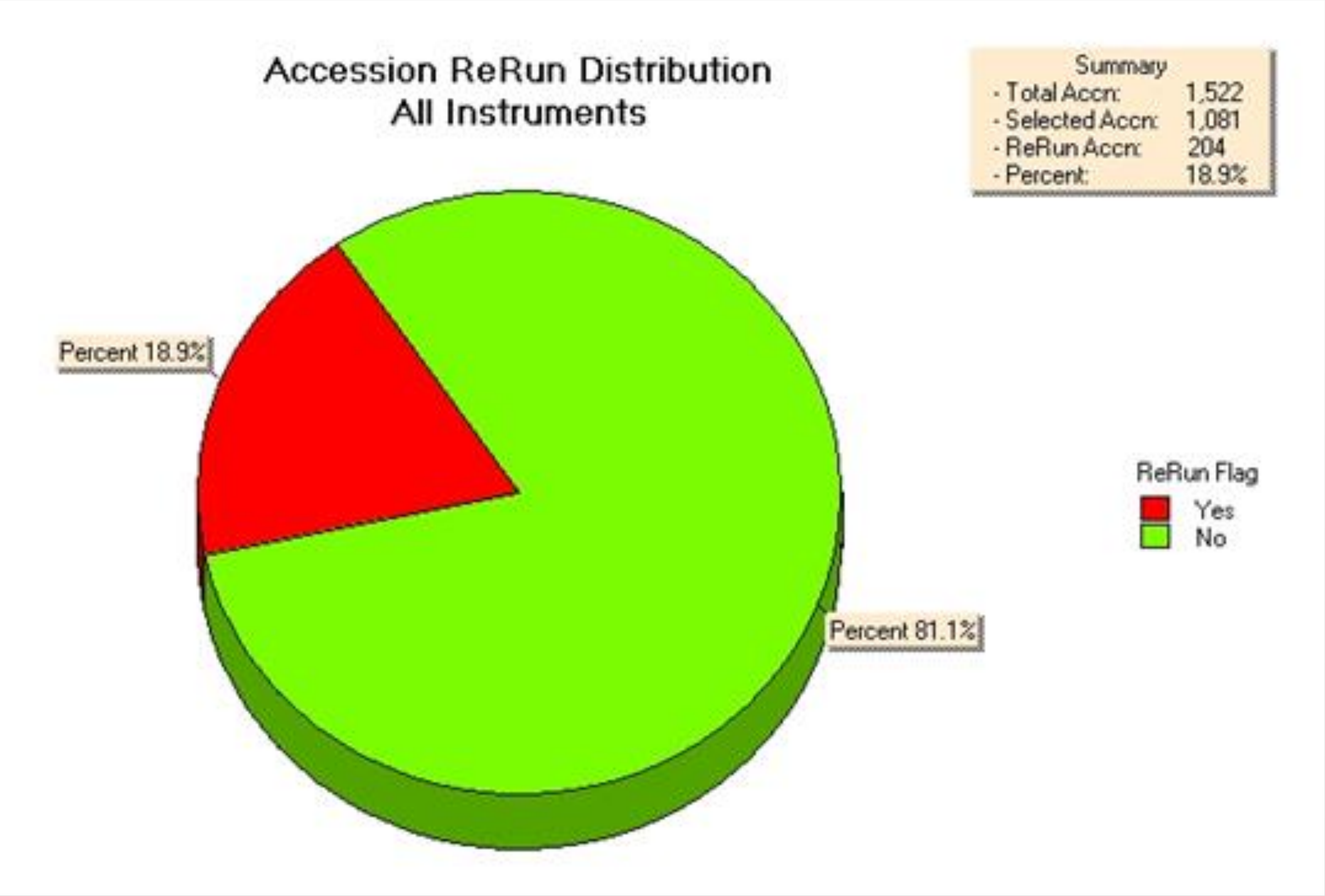



Example

# Repeats: Impact of 'Tight Ranges'

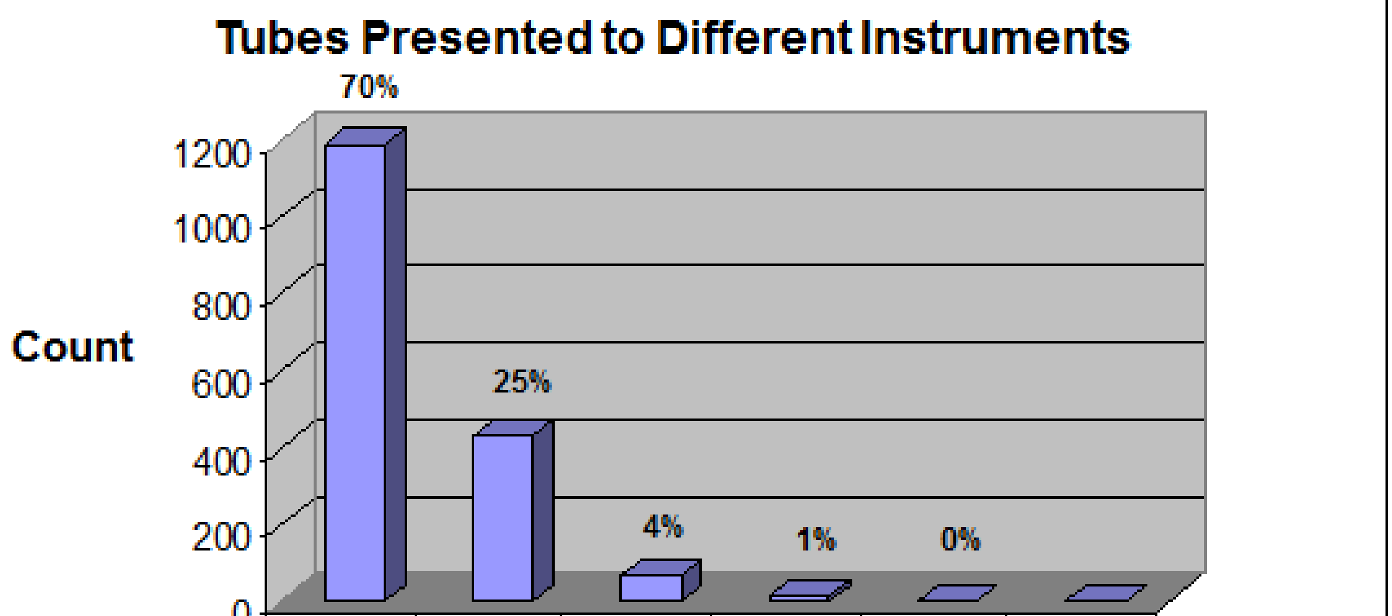
QC Rules resulting in ~ 19% of Accessions Repeated



Example

# Impact of 'Shared Tubes'

**(When Tubes are routed to Different Instruments due to Tests Ordered or Instrument Setup)**




| | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| Total | 1188 | 431 | 70 | 15 | 2 | 1 |

***~30% Reduction in Net Calculated System Throughput***

# Summary: Steps to Manage Constraints

*It's a journey of Continuous Improvement with Perfection Unattainable*

**Identify the Process' Constraint**

Find the Largest WIP Inventory

Explore the reasons as to 'Why'

