Adding Industrial Engineering to the Lean/Six Sigma Mix: Lessons from More Than Five Years of Continuous Improvement at ARUP Laboratories

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Objectives

- Consider applying industrial engineers in the laboratory.
- Discuss how typical industrial engineering curriculum can be applied to your laboratory.
- Observe real laboratory examples of how industrial engineering principles are creatively applied in context in the laboratory.

Challenges

Employees:	3,000+
Specimens:	30,000–50,000/day
Test Menu:	3,000+ tests and test combinations
Organization:	7 Divisions, 50 labs
ARUP Managed Hospital Labs:	University of Utah and Huntsman Cancer Hospital
Clients:	University hospitals, children's hospitals, multi-hospital groups, major commercial laboratories, group purchasing organizations, military and government facilities

Continuous Improvement History

- A solid background in continuous improvement embraced since inception (1984)
- Provided governance in the early 1990s with a continuous improvement board
- Strives for an integrated environment with an emphasis on standardization and flexibility
- Efforts made to:
  - Physically configure labs to facilitate the flow of specimens
  - Use our workforce as efficiently as possible
  - Ensure our processes maximize efficiency

Continuous Improvement History

- Found merit in LEAN philosophies with specific projects
- Used industry consultants, including industrial engineers, and regularly found a lack of laboratory context
- In mid-2000s decided to bring in industrial engineers as full-time employees
- Industrial engineers have come to understand the laboratory and are able to apply LEAN in context

Barriers

Some asked:

- What do industrial engineers or manufacturing engineers know about laboratories?
- Laboratories are not manufacturing or industrial plants.
- We do not make a widget.
- How will the expertise or training of an industrial or manufacturing engineer apply to my laboratory?

Typical Engineering Curriculum

Industrial Engineering

- Statistics
- Manufacturing Design & Processes
- Manufacturing Systems
- Industrial Engineering Design
- Simulation
- Production Planning and Control
- Cost Analysis
- Materials Handling
- Automated Manufacturing

Manufacturing Engineering

- Quality Systems
- Process & Systems Design
- Manufacturing Systems
- Design for Manufacturing
- Manufacturing Simulation
- Project Management
- Engineering Economics
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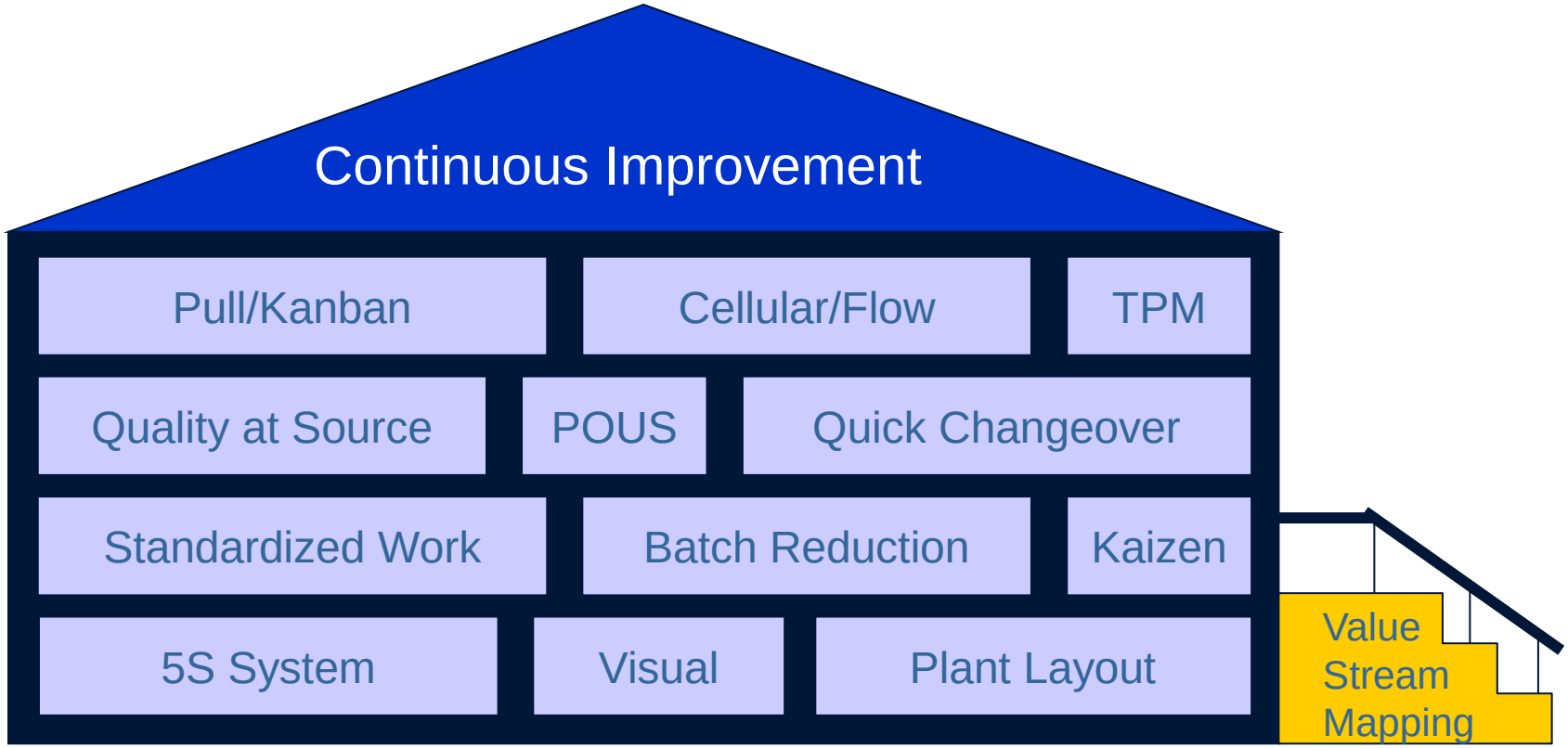
Process Design

House of LEAN



All-or-Nothing Philosophies

"LEAN does not simply work by employing one or even a couple elements of the LEAN philosophy."

—J. Oliver, Ball State University

"The key to making the transition to a LEAN organization is the fundamental change in the corporate culture that must be made."

—Infor Healthcare Essentials

Roadblocks to LEAN Laboratories

- Laboratories are different than other industries.
- LEAN cannot be applied to the laboratory out of context.
- Quality must be a priority over efficiency in the laboratory.

Our LEAN Philosophy

"Sadly, we've watched other firms set off full of vision, energy, and high hopes, but make very little progress because they went tearing off after perfection in a thousand directions. Select the two or three most important steps…defer the other steps until later…doing one thing at a time…until completion…."

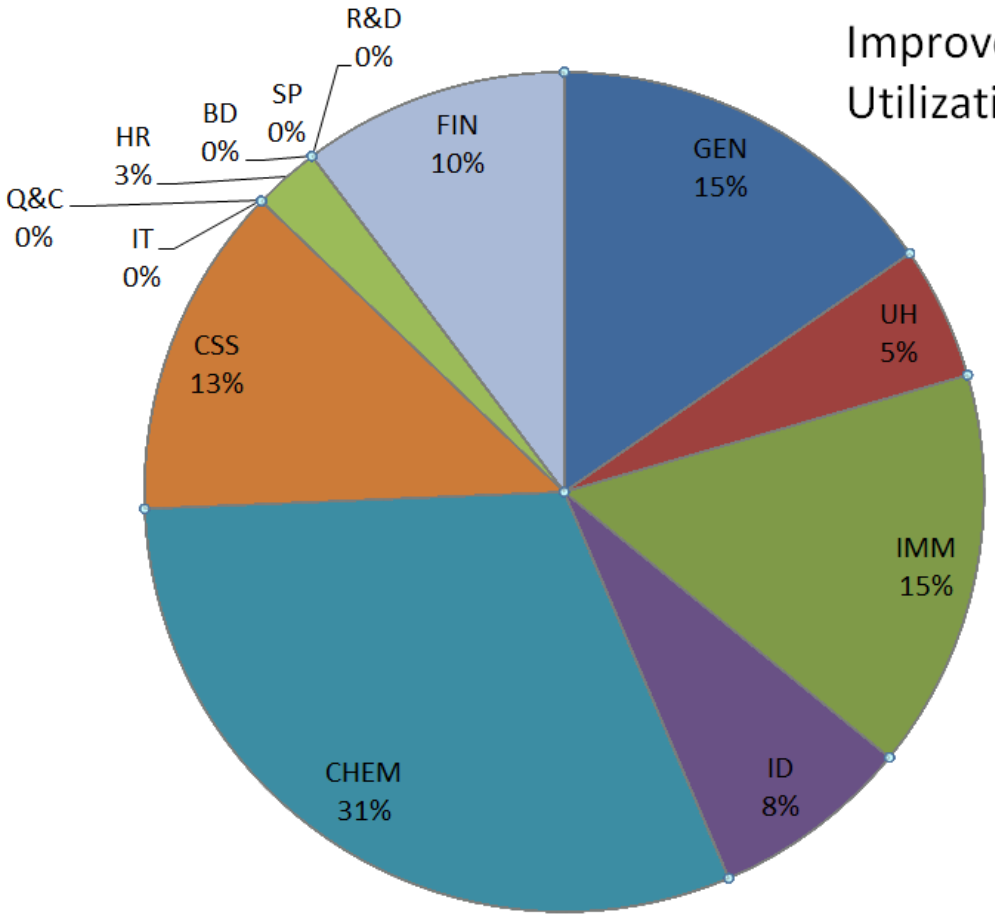
—*Lean Thinking: Banish Waste and Create Wealth in Your Corporation*, Womack and Jones

Leadership in the Lab

- Seven division managers and 25 group managers have the responsibility to continuously improve their laboratories.

- Meet with division managers and group managers quarterly to consider how improvement engineering is or can better assist them in their areas of responsibility.

Engineering Utilization



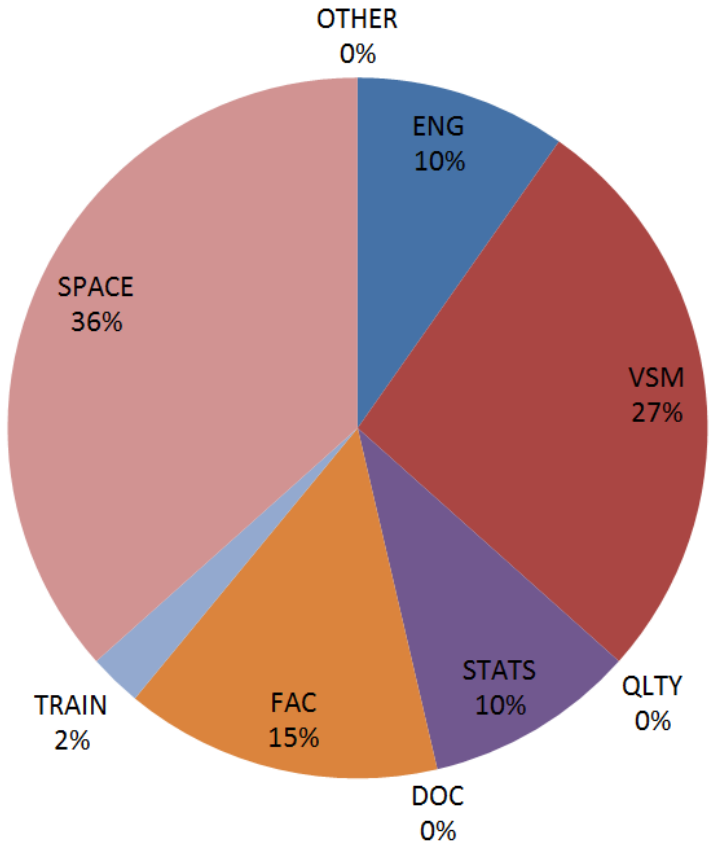
Snapshot of whom we are helping

Resource Utilization

Types of Offerings

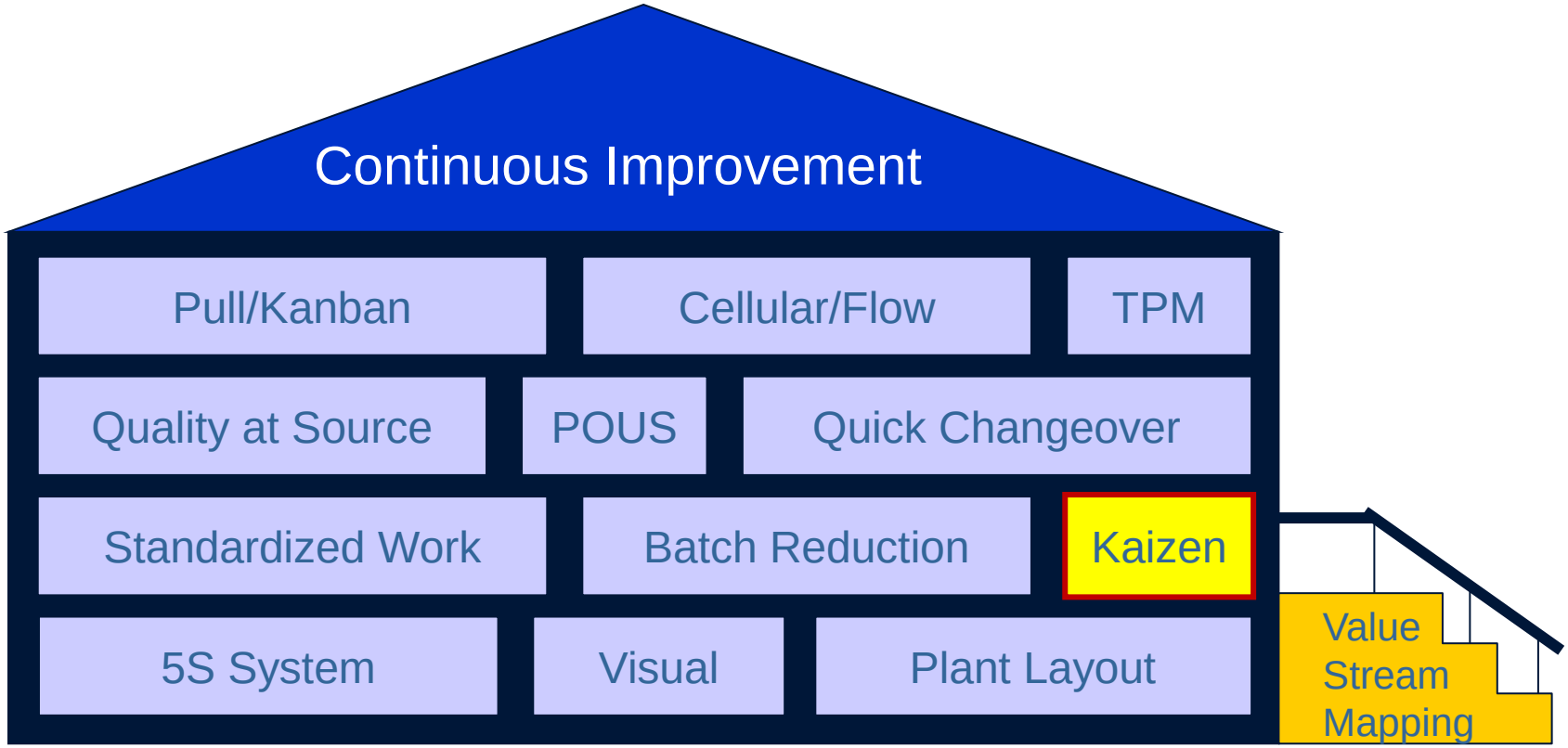
- Space
- Waste elimination
- Facilitation
- Statistical analysis
- Small tool engineering
- Training
- Quality
- Documentation
- Other

