LAB CON 2024
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Planning for Laboratory Automation

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TEAM OVERVIEW

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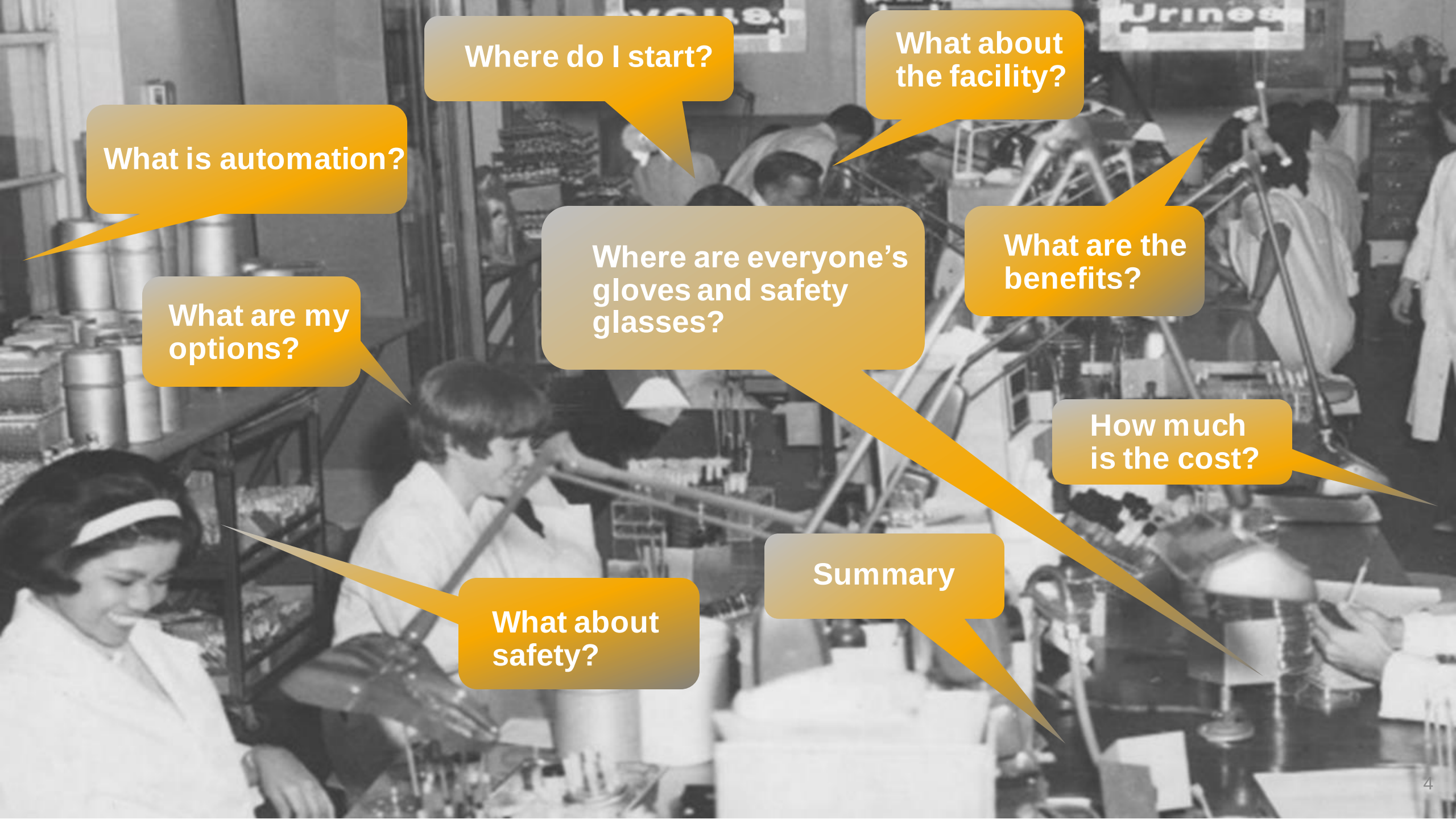
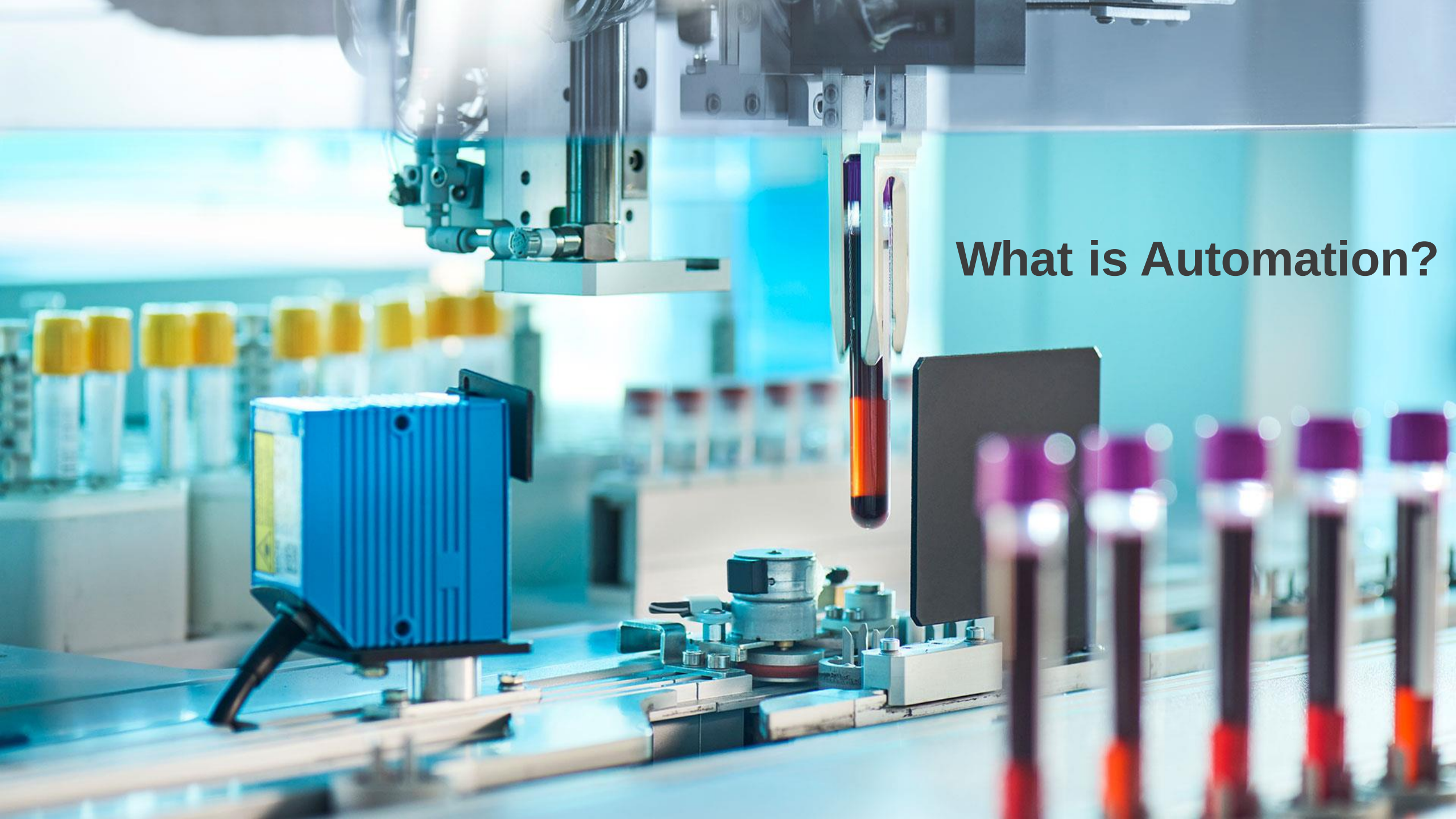