**Decide how best to Exploit the Constraint**

Optimize Instrument Speed; Add Capacity

Give Maintenance High Priority & Off Peak

**Subordinate everything else to the above Decision**

Let Non-Bottlenecks help the Bottleneck

Everyone work at the Rate of the Bottleneck

**Elevate the Process Constraint**

Add more people or instruments

Train

**Remove the Constraint and Re-evaluate the Process**

New Bottlenecks will emerge

Repeat the Steps

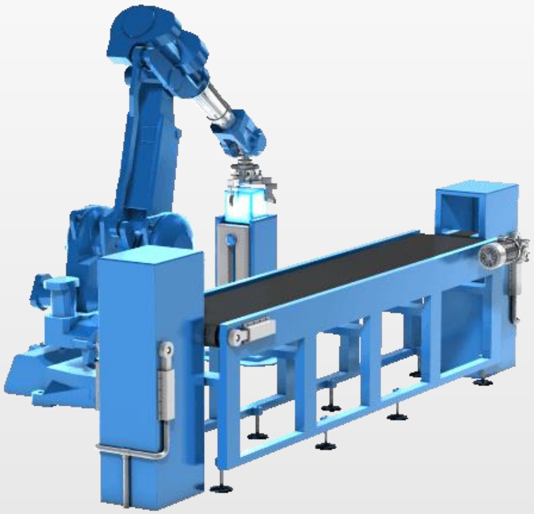
The GOAL – Theory of Constraints

Dr. Eliyahu M. Goldratt 1981

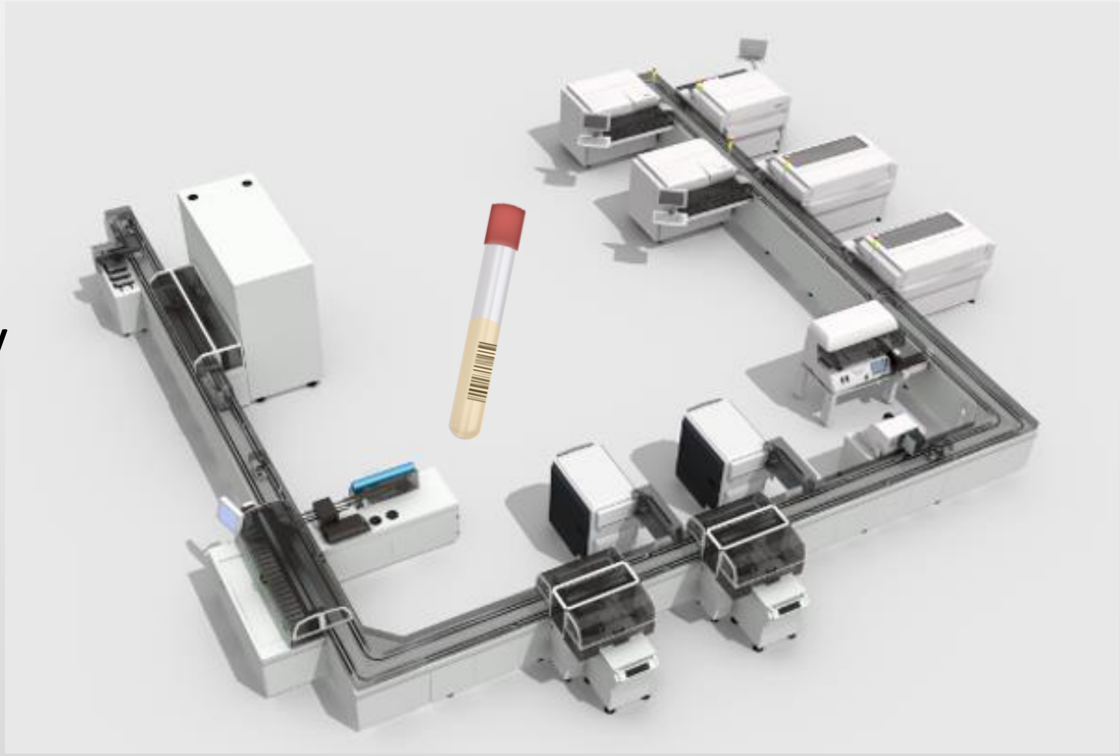
Step 4

# Balanced System

Cycle Time = Demand



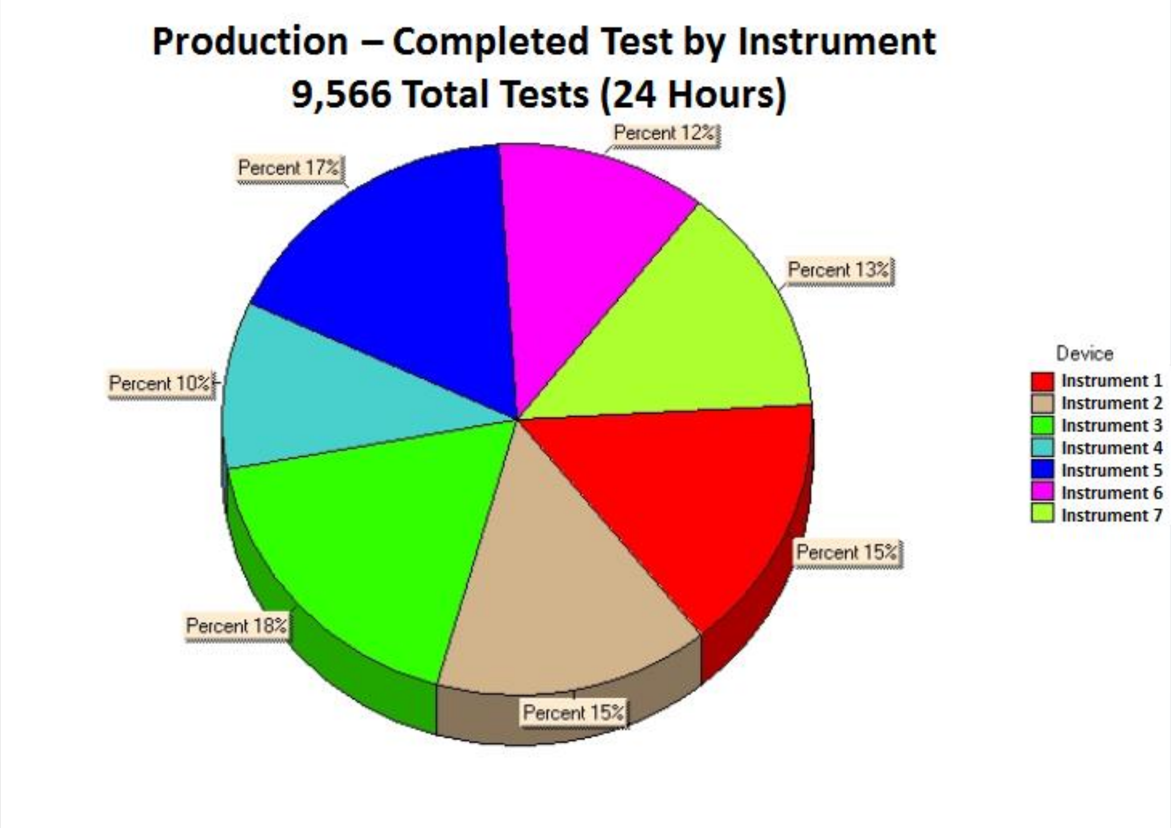
- Maximum Productivity
- Minimum Waste
- High Efficiency
- Predictable TAT
- Smooth Operations