Utilization by Resource

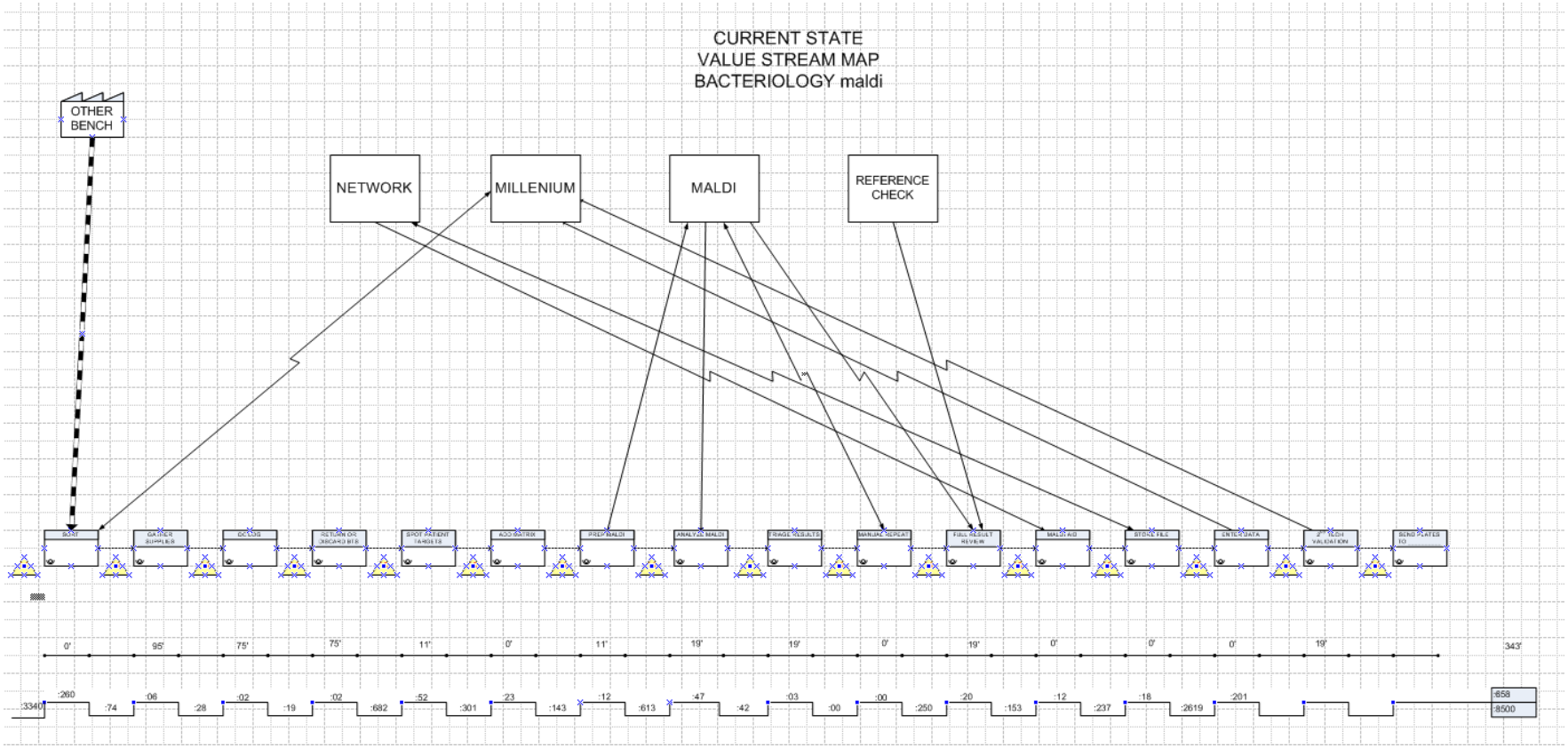


Manufacturing Design & Processes

House of LEAN

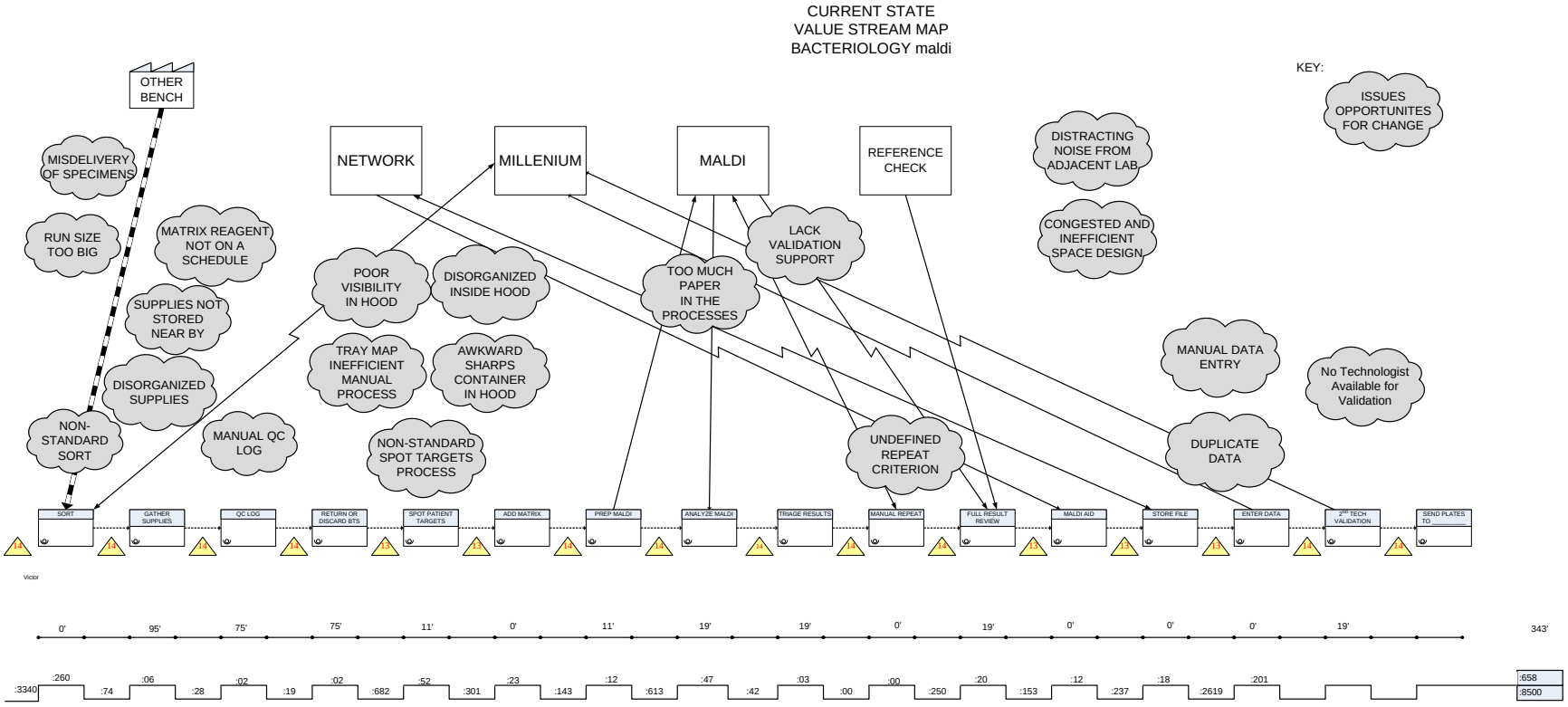


Waste-Elimination Events



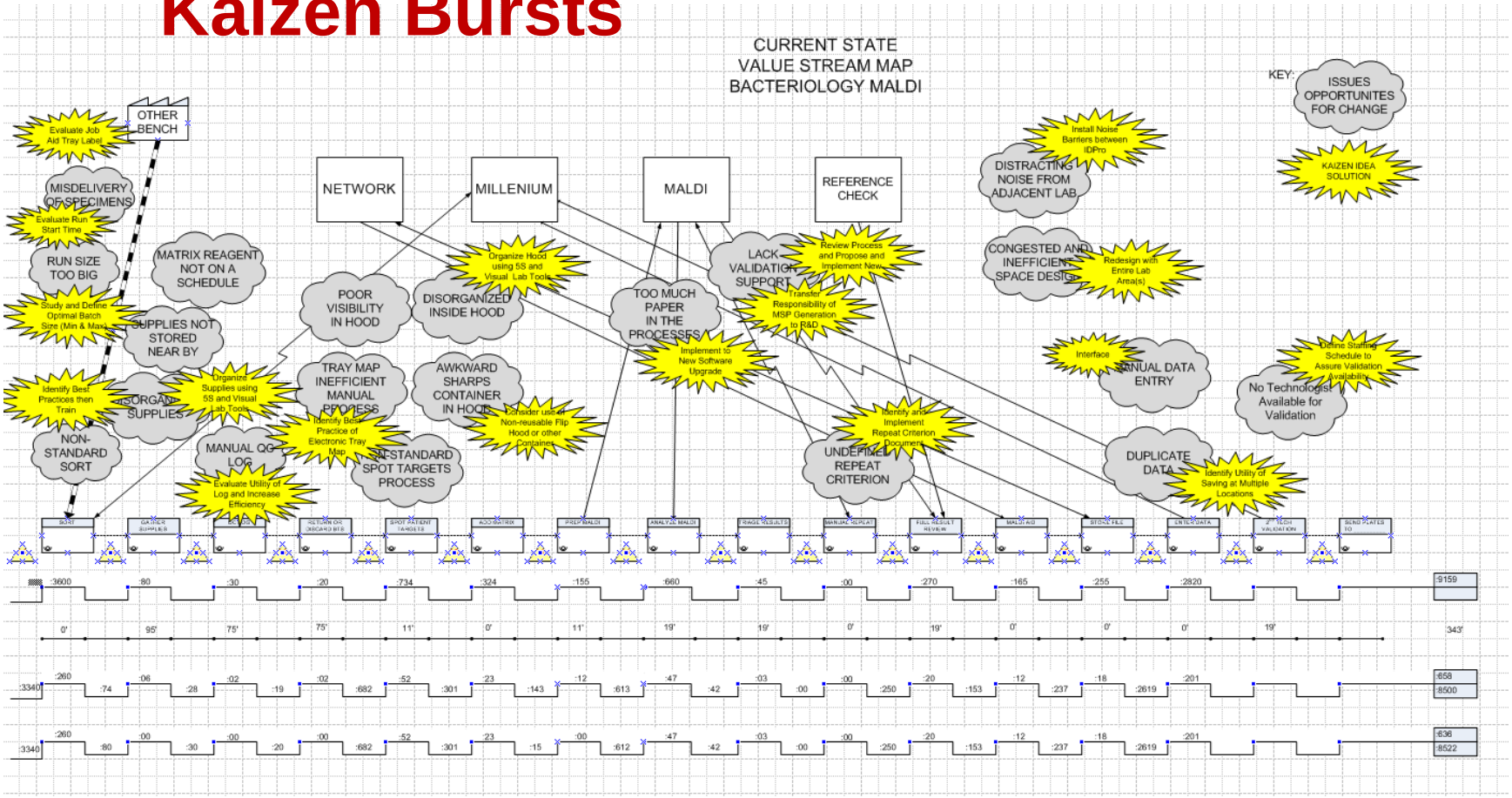
Waste-Elimination Opportunities

Trouble Bubbles



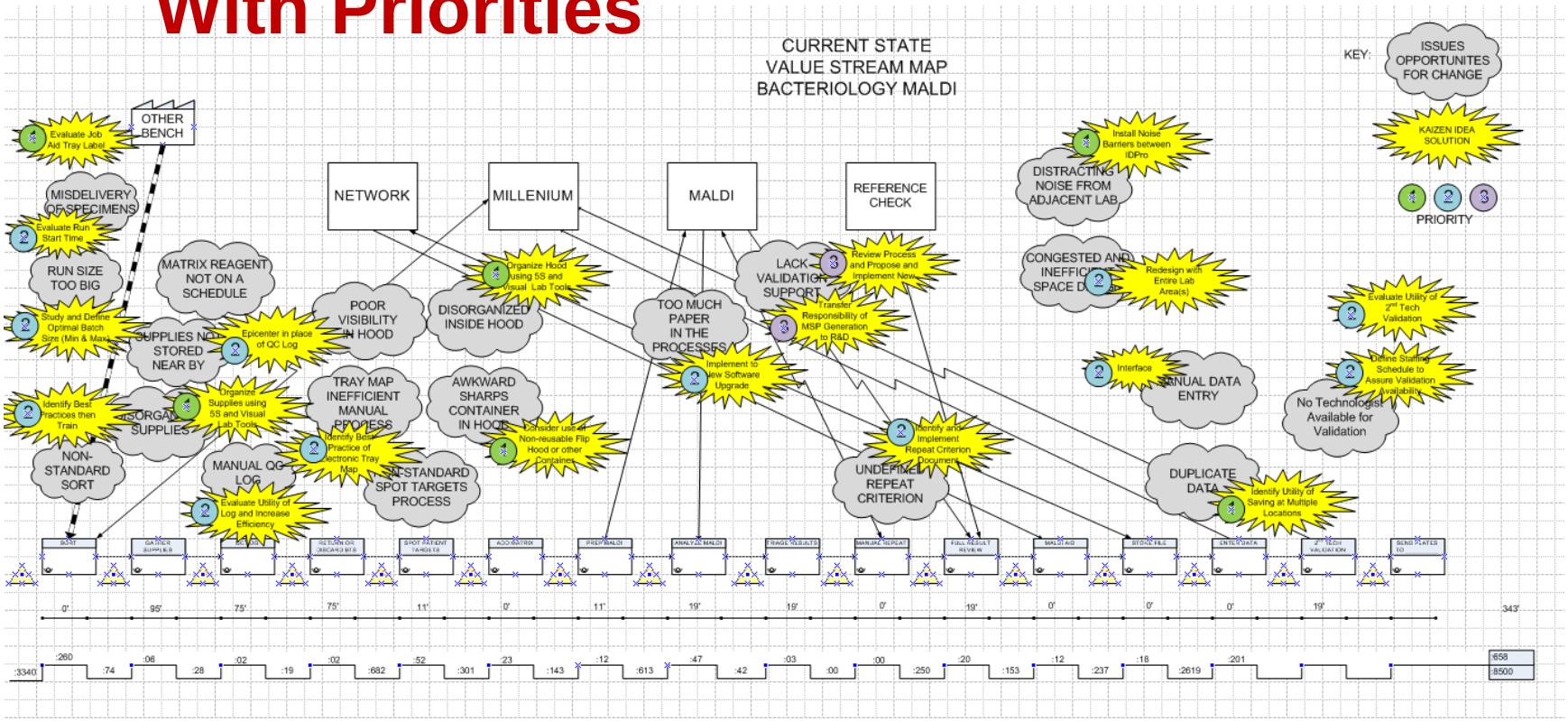
Waste Elimination: Kaizen

Kaizen Bursts



Waste Elimination: Kaizen Priorities

With Priorities



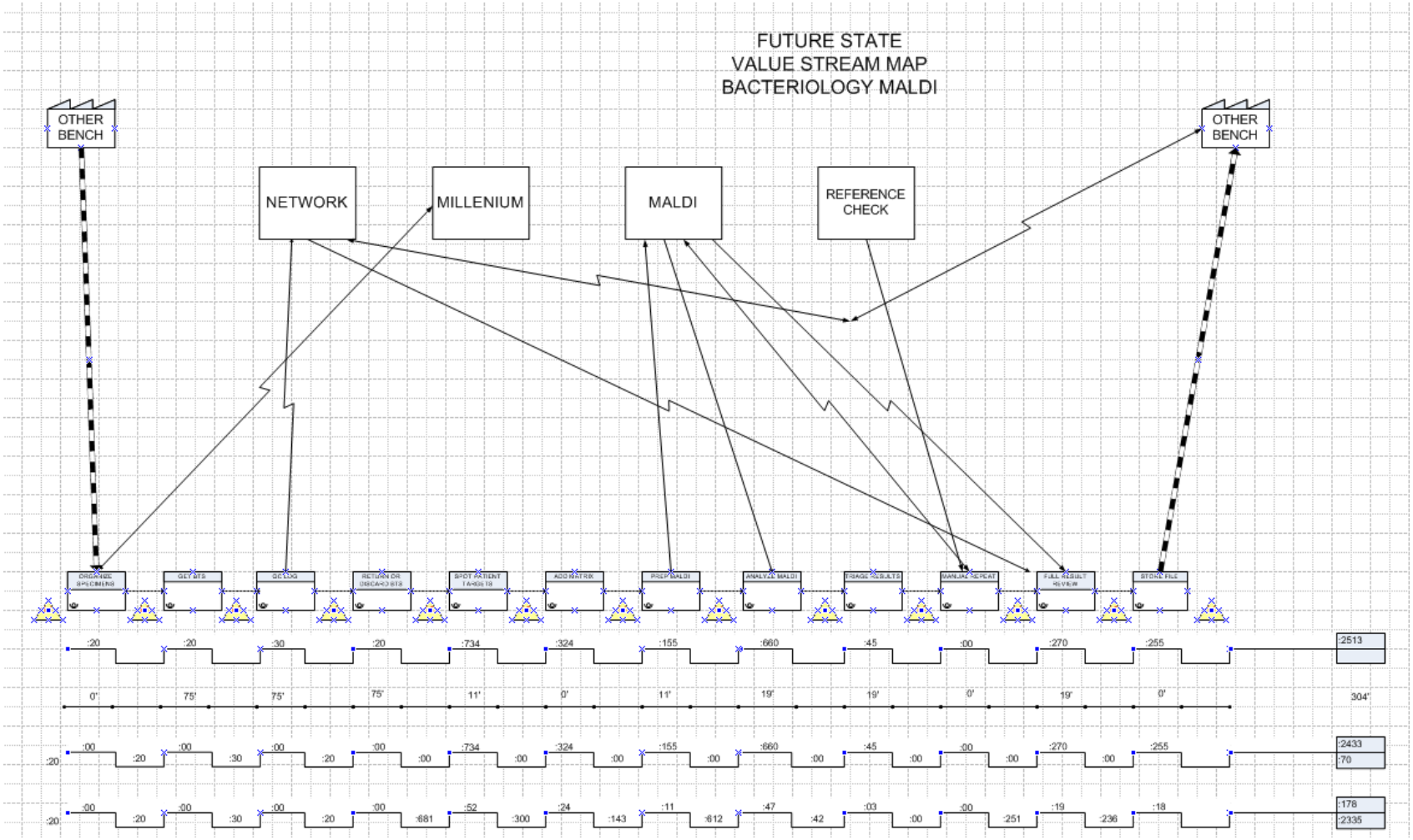
Kaizen Priorities with Assignments

MALDI process review 8/13/13

Issue Identified	Improvement Ideas	Comments	Priority	Assignment
Misdelivered Specimens	evaluate tray labeling	look for improvement opportunities	1	Robert
	Add to specimen process job aid		1	Robert and Susan
	Education of Techs		1	Robert
Disorganized supplies	5S Tools evaluation	use visuals and labels; potential to reorganize lab space	1	Dave Layton and Diana Hall
Disorganized hood	Same as "disorganized supplies"		1	Dave Layton and Diana Hall
Poor Visibility in the hood	Light and magnifications	Robert to investigate small lighted magnifier; future new hood	1	Dave Layton and Diana Hall
Awkward sharps container in the hood	New size sharps container	eliminate large container that has to be tipped	1	Dave Layton and Diana Hall
Supplies not stored nearby	keep tips, toothpicks in the hood		1	Dave Layton and Diana Hall
Distracting Noise from adjoining lab	Add in additional barrier	Dave Layton and Diana Hare in process. Additional measurement of before and after barrier needs to be conducted.	1	Dave Layton and Diana Hall
Duplicate Data	Identify what data is required/needed	create one process	1	Robert
Matrix reagent not on a schedule	Make it every Monday	Identify appropriate volume, make scheduled assignment, also applies to BTS	1	Robert
No Tech available for validation	Eliminate 2nd QC review	Susan to collect feedback from the techs to determine usefullness. Do they go back and use the information?	1	Susan
	Define availability for validation process/ schedule for verification	being fully staff will help this issue	2	Robert
Run Size too big	Study and define ideal run size	minimum and maximum,	2	Robert
	Define ideal run times/days of week	days of week and run start times, gather data for MCORG	2	Robert
Non-Standard sort	Identify the most efficient way to sort	Seek input from staff at staff meeting; train to best practice		Robert and Dave Layton
Tray map inefficient - manual process	Software upgrade solution (in process)	Identify best practice and train staff	2	Robert and Joe Wiggins
Non Standard spot target process		May also be improved by software upgrade, could be improved by monitor on an arm near or in hood and a wireless barcode scanner	2	Robert and Joe Wiggins
Too much paper in the process	move to new software	eliminate paper and handwriting process	2	Robert and Joe Wiggins
Elininate Manual Data Entry	Software interface		2	Robert and Joe Wiggins
	Log QC info in EpiCenter	Copy Mycology process	2	Robert and Anita N.
Undefined repeat criterion	Identify Criteria	needs to include the score of what to result or send to sequencing, requires gathering data and put in writing (SOP)	2	Robert
Conjested and inefficient space design	5S review (lean)		2	Dave Layton and Diana Hall
Lack of Validation support	Realtime updates to database	only 6 per day can be entered; can we transfer the responsibilitiy of MSP generation to R&D for a speedier streamlined process	3	Robert, Managers and MDs

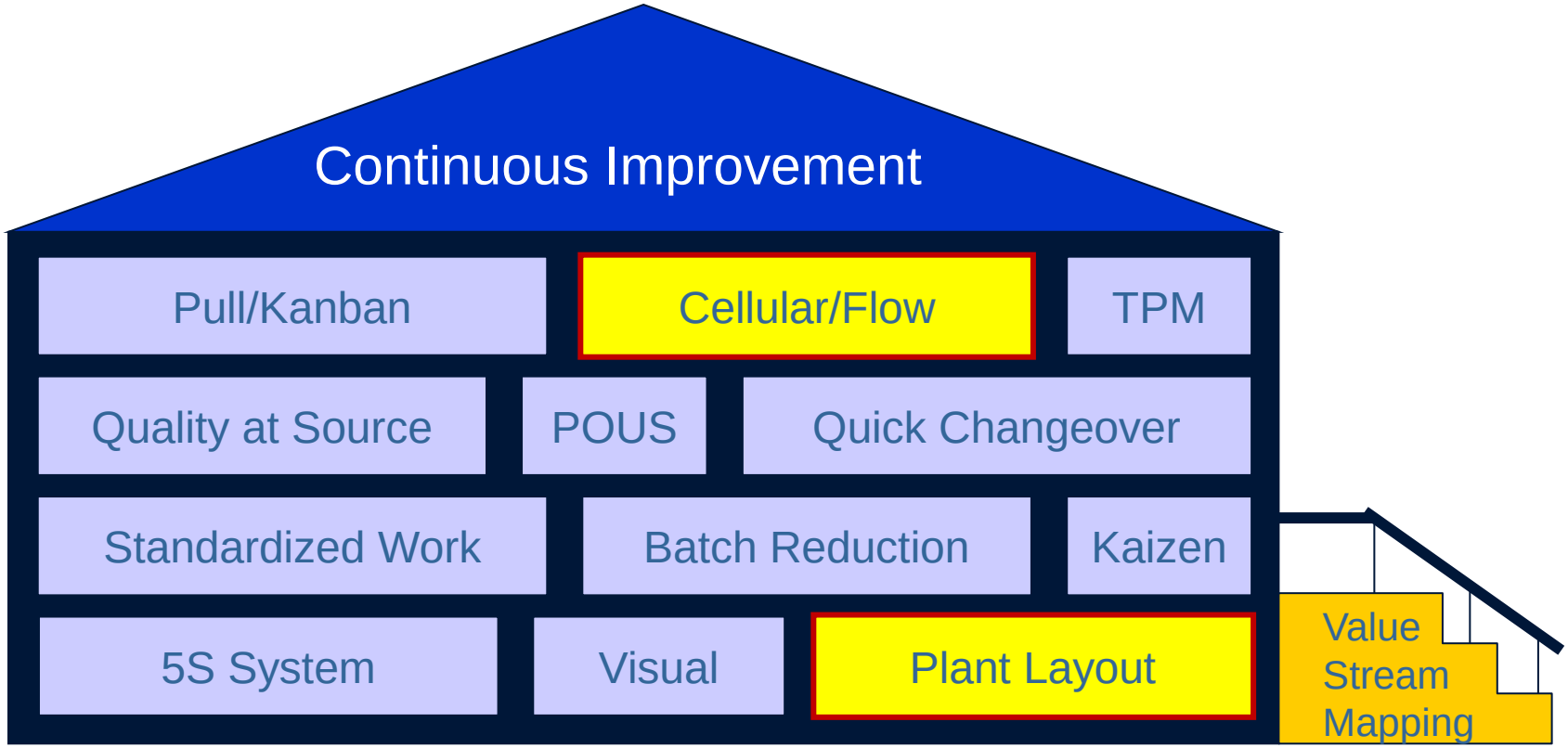
Note that two of the high priority tasks included 5S and Visual Tools.

Waste Reduced

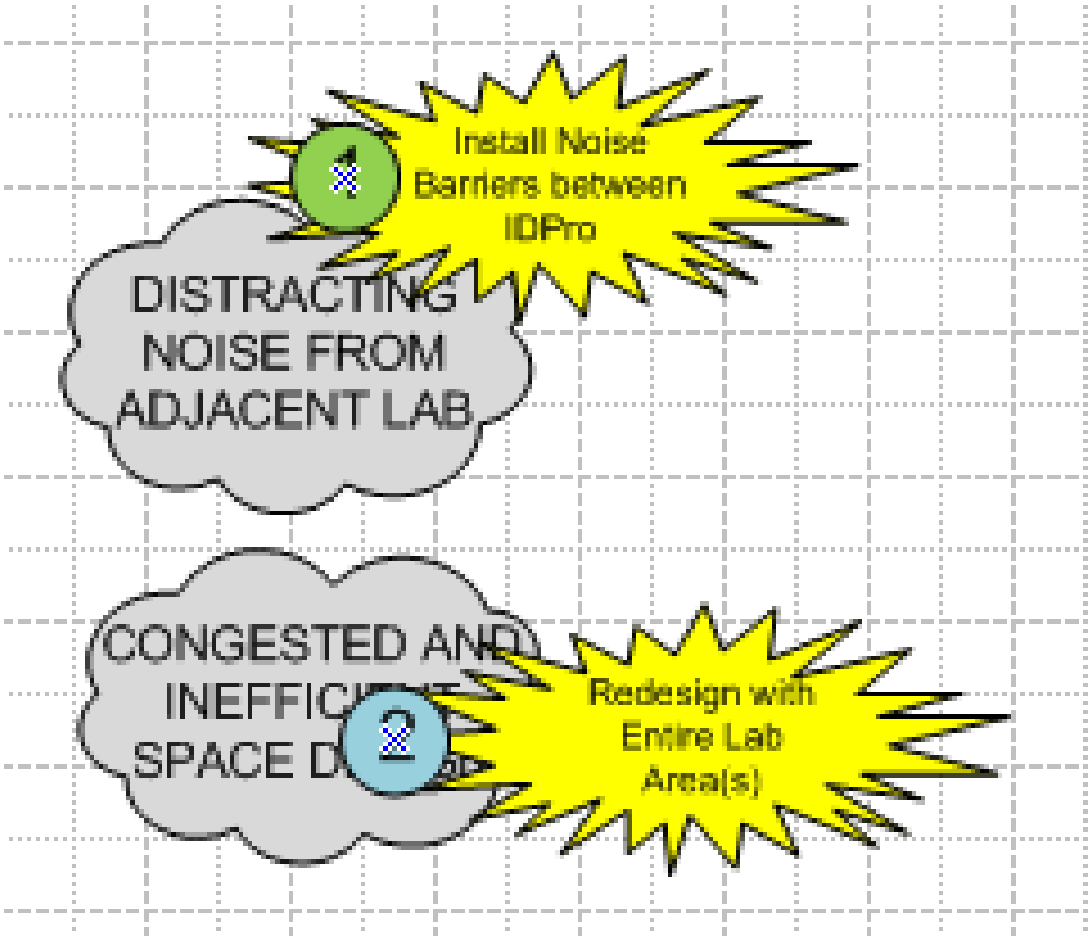


Manufacturing Design & Processes

House of LEAN



Space Design

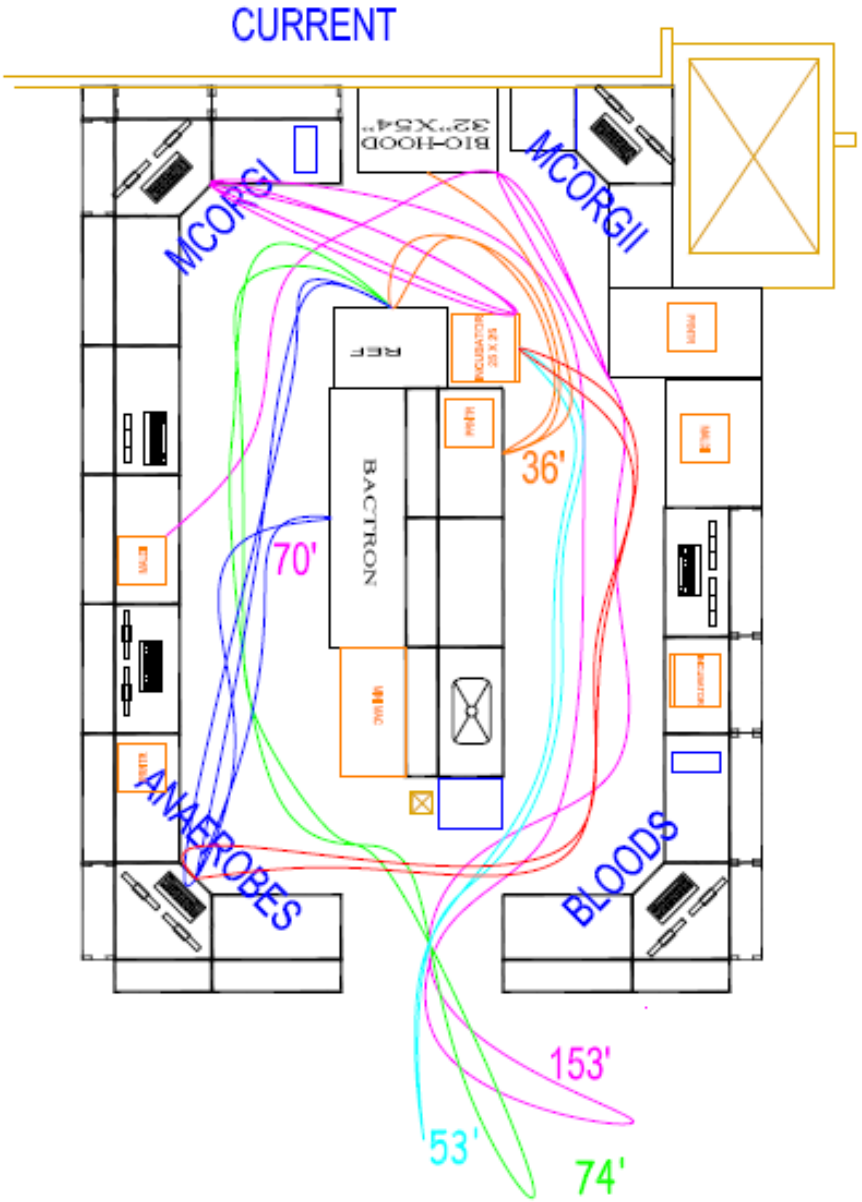


Facilities Organization Umbrella

- Skilled with 2D CAD space layouts
- Industrial engineers able to manipulate the facilities drawings
- Design with efficiencies in mind
- Hand off to construction manager
- Member of corporate space committee

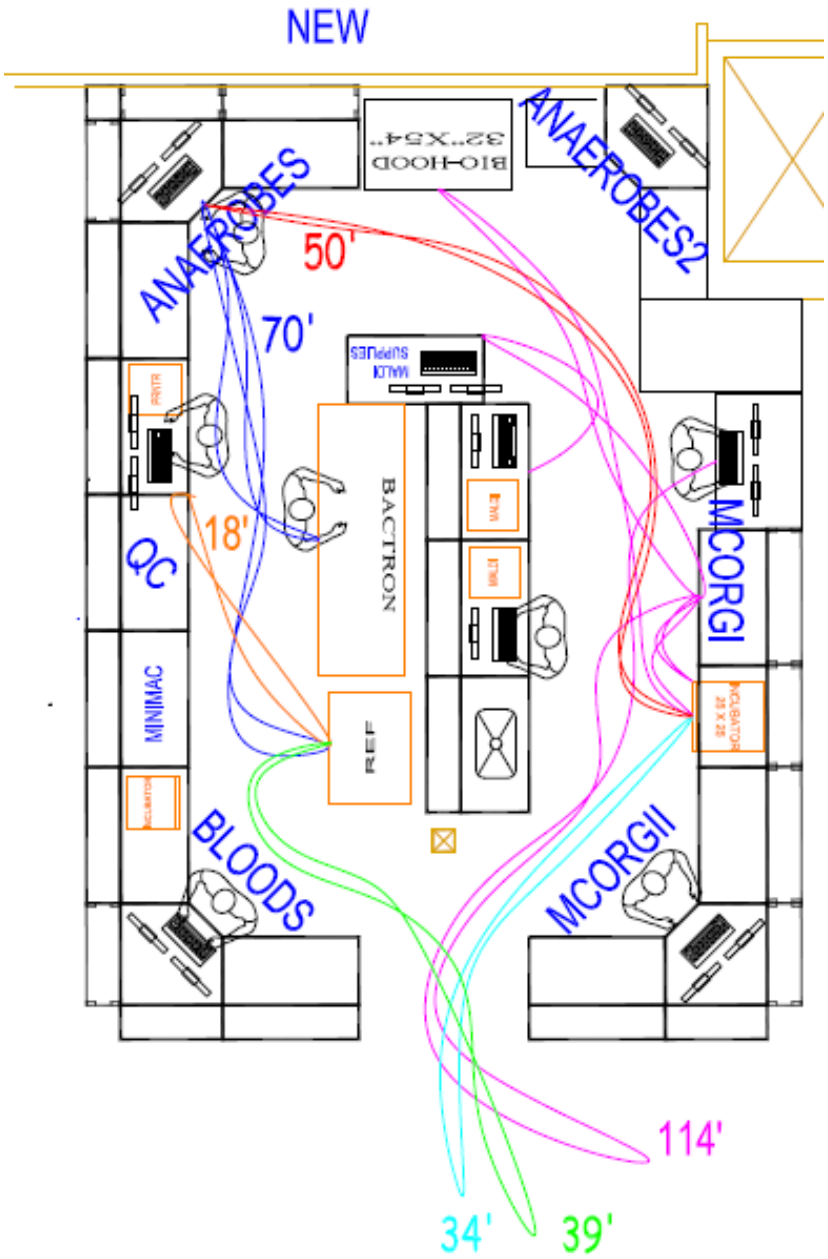
Current Layout with Traffic Flow

Typical lab reconfiguration



New Layout with Traffic Flow

Traffic in lab reduced by 29%



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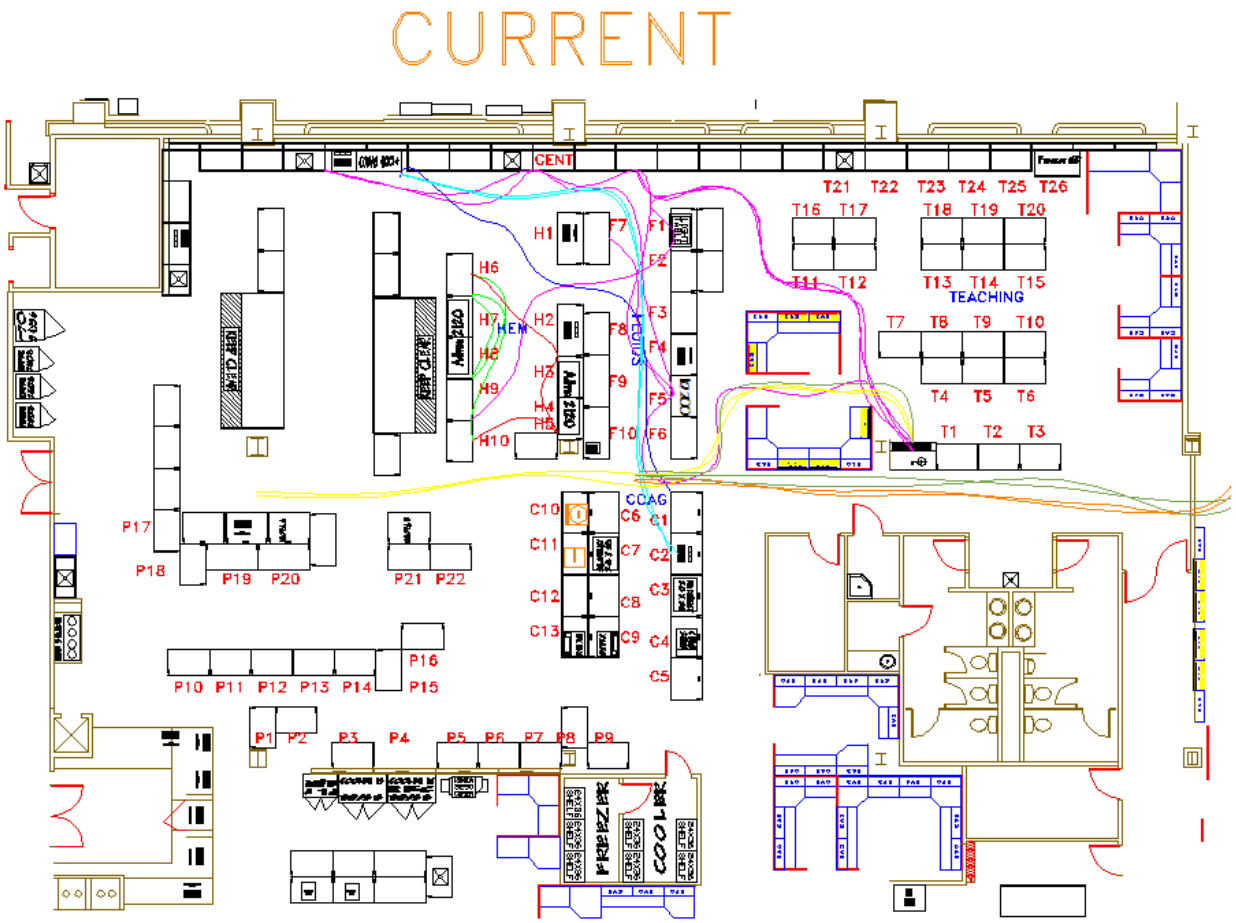
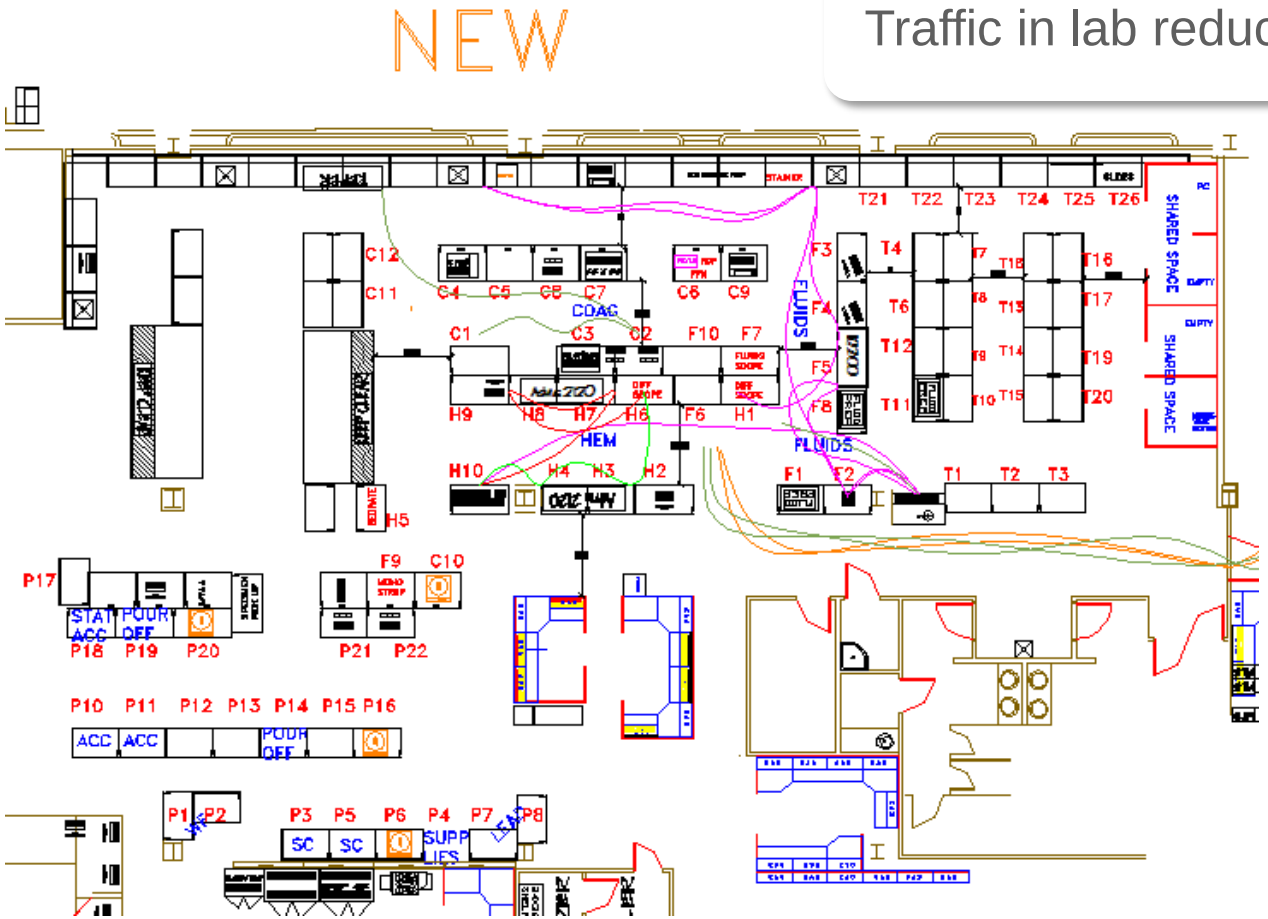


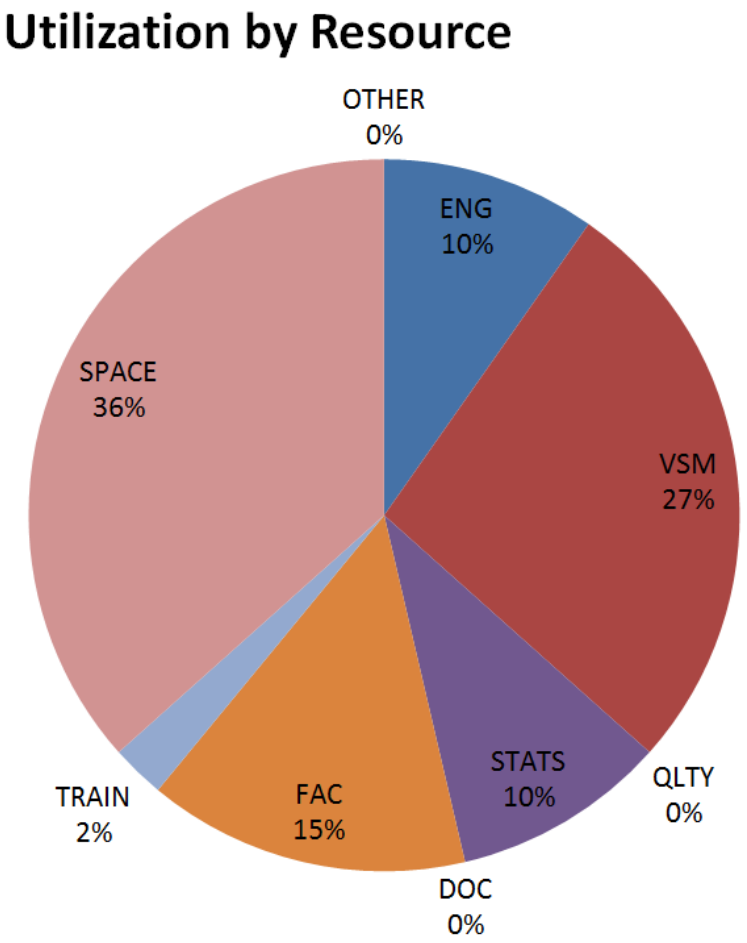
New Layout with Traffic Flow



Traffic in lab reduced by 27%

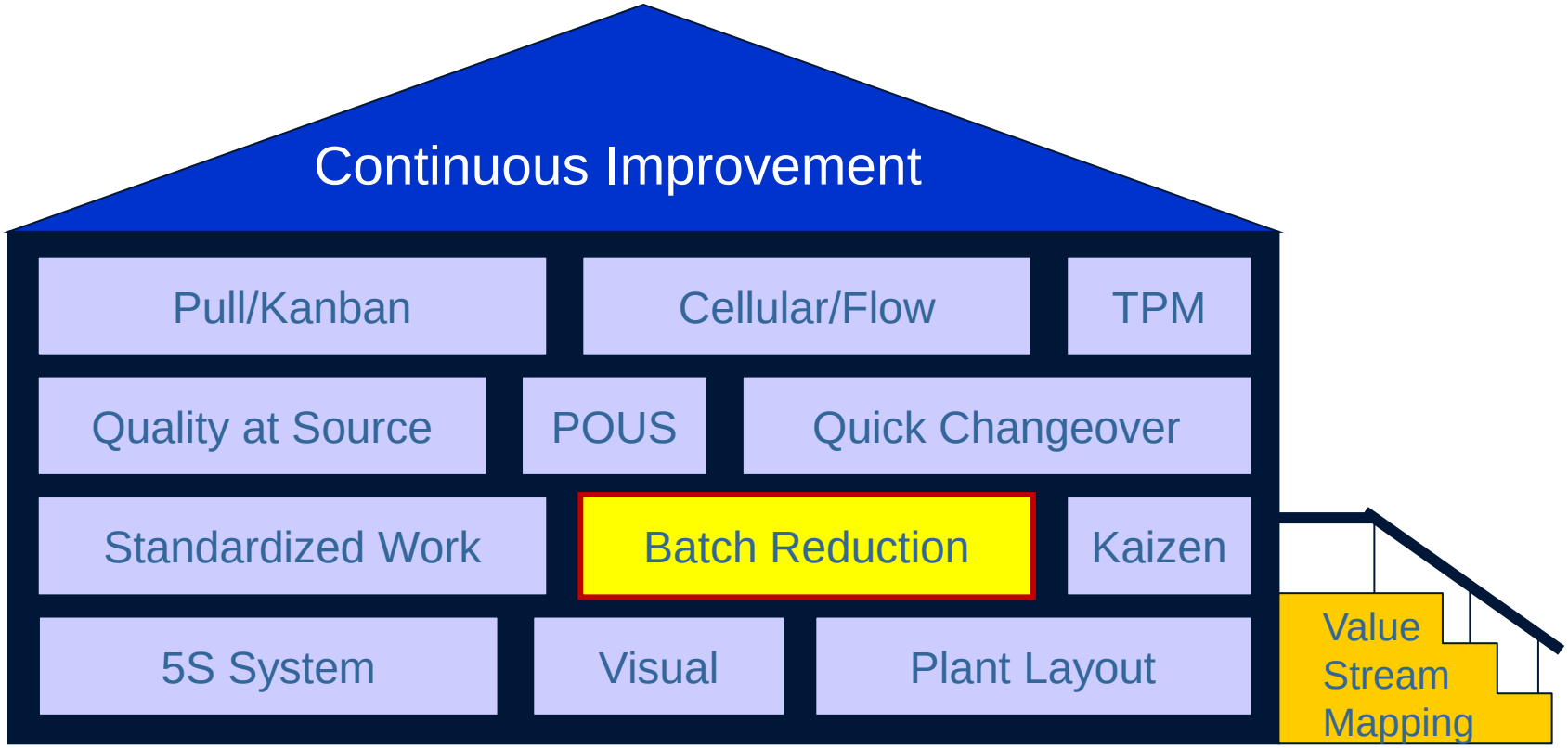
Space vs. Waste Elimination

Turn **space projects** into **waste elimination projects.**

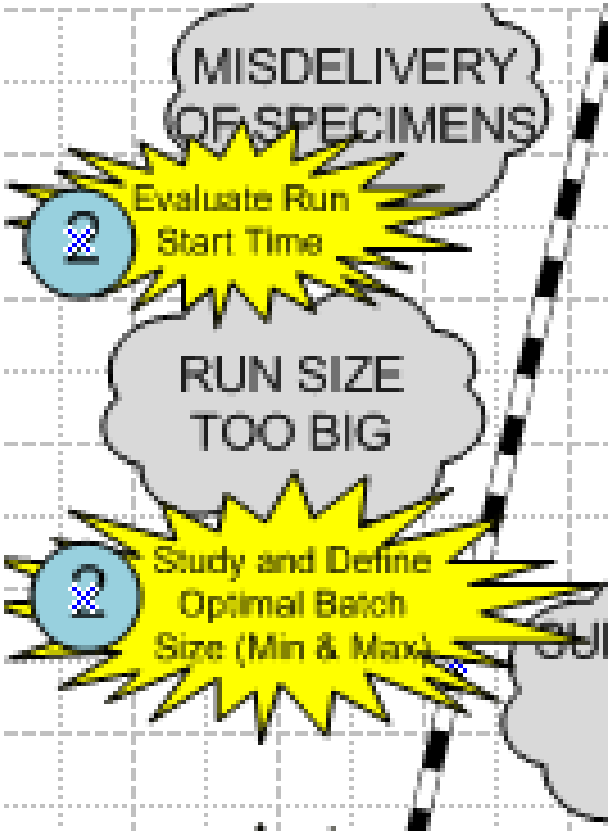


Manufacturing Design & Processes

House of LEAN

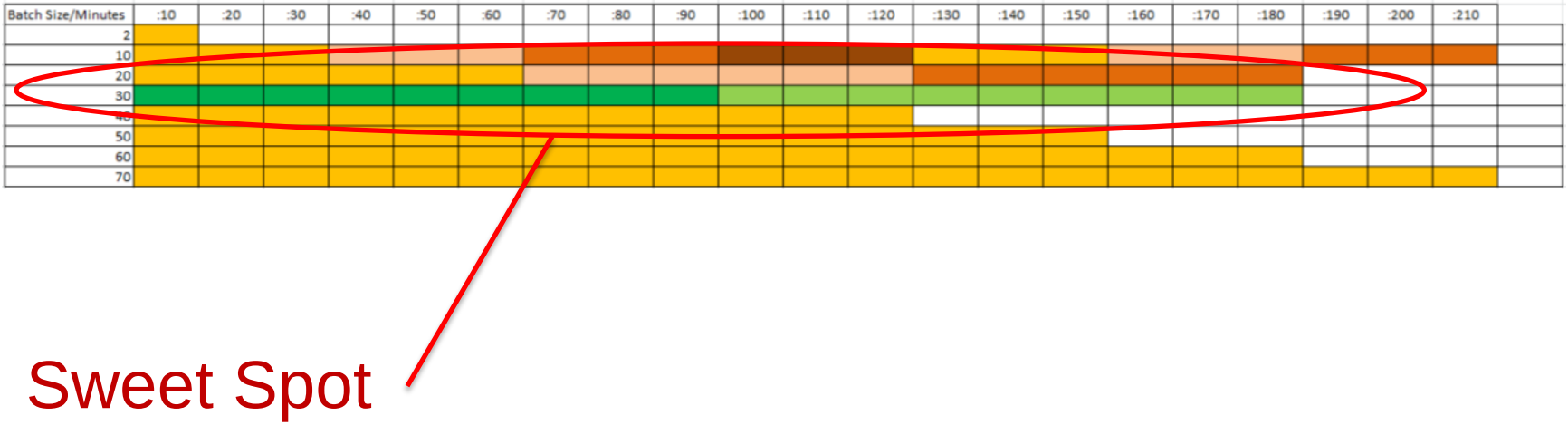


Batch Reduction

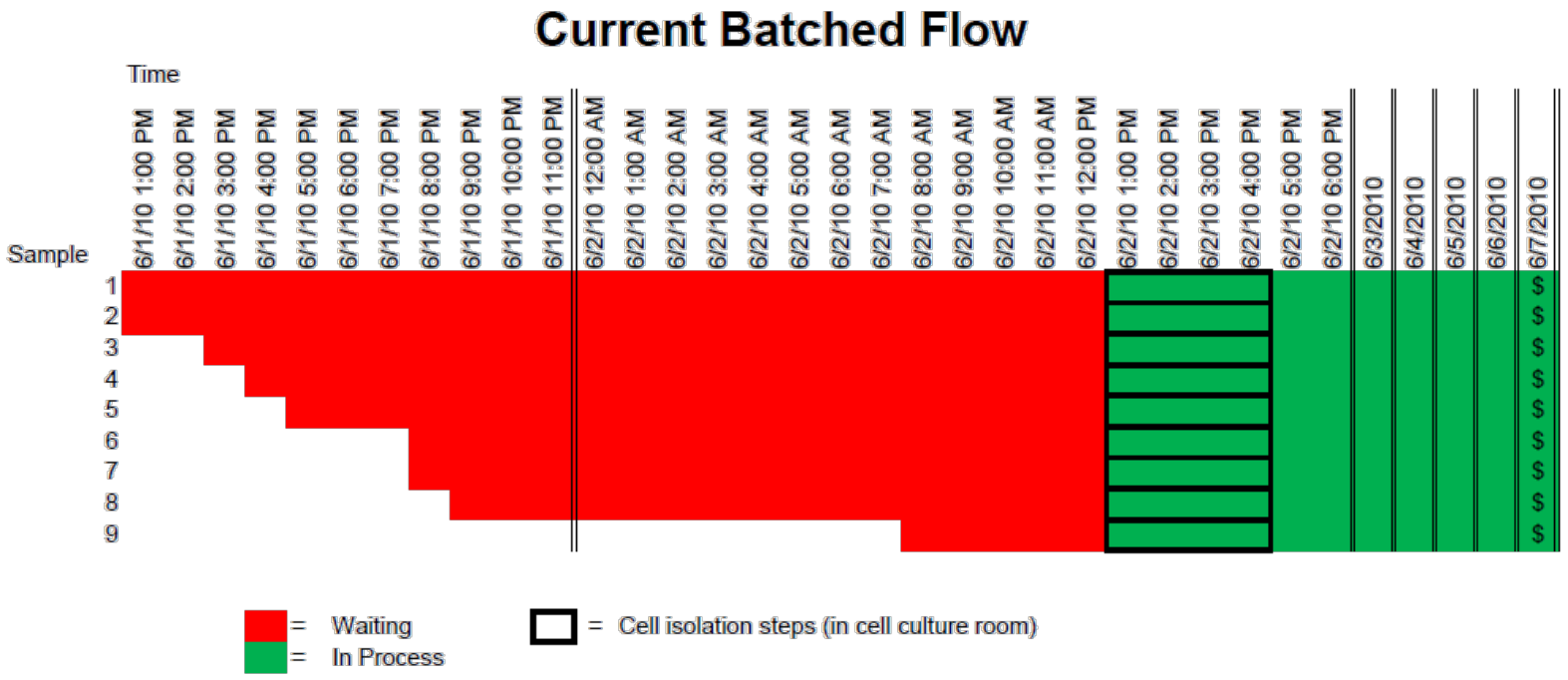


Batch Reduction

20–30 Count Batch Size



Batch Reduction

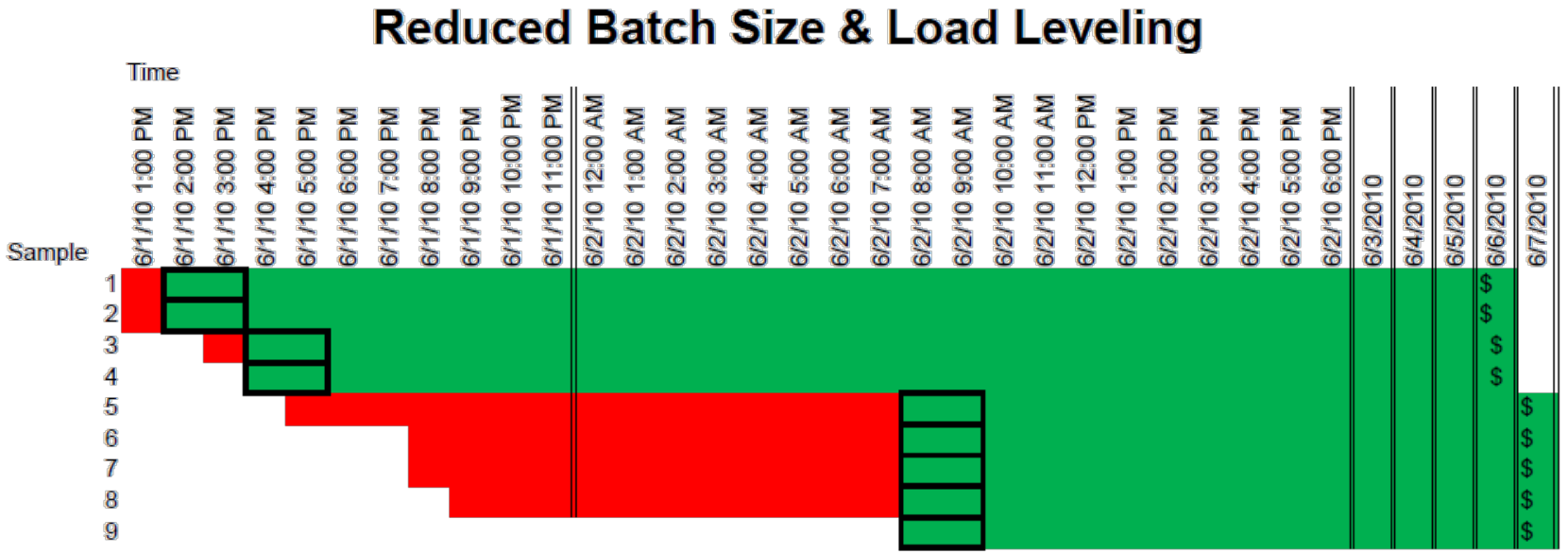


Batch Reduction

Specimens tested and reported up to a full day earlier.

Waiting “open” time reduced by 85%.

Capacity increased by 82%.



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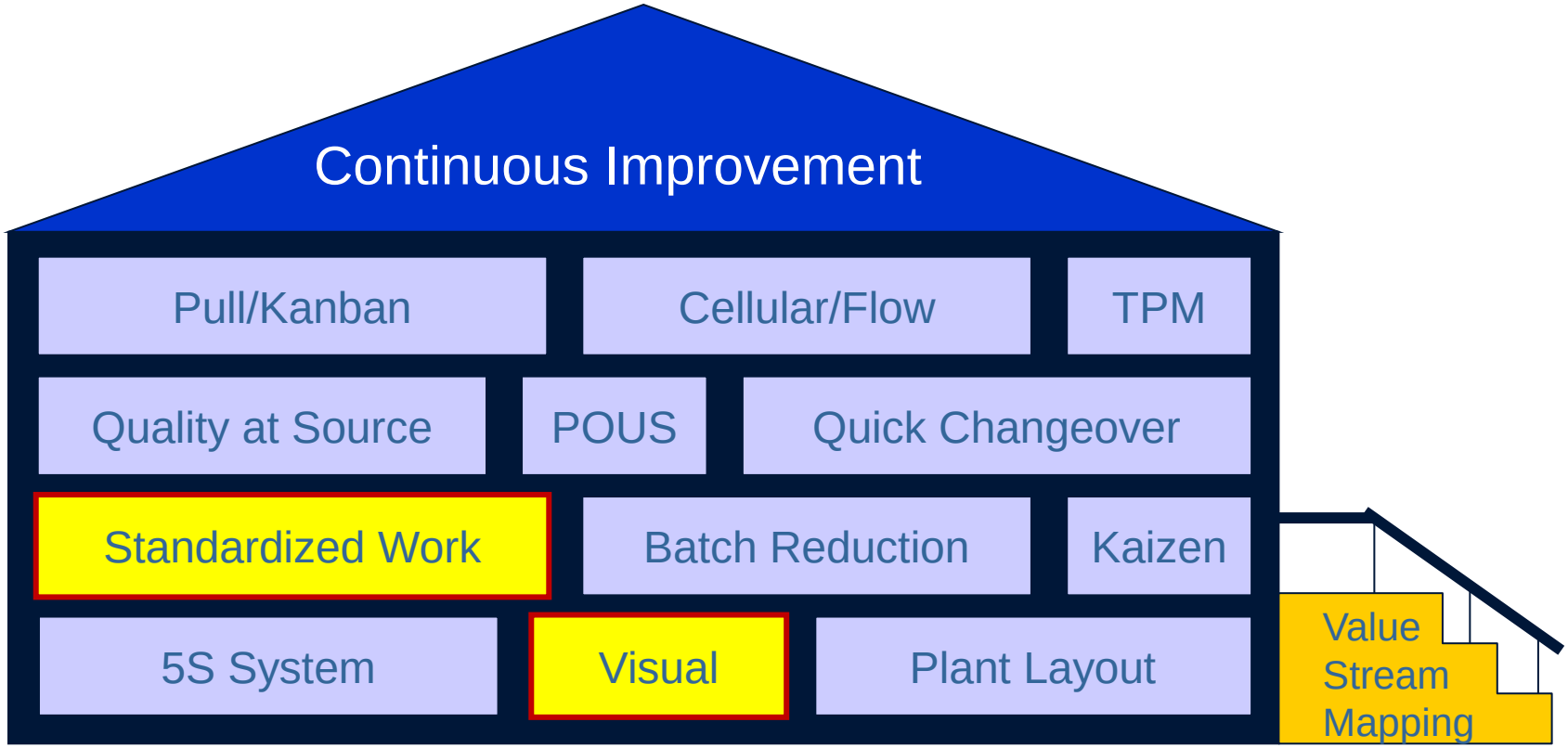
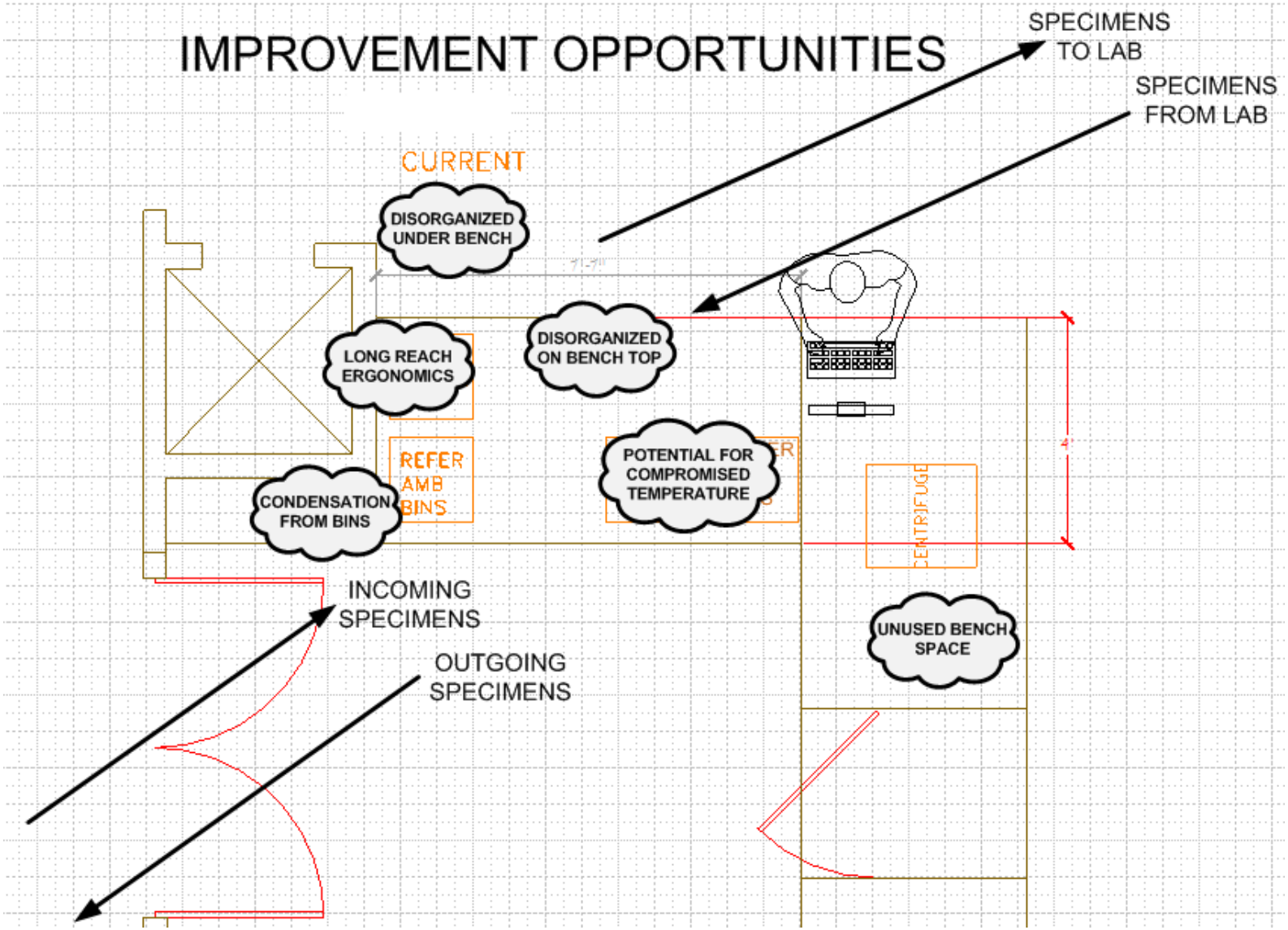
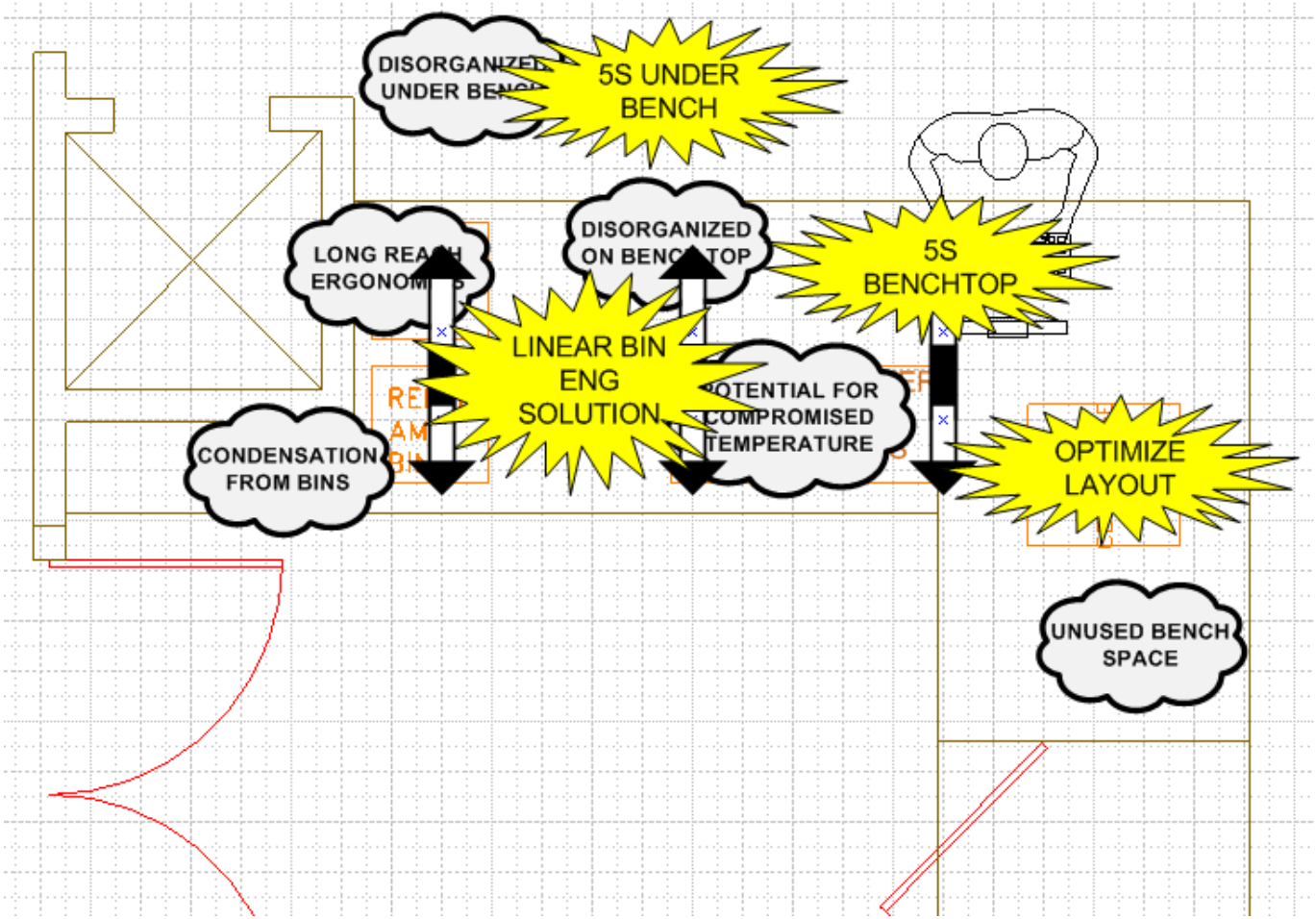
Industrial Design

House of LEAN

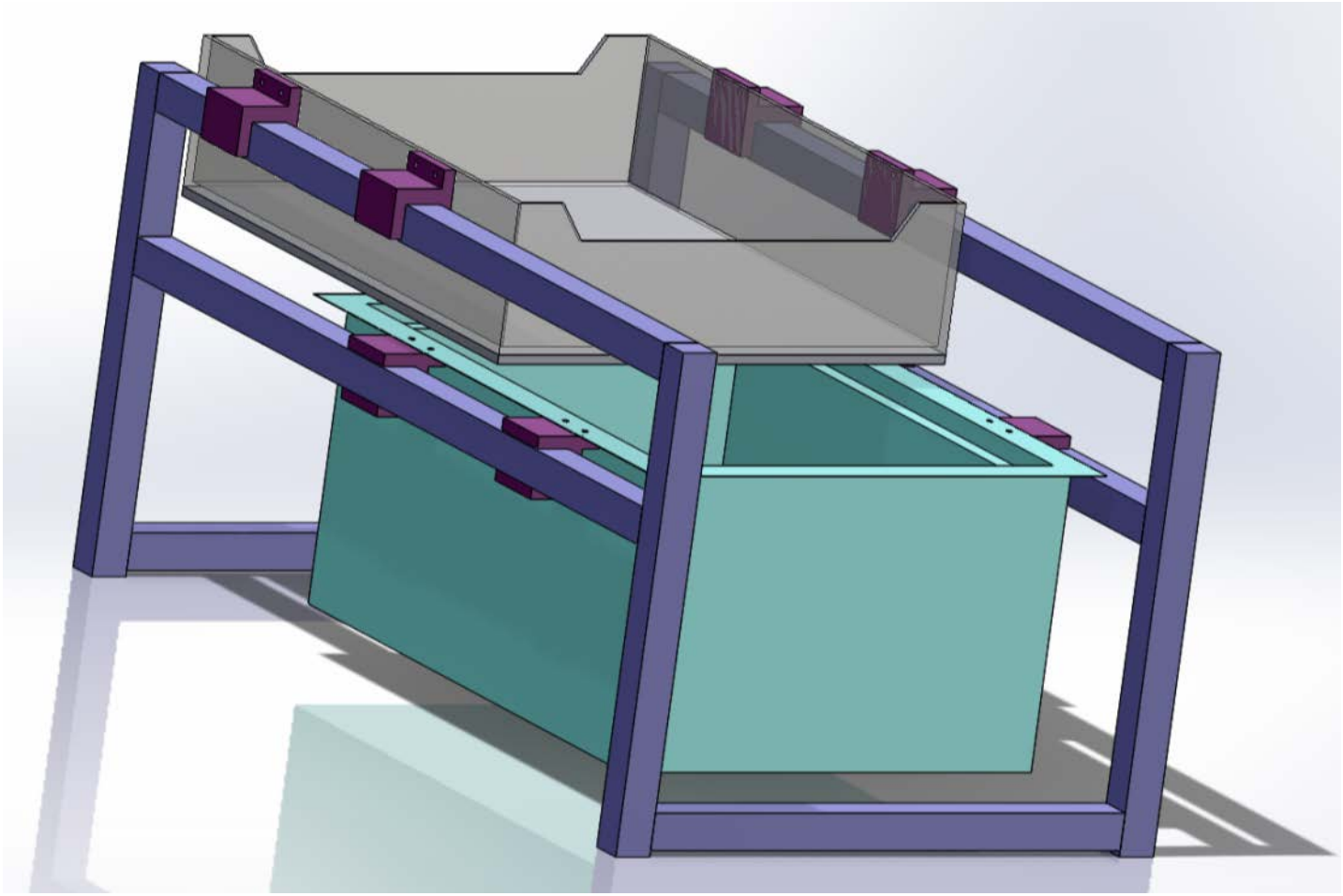



IMPROVEMENT OPPORTUNITIES
SPECIMENS TO LAB
SPECIMENS FROM LAB
CURRENT
DISORGANIZED UNDER BENCH
LONG REACH ERGONOMICS
DISORGANIZED ON BENCH TOP
REFER AMB BINS
CONDENSATION FROM BINS
POTENTIAL FOR COMPROMISED TEMPERATURE
CENTRIFUGE
INCOMING SPECIMENS
OUTGOING SPECIMENS
UNUSED BENCH SPACE

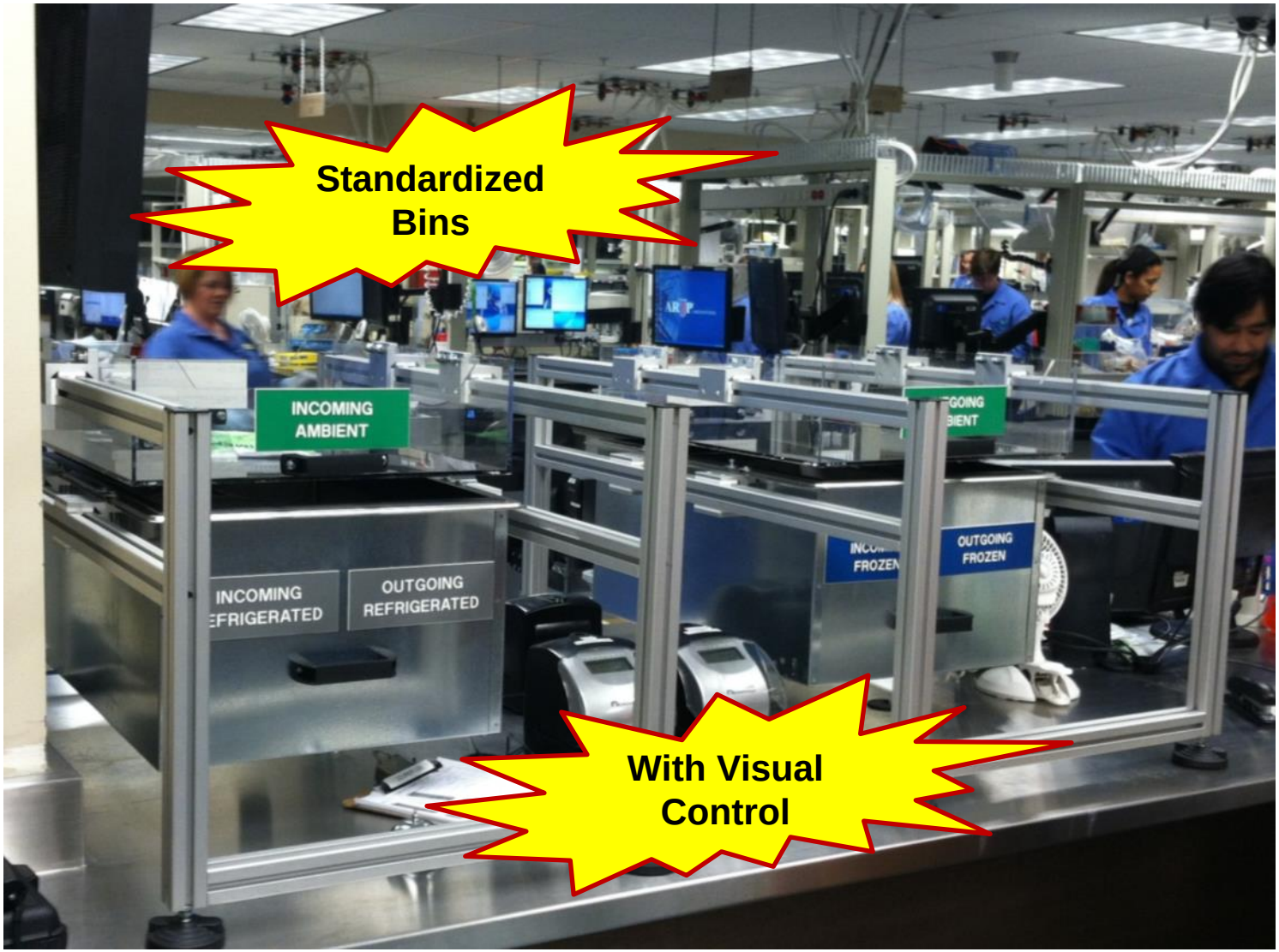
Kaizen Bursts



Solid Modeling of Sliding Bins



Linear Bin Engineered Solution



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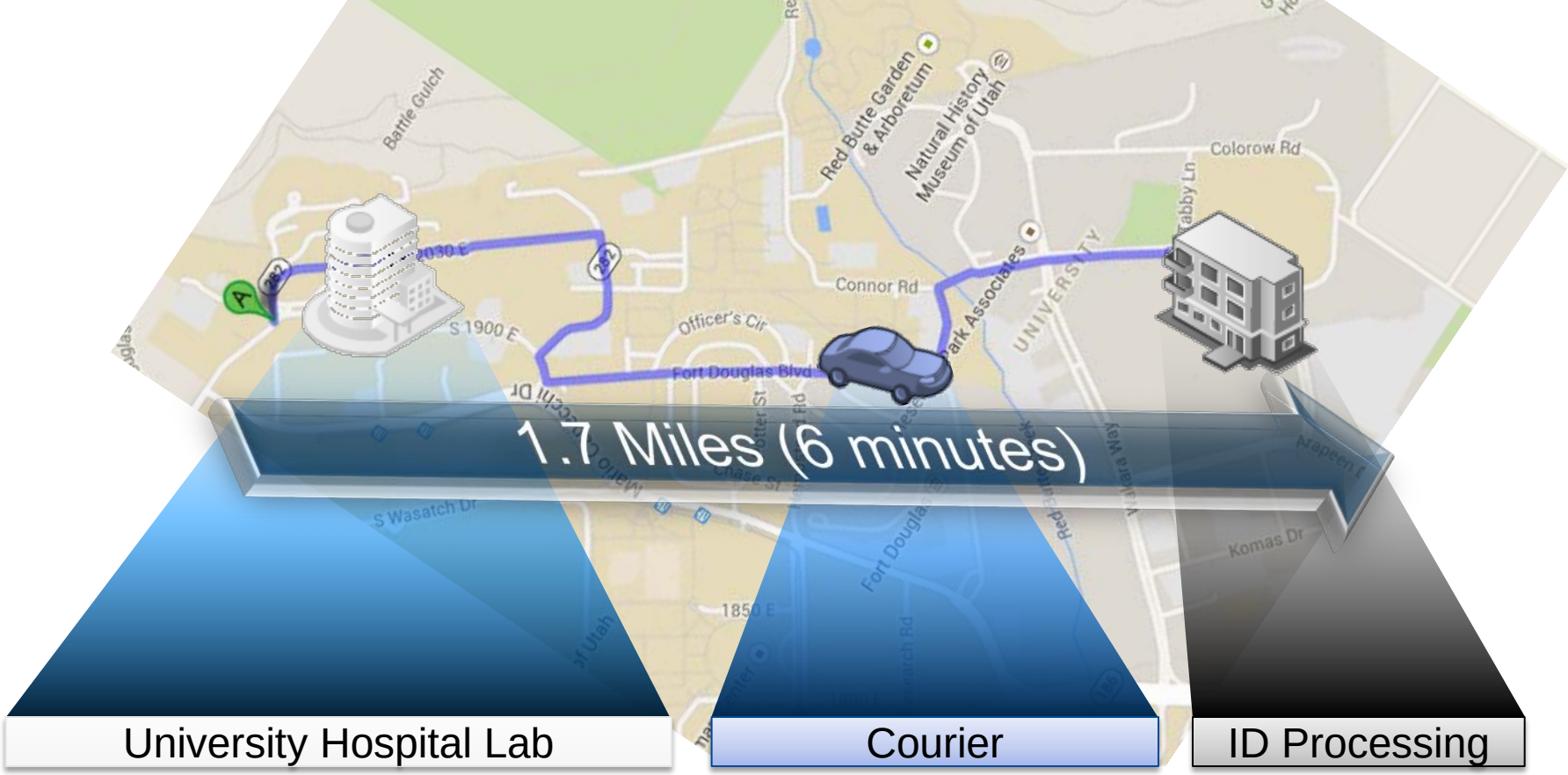
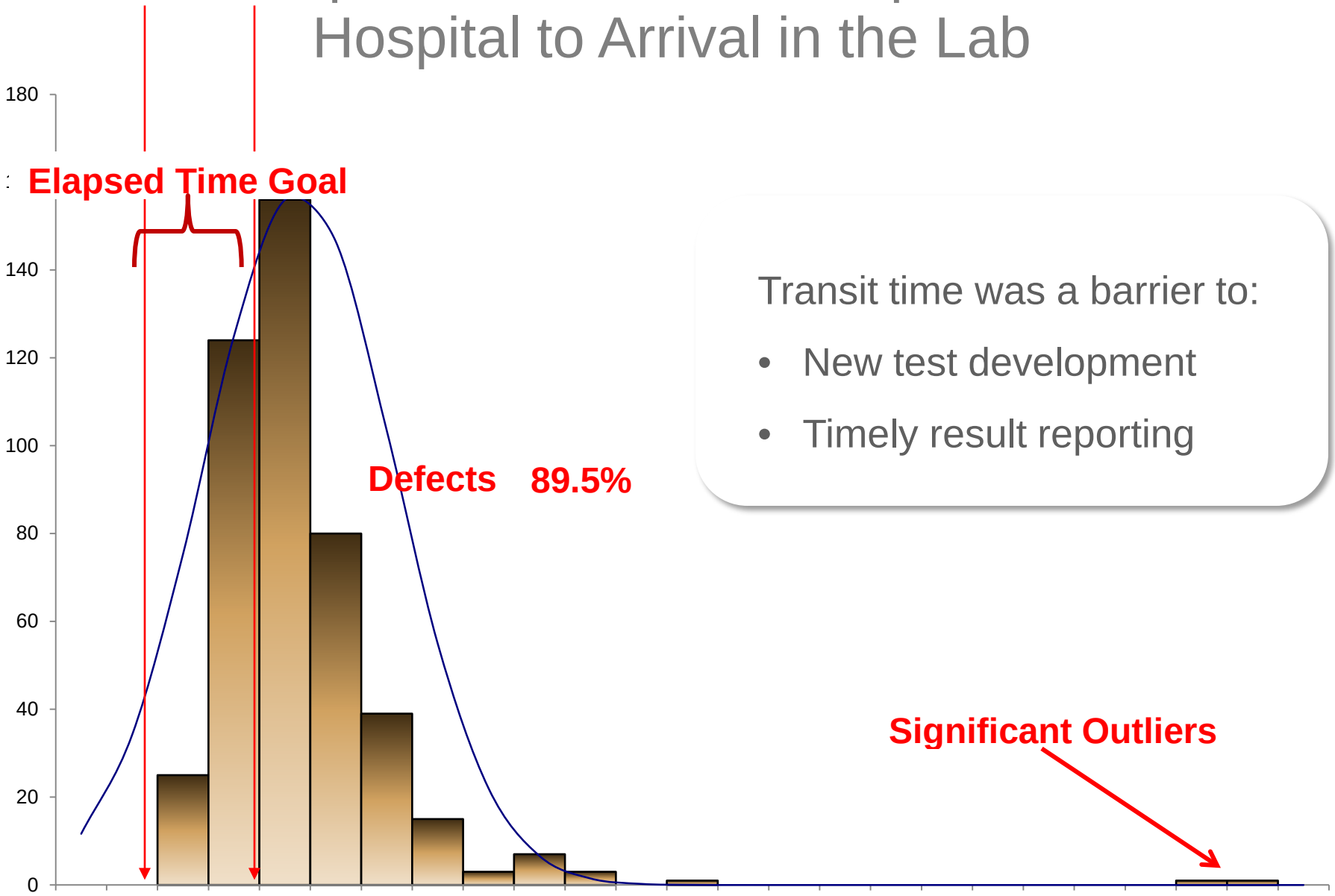
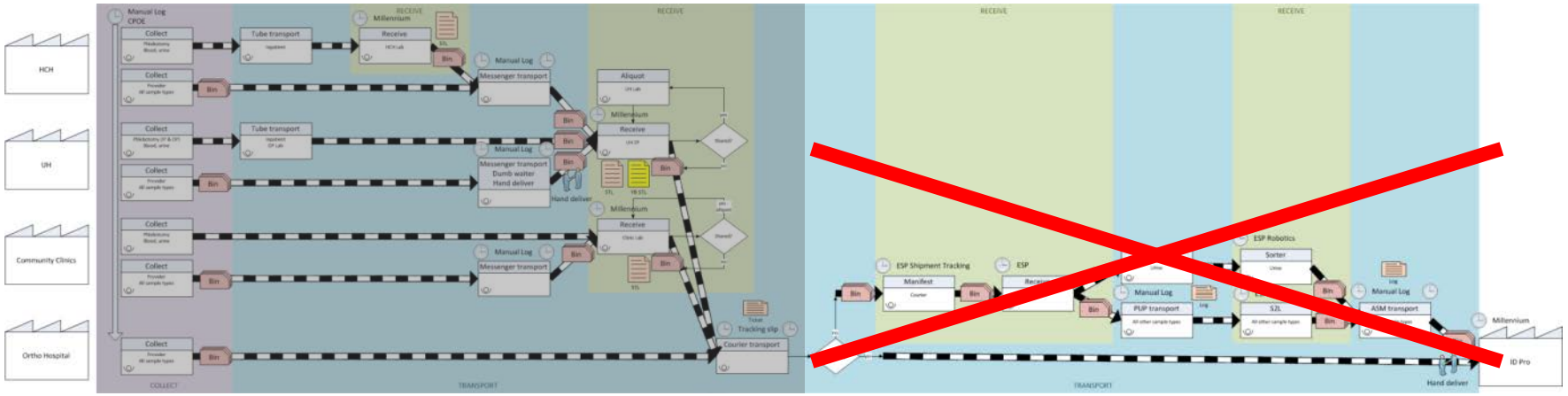

1.7 Miles (6 minutes)
University Hospital Lab
Courier
ID Processing
Received and prepared for transport
Prepared to be picked up
En route
Arrived at Central Facility and sent to lab
Lab received for processing

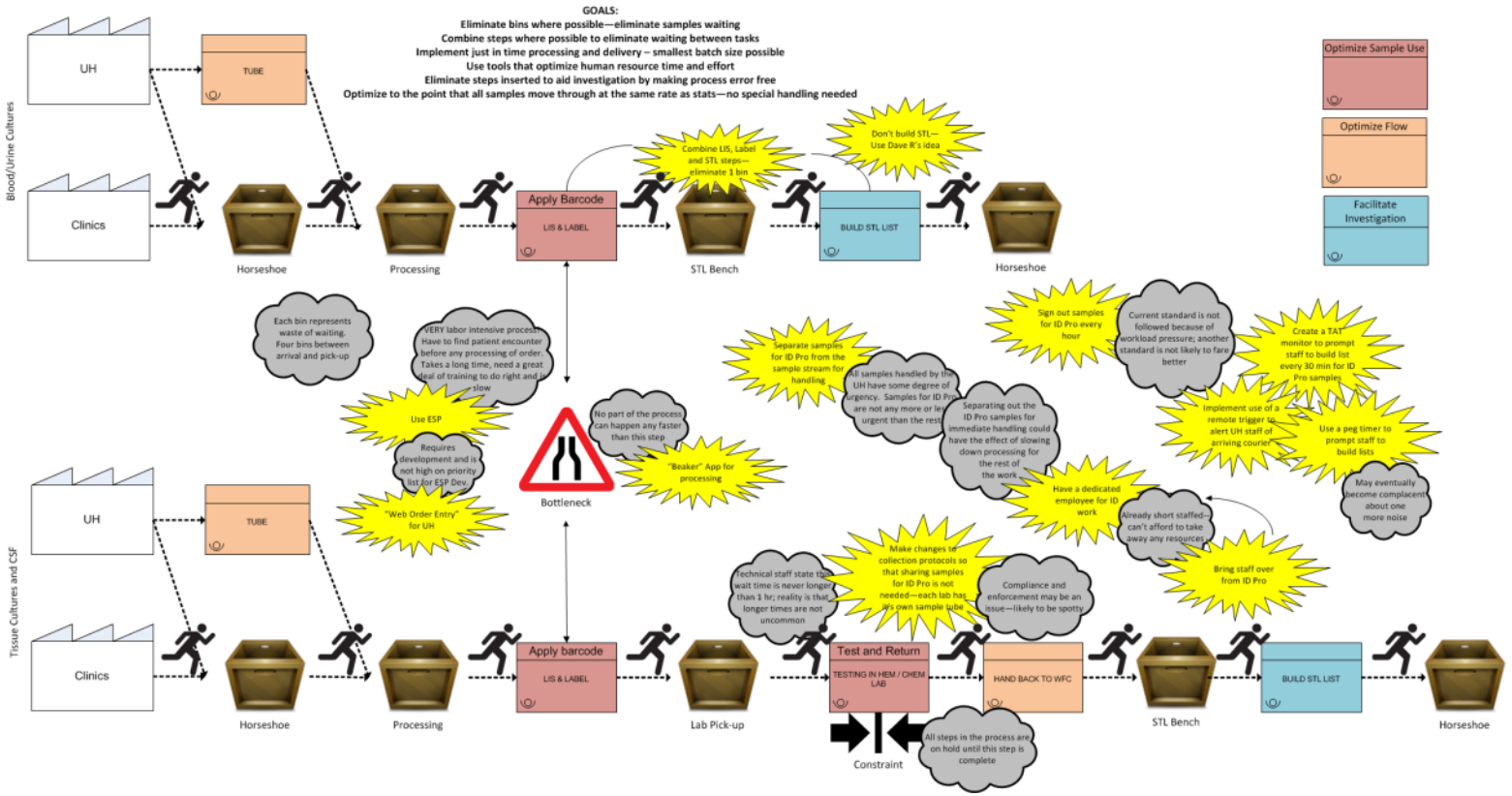
Elapsed Time from Receipt at the Hospital to Arrival in the Lab



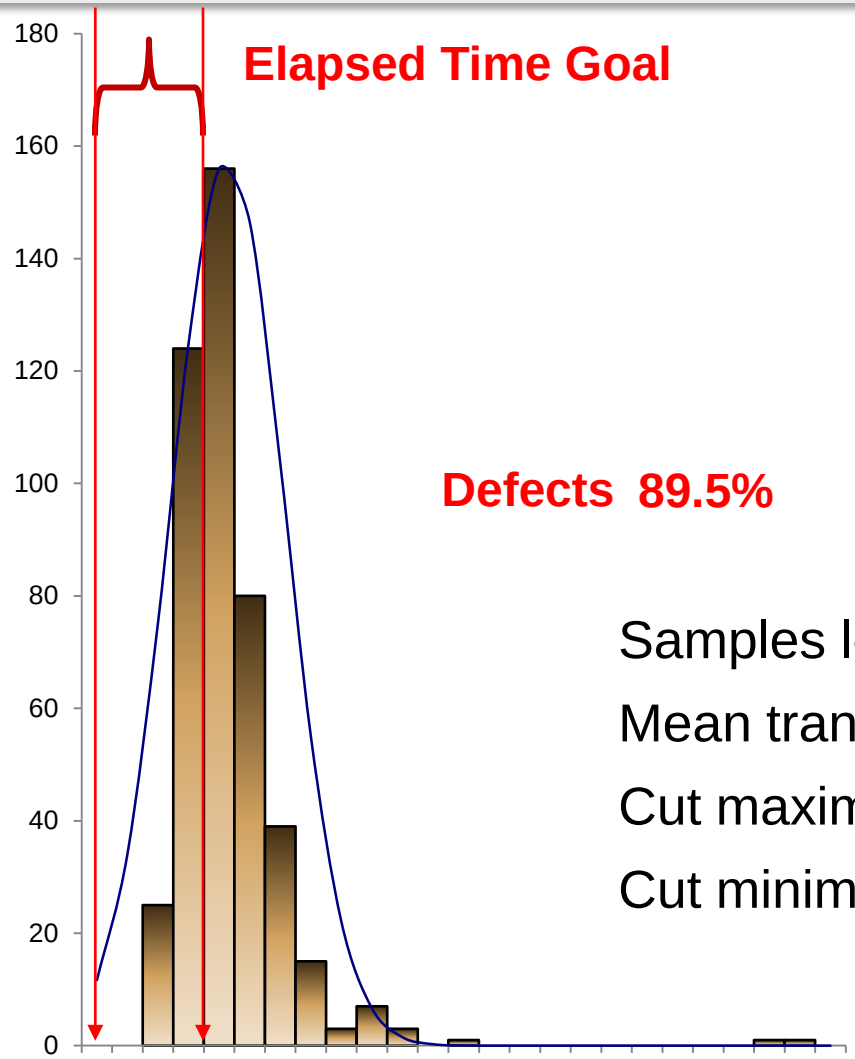
Transit time was a barrier to:

- New test development
- Timely result reporting

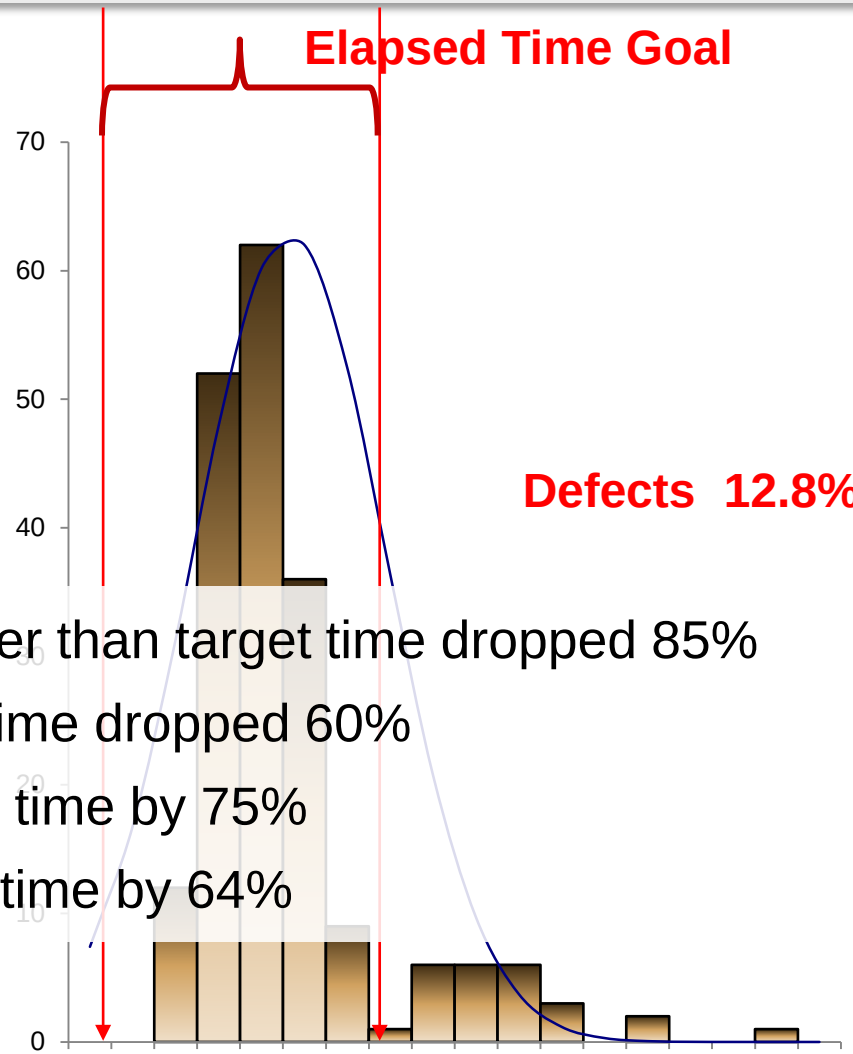

HCH
UH
Community Clinics
Ortho Hospital
Manual Log
CPOE
Collect
Tube transport
Receive
Millennium
Bin
Messenger transport
Aliquot
Dumb waiter
Hand deliver
Tracking slip
Courier transport
COLLECT
TRANSPORT
RECEIVE
ESP Shipment Tracking
Manifest
ESP
PUP transport
ESP Robotics
Sorter
SJL
ASM transport
ID Pro


GOALS:
Eliminate bins where possible—eliminate samples waiting
Combine steps where possible to eliminate waiting between tasks
Implement just in time processing and delivery – smallest batch size possible
Use tools that optimize human resource time and effort
Eliminate steps inserted to aid investigation by making process error free
Optimize to the point that all samples move through at the same rate as stats—no special handling needed
Optimize Sample Use
Optimize Flow
Facilitate Investigation
Blood/Urine Cultures
UH
TUBE
Clinics
Horseshoe
Processing
Apply Barcode
LIS & LABEL
STL Bench
BUILD STL LIST
Combine LIS, Label and STL steps—eliminate 1 bin
Don't build STL—Use Dave R's idea
Each bin represents waste of waiting. Four bins between arrival and pick-up
VERY labor intensive process. Have to find patient encounter before any processing of order. Takes a long time, need a great deal of training to do right and is slow
Use ESP
Requires development and is not high on priority list for ESP Dev.
"Web Order Entry" for UH
Bottleneck
No part of the process can happen any faster than this step
"Beaker" App for processing
Separate samples for ID Pro from the sample stream for handling
All samples handled by the UH have some degree of urgency. Samples for ID Pro are not any more or less urgent than the rest
Separating out the ID Pro samples for immediate handling could have the effect of slowing down processing for the rest of the work
Sign out samples for ID Pro every hour
Current standard is not followed because of workload pressure; another standard is not likely to fare better
Create a TAT monitor to prompt staff to build list every 30 min for ID Pro samples
Implement use of a remote trigger to alert UH staff of arriving courier
Use a peg timer to prompt staff to build lists
May eventually become complacent about one more noise
Have a dedicated employee for ID work
Already short staffed—can't afford to take away any resources
Bring staff over from ID Pro
Tissue Cultures and CSF
UH
TUBE
Clinics
Horseshoe
Processing
Apply barcode
LIS & LABEL
Lab Pick-up
Test and Return
TESTING IN HEM / CHEM LAB
HAND BACK TO WFC
STL Bench
BUILD STL LIST
Horseshoe
Technical staff state that wait time is never longer than 1 hr; reality is that longer times are not uncommon
Make changes to collection protocols so that sharing samples for ID Pro is not needed—each lab has its own sample tube
Compliance and enforcement may be an issue—likely to be spotty
Constraint
All steps in the process are on hold until this step is complete

Elapsed time from receipt at the hospital to arrival in the lab: Before Condition



Elapsed time from receipt at the hospital to arrival in the lab: Pilot Study



Samples longer than target time dropped 85%

Mean transit time dropped 60%

Cut maximum time by 75%

Cut minimum time by 64%

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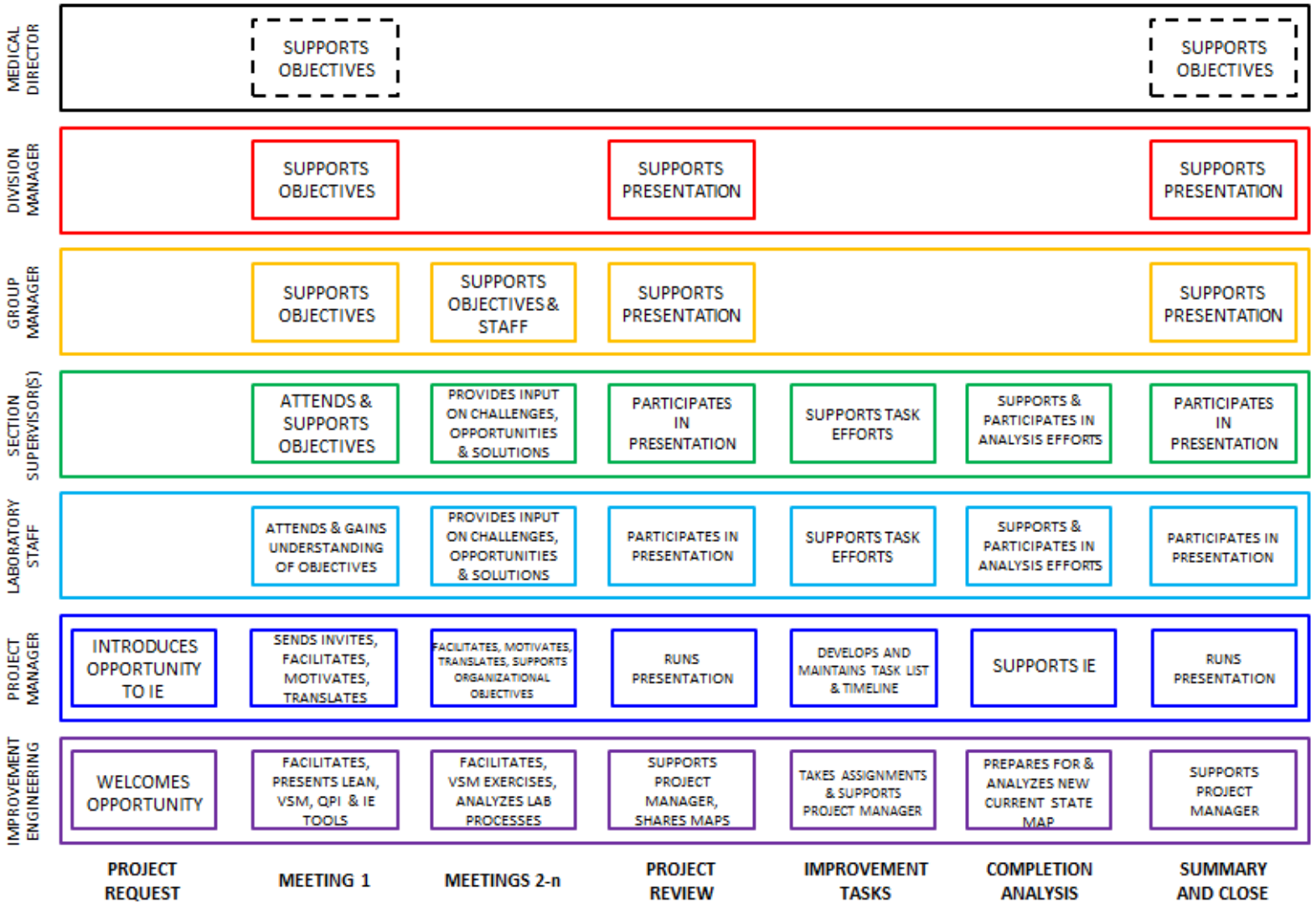
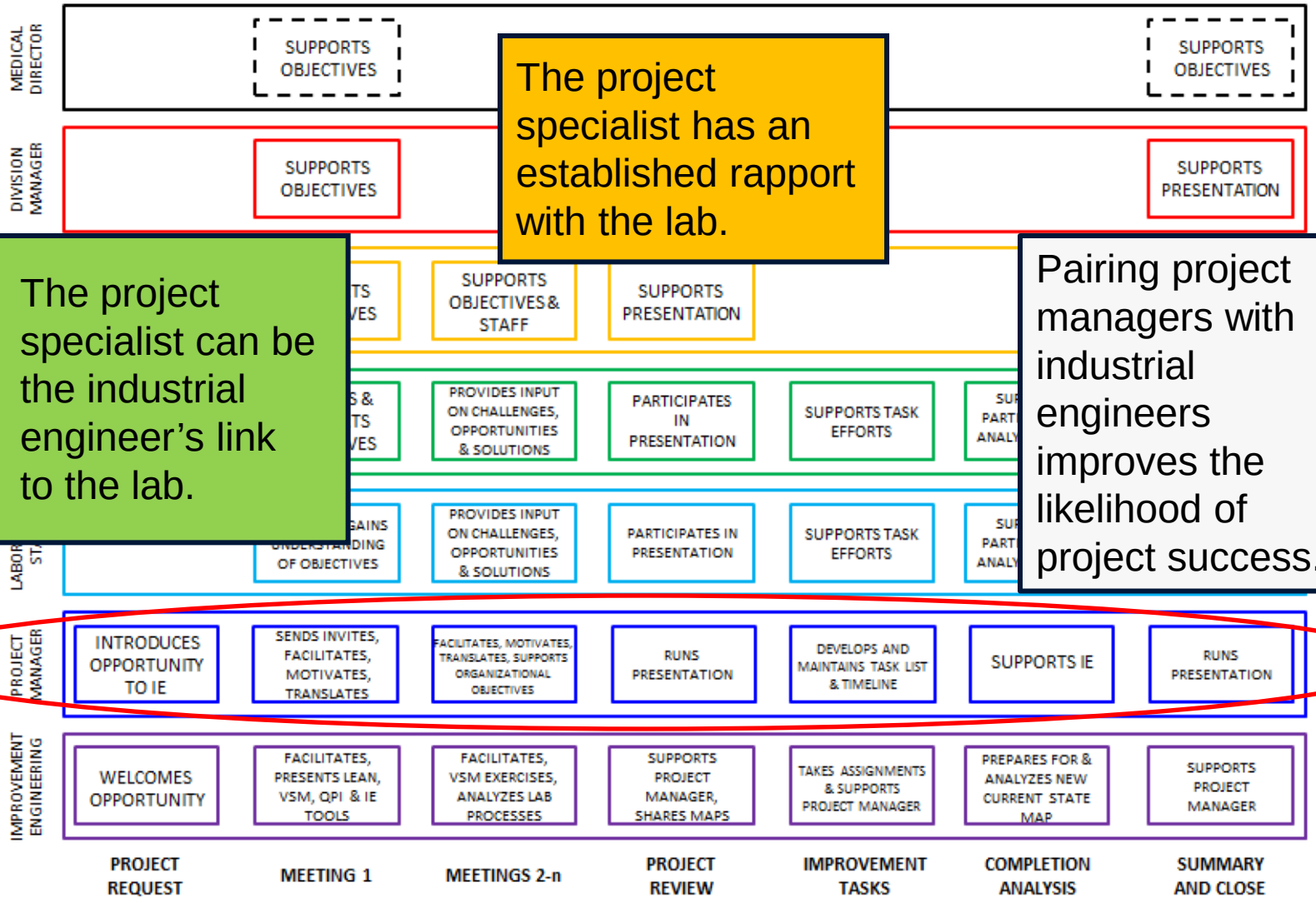
IMPROVEMENT ENGINEERING LAB IMPROVEMENT PROCESS



IMPROVEMENT ENGINEERING LAB IMPROVEMENT PROCESS



The project specialist has an established rapport with the lab.

The project specialist can be the industrial engineer's link to the lab.

Pairing project managers with industrial engineers improves the likelihood of project success.

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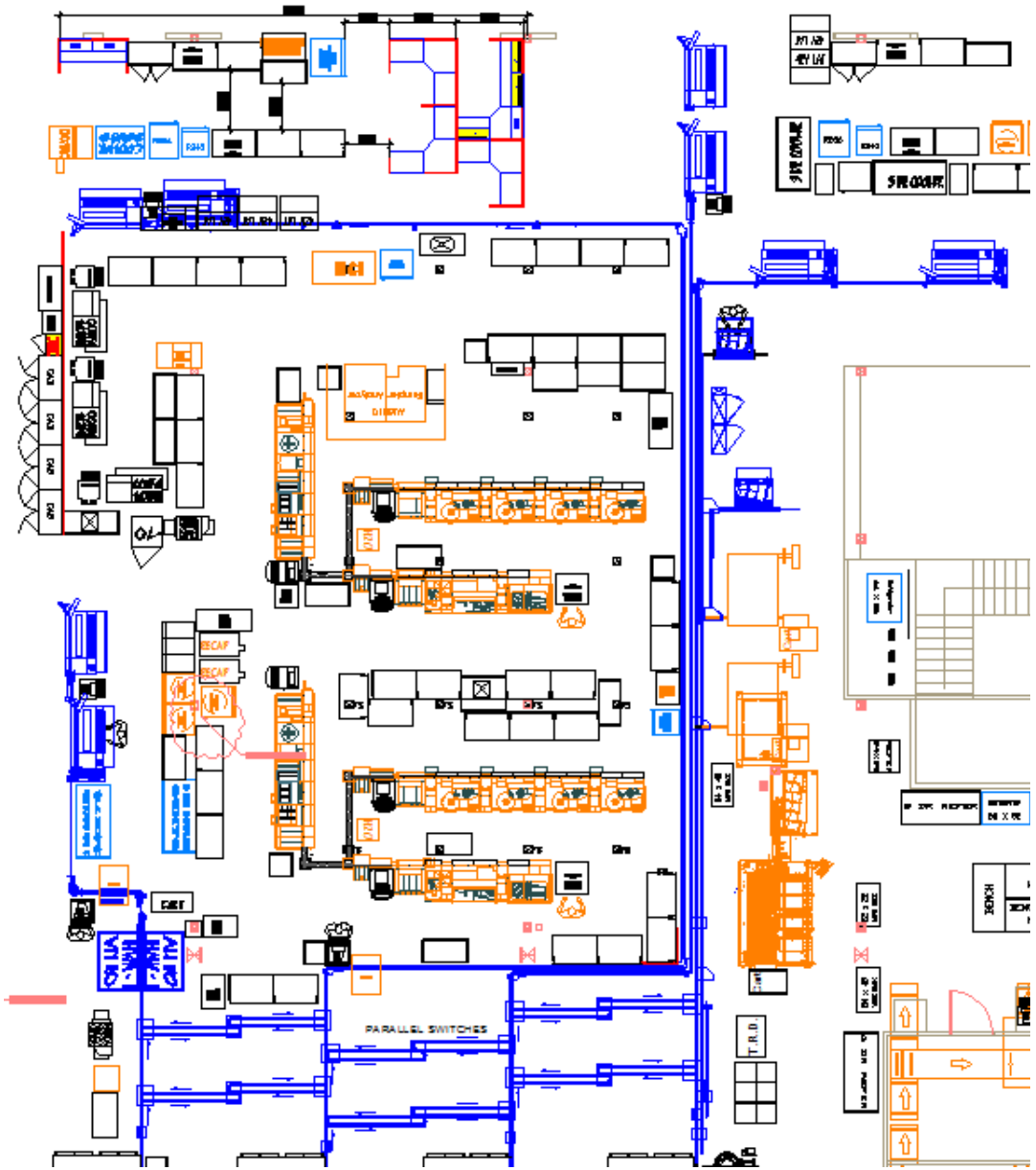
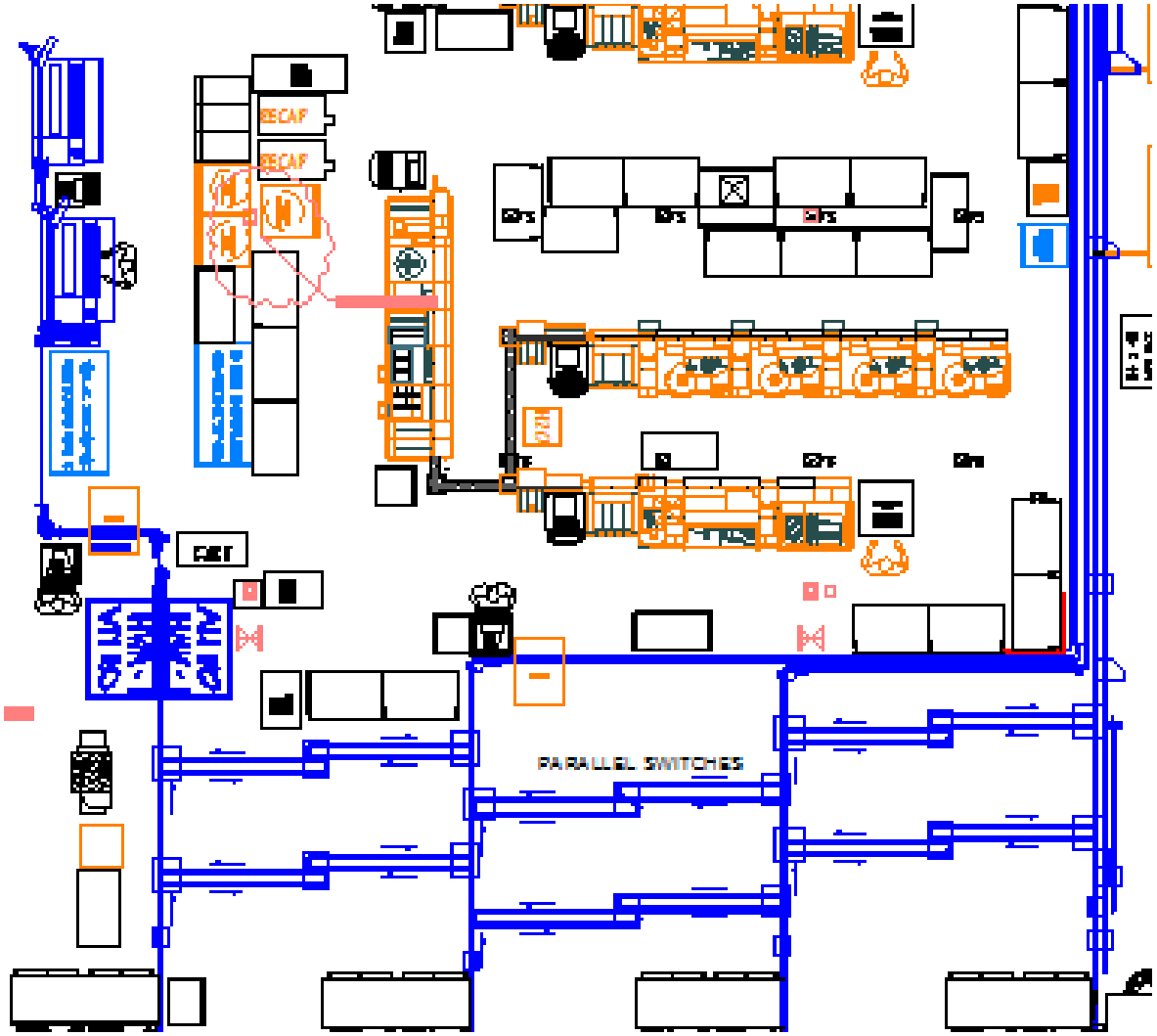
- Automation

Current Specimen Routing Automation



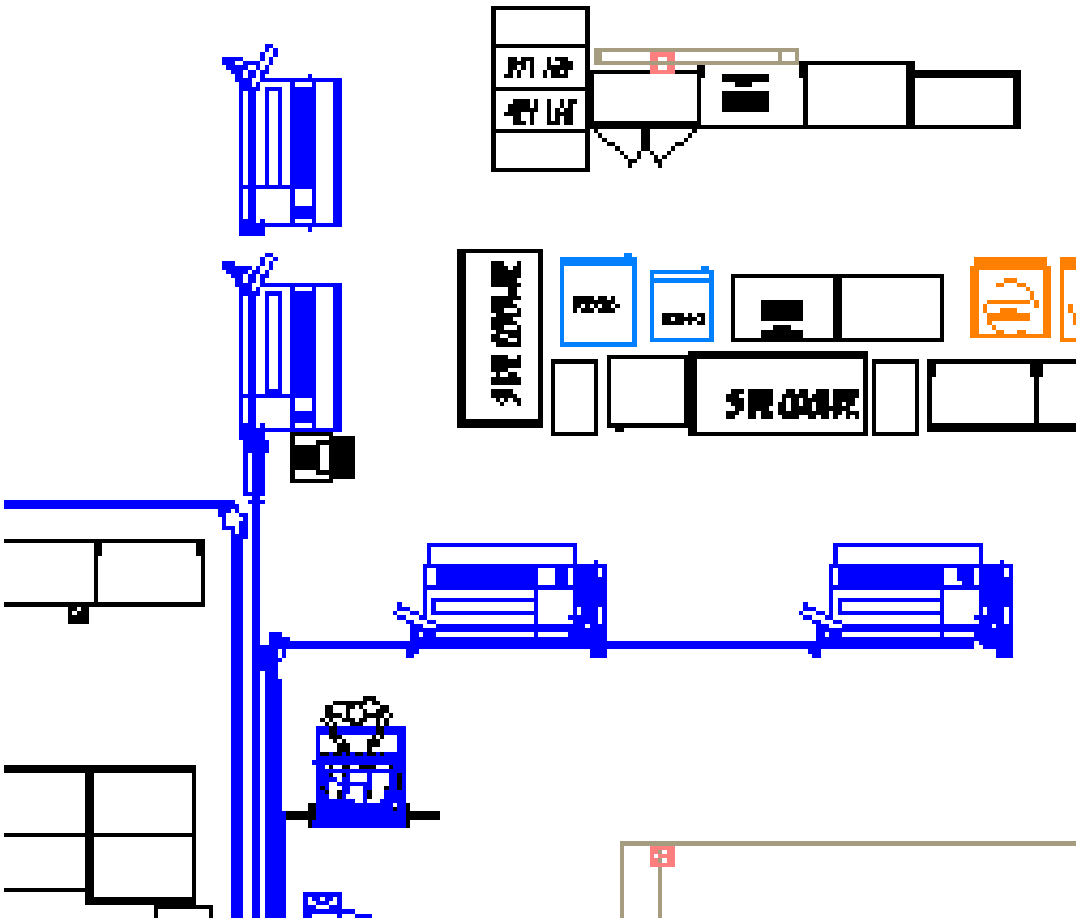
Current Specimen Routing Automation

- Switch yard maintenance and downtime
- Large maintenance contracts
- Routing software through vendor



Current Specimen Routing Automation

- Track vendor supplied sorters
- Acquire spare parts through old customers and hoarding

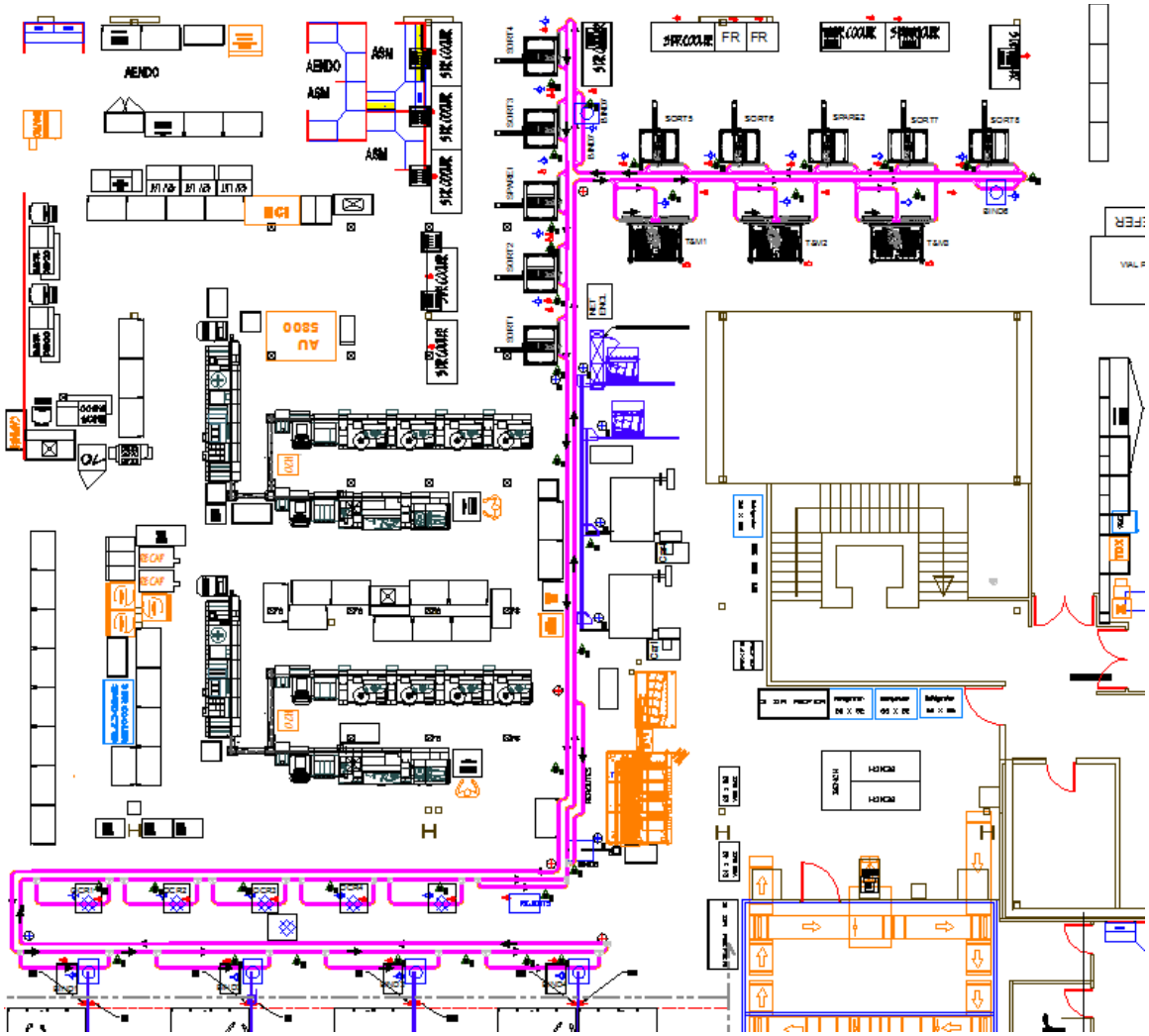


New Specimen Routing Automation

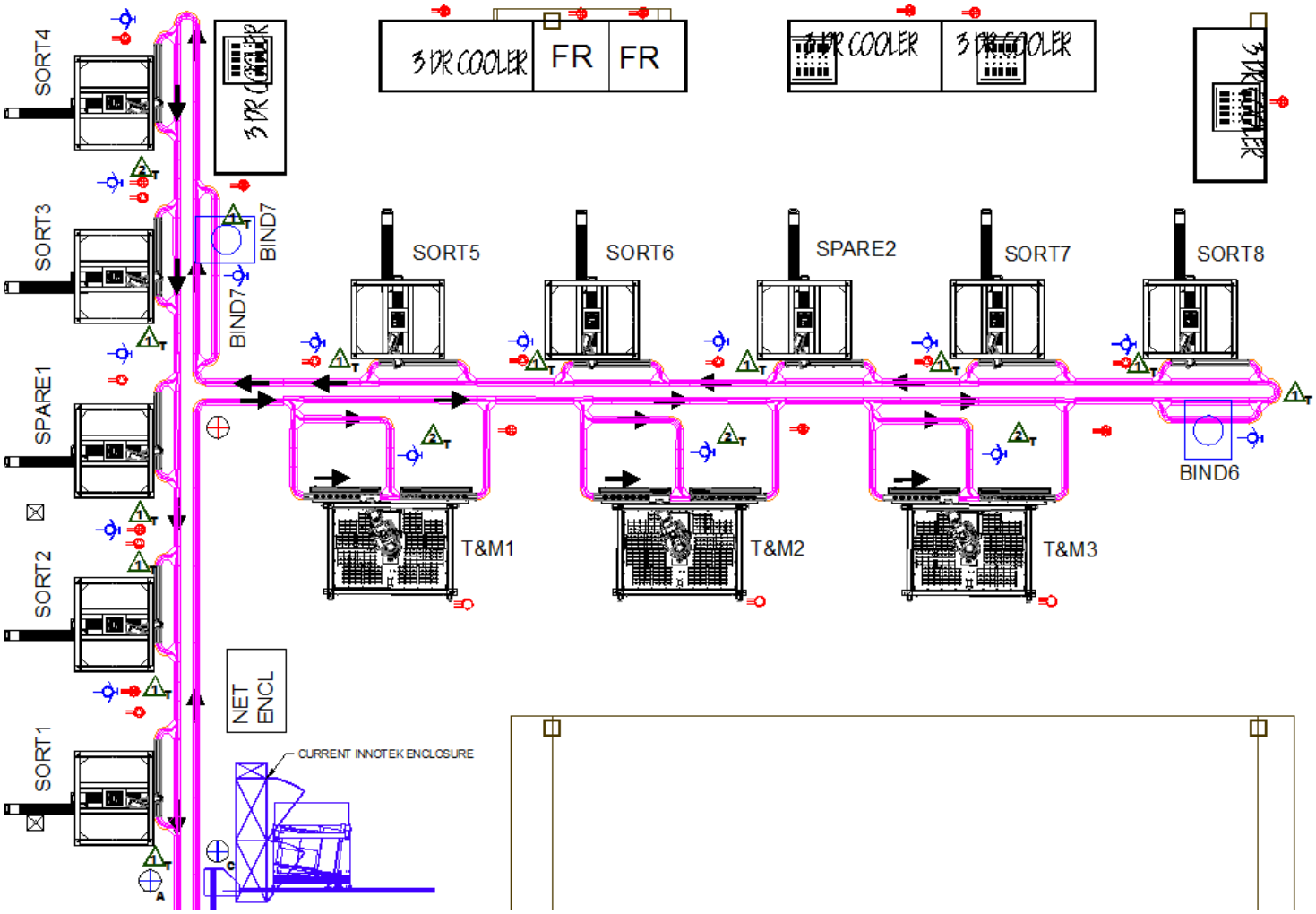
- Experienced industrial engineers provided confidence with the in-house automation initiative.

New Specimen Routing Automation

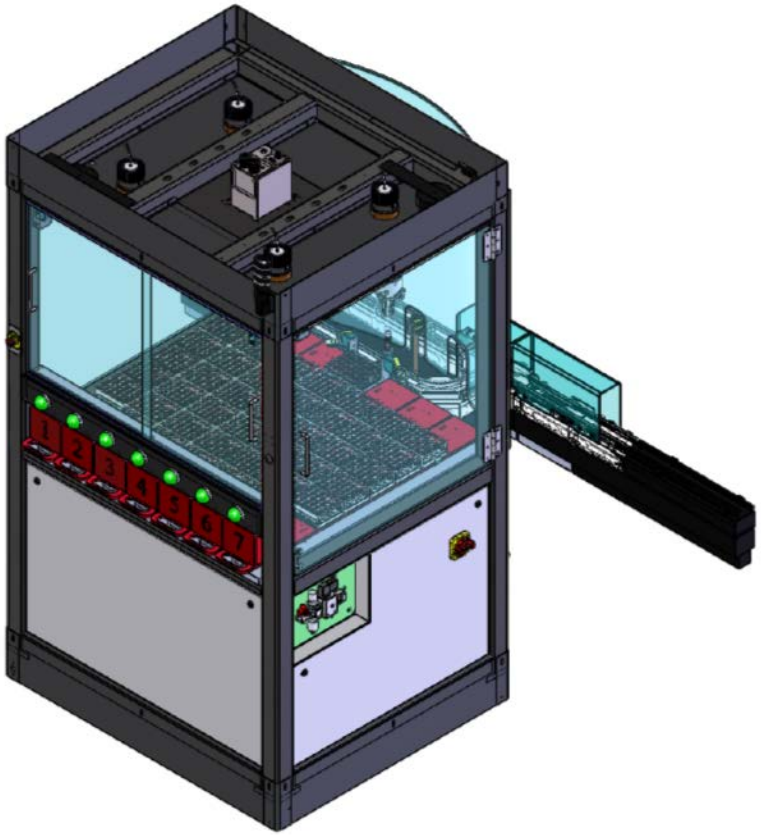
- Industrial engineers designed the new track configuration and the new robotic specimen handling systems.
- New track programmed by in-house talent.



Specimen Sorters

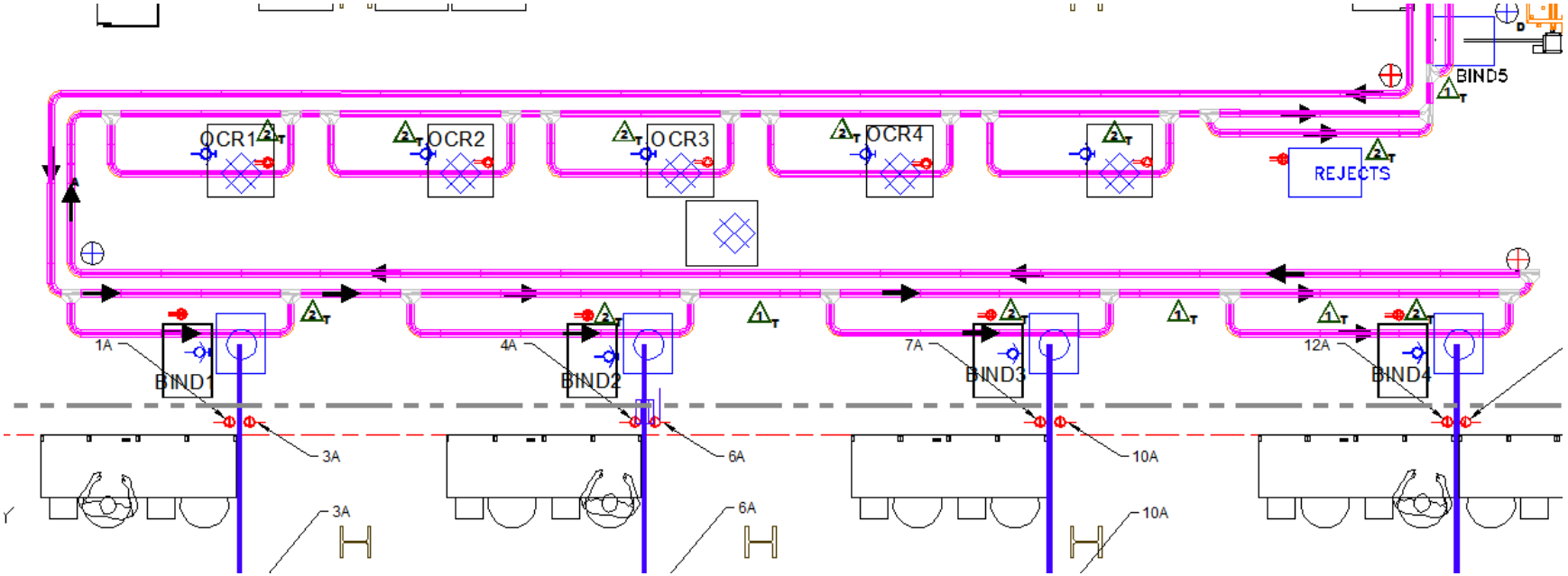


Specimen Sorters

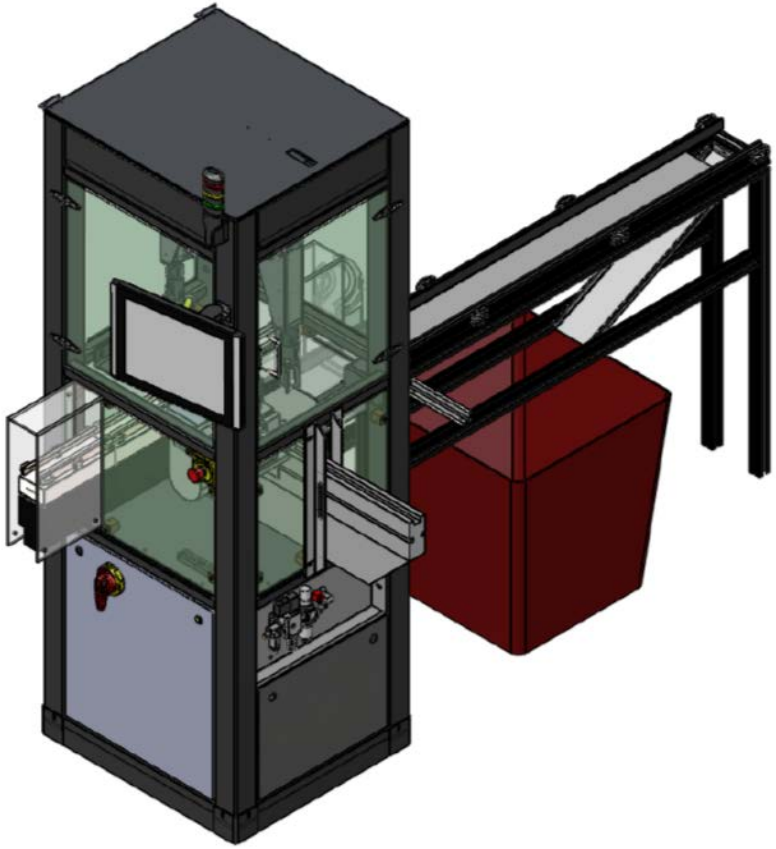


Specimen Sorters

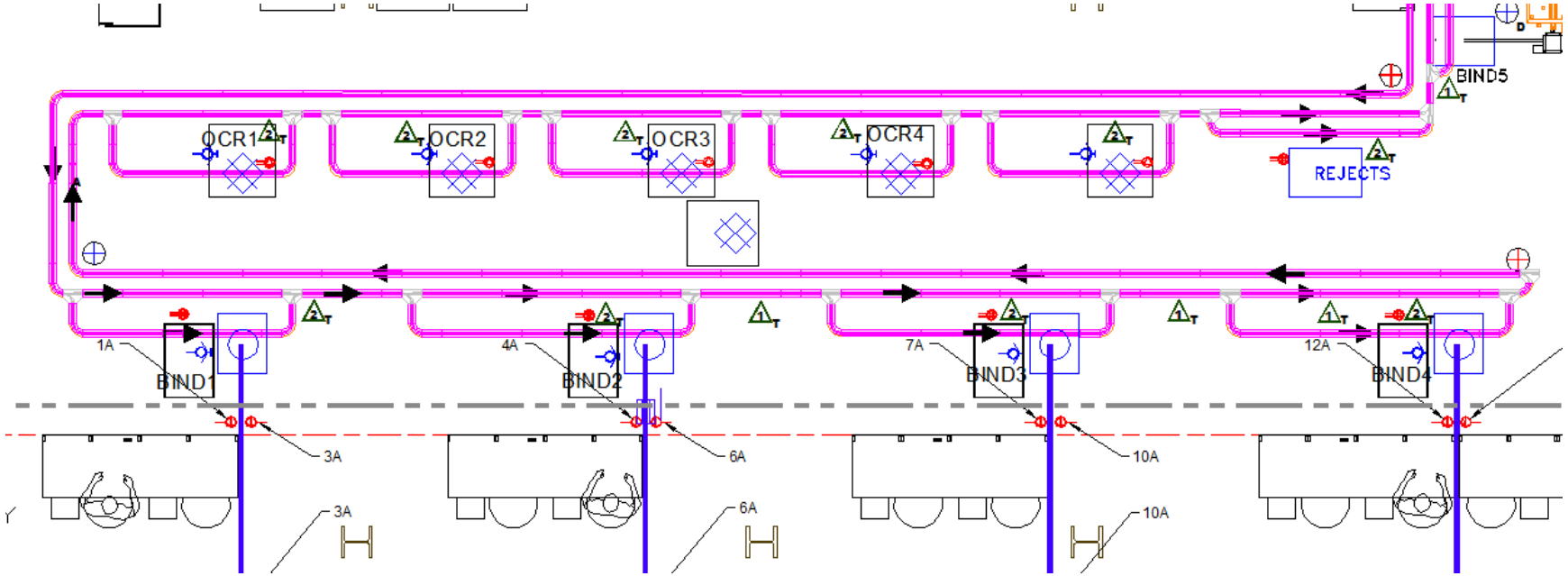
Specimen Binders



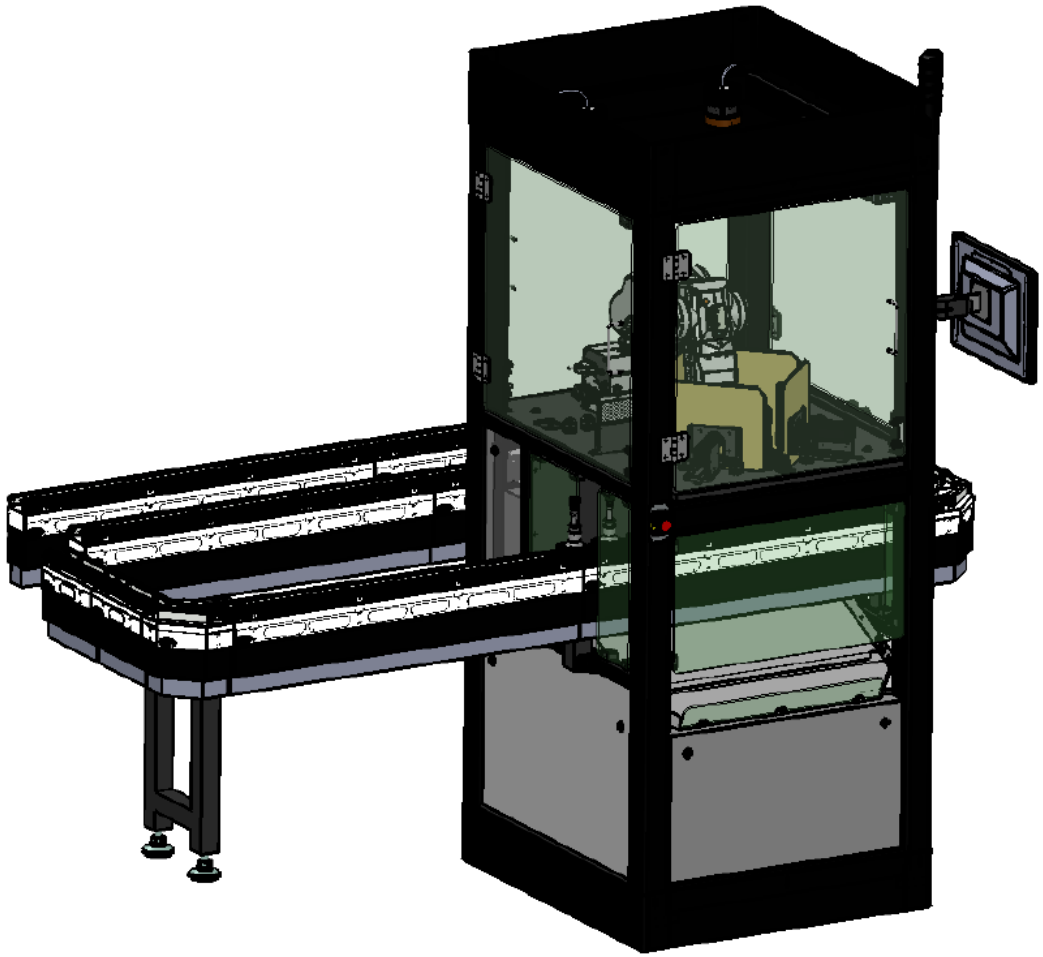
Specimen Binders



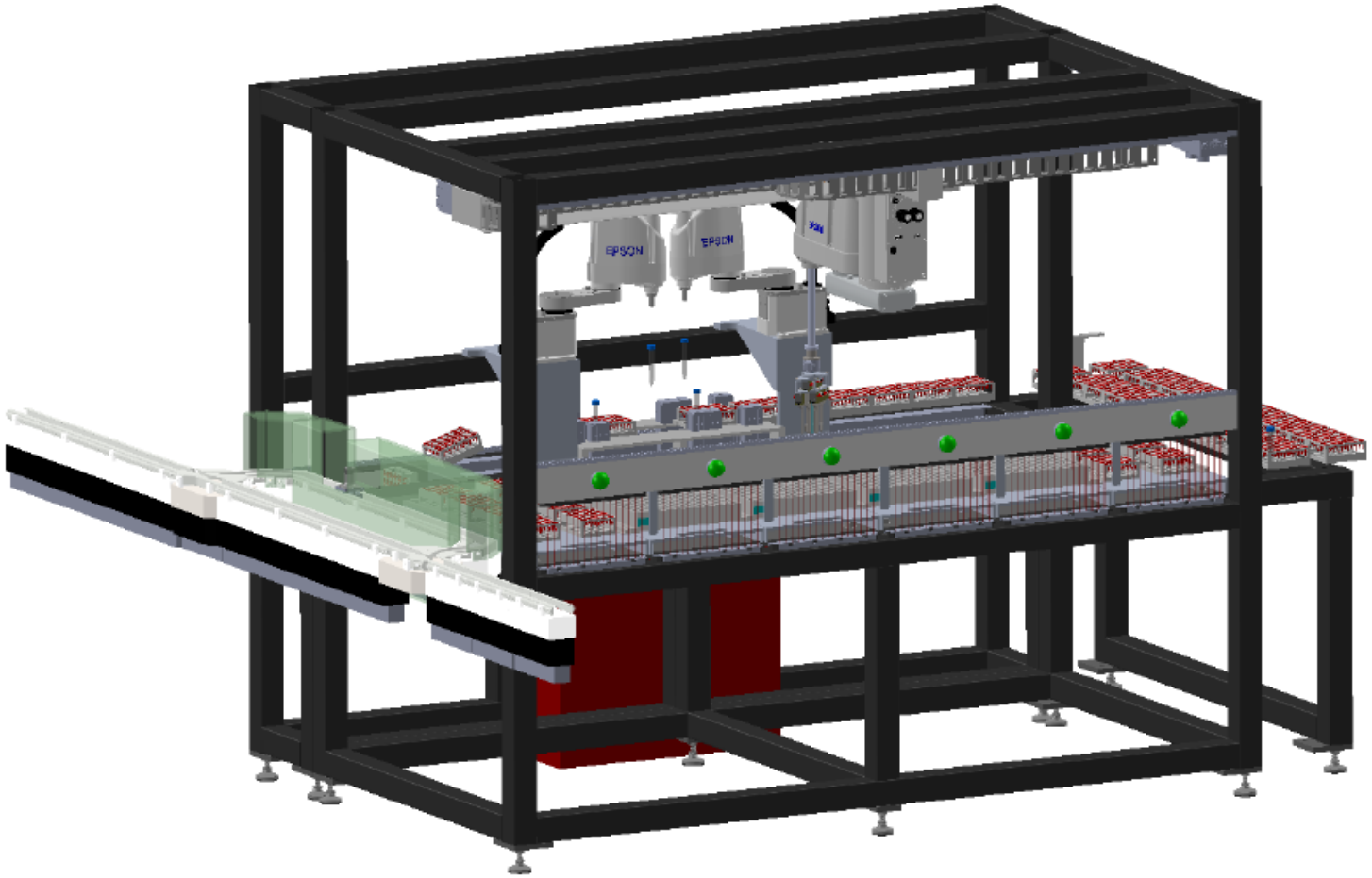
Optical Character Recognition (OCR)



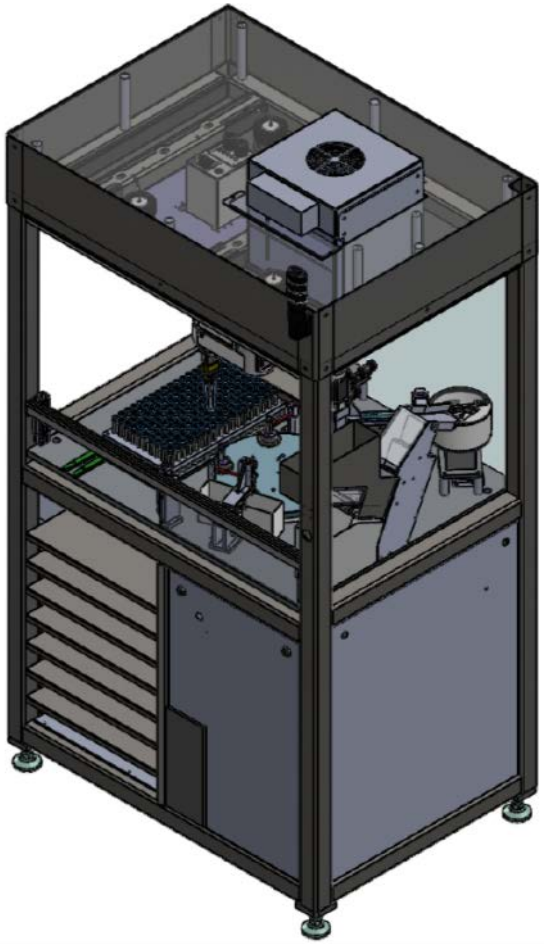
Optical Character Recognition



Storage Sorters



Decapper Cappers

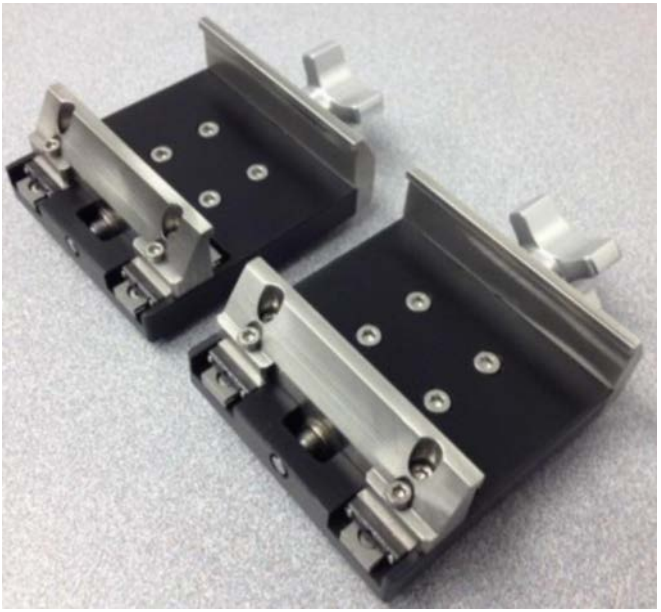


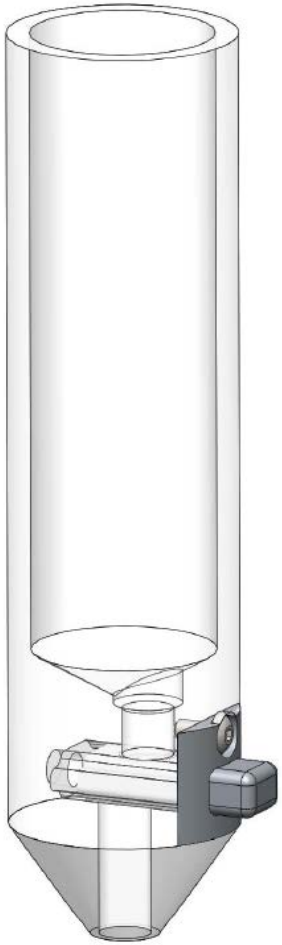
Other Automation

Focus on:

- Pre-analytic processes:
  - Pick and place binders
  - Sorters
  - Storage sorters
  - Decappers
  - Optical character recognition (OCR)
- Post-analytic processes:
  - Storage sorters
  - Cappers
- Tool design

Tool-Design Projects





Conclusion

- Industrial engineers apply their educational curriculum in the lab while implementing the tools of LEAN.
- Reporting is under facilities organizational umbrella.
- Engineers will thrive and have an impact in the lab environment as they are able to implement engineering technologies.
- Lab can benefit from short and long-term wins.
- The industrial engineer who understands the laboratory can effectively apply LEAN/Six Sigma and engineering principles in context.

Conclusion

"We have developed an effective strategy for applying industrial engineering or manufacturing engineering concepts in the laboratory; while our process includes some typical applications, it also includes many atypical applications of industrial engineering principles used in our laboratory."

—ARUP executive

Open Discussion