Example

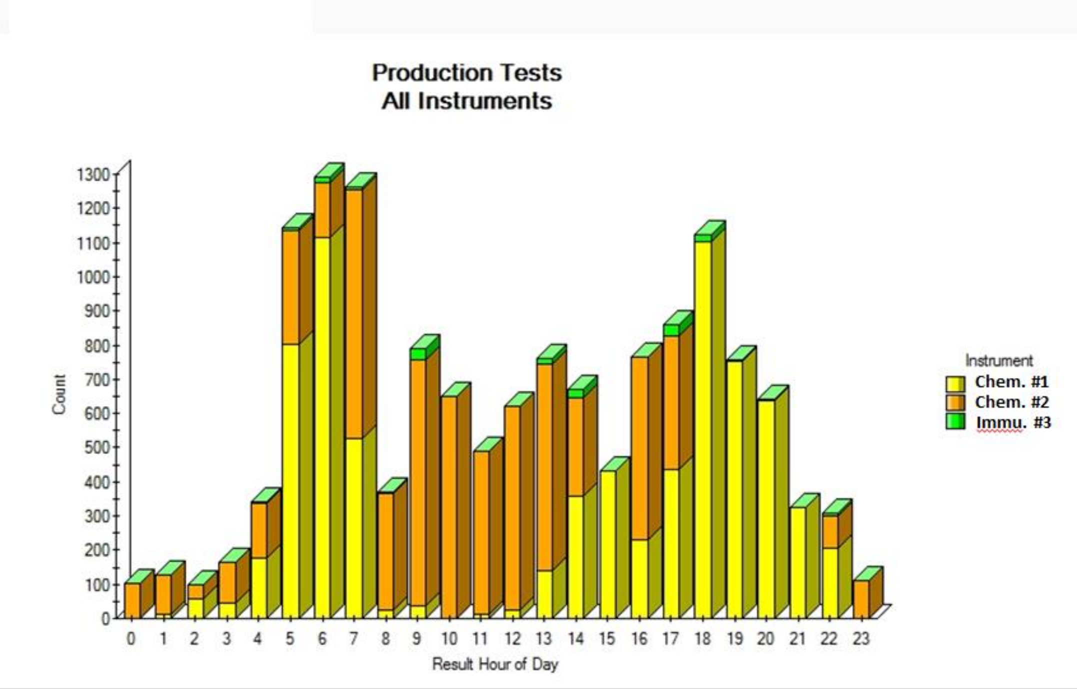
# Balance Workload for Immunoassays in Reference Lab

Accomplished by Configuring Menus on Each Instrument to Achieve Maximum Throughput while meeting TAT



# Common Causes of Unbalanced Workloads

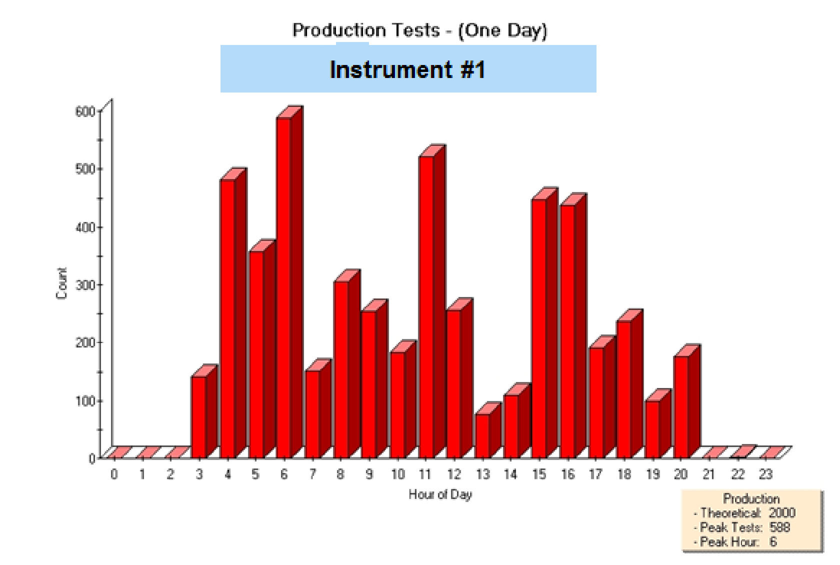
1. **The amount of <u>workload</u> at each operation involved in the overall process.**
2. **<u>Fluctuations</u> in customer demand, which starve or overburden the production process.**
3. **Inability to implement "<u>production smoothing</u>".**

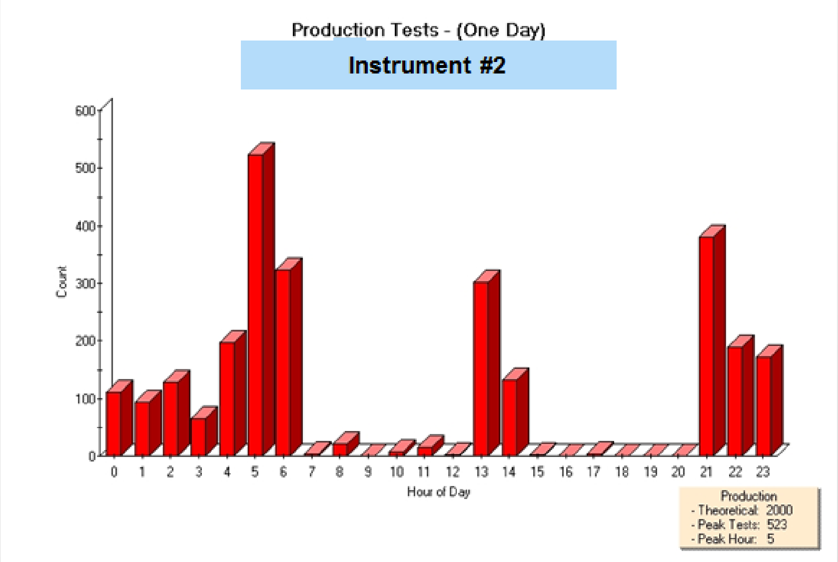


Example

# Like Instruments Not Balanced on a Track

Further analysis required to determine why…




Tests 5,018 of Total Tests 7,688 (Percent 65%)

Tests 2,670 of Total Tests 7,688 (Percent 35%)

# Process to Balance Workloads

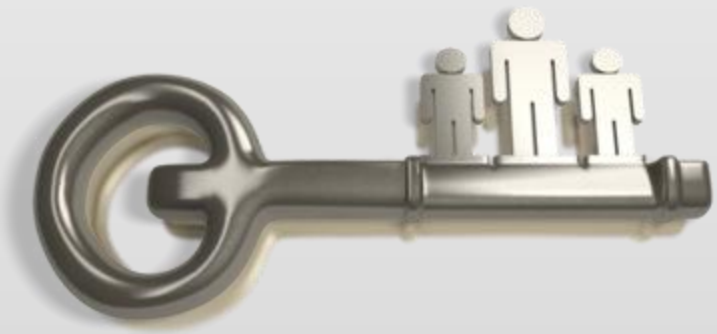

1. Determine customer demand (what’s needed and by when)
2. Implement a workplace organization process, improve process flow, reduce changeover times.
3. Complete time studies on workflows at each workstation
4. Implement a pull system.
5. Evenly distribute the workload between like workstations.
6. Schedule the work in small ‘Kanban’ quantities.

# *Real Time Management of All Operational Domains and Workflows in Your Laboratory*

**Process**

1. Forecast Demand
2. Determine Capacity
3. Exploit Constraints
4. Balance Workloads

<Repeat>




THANK you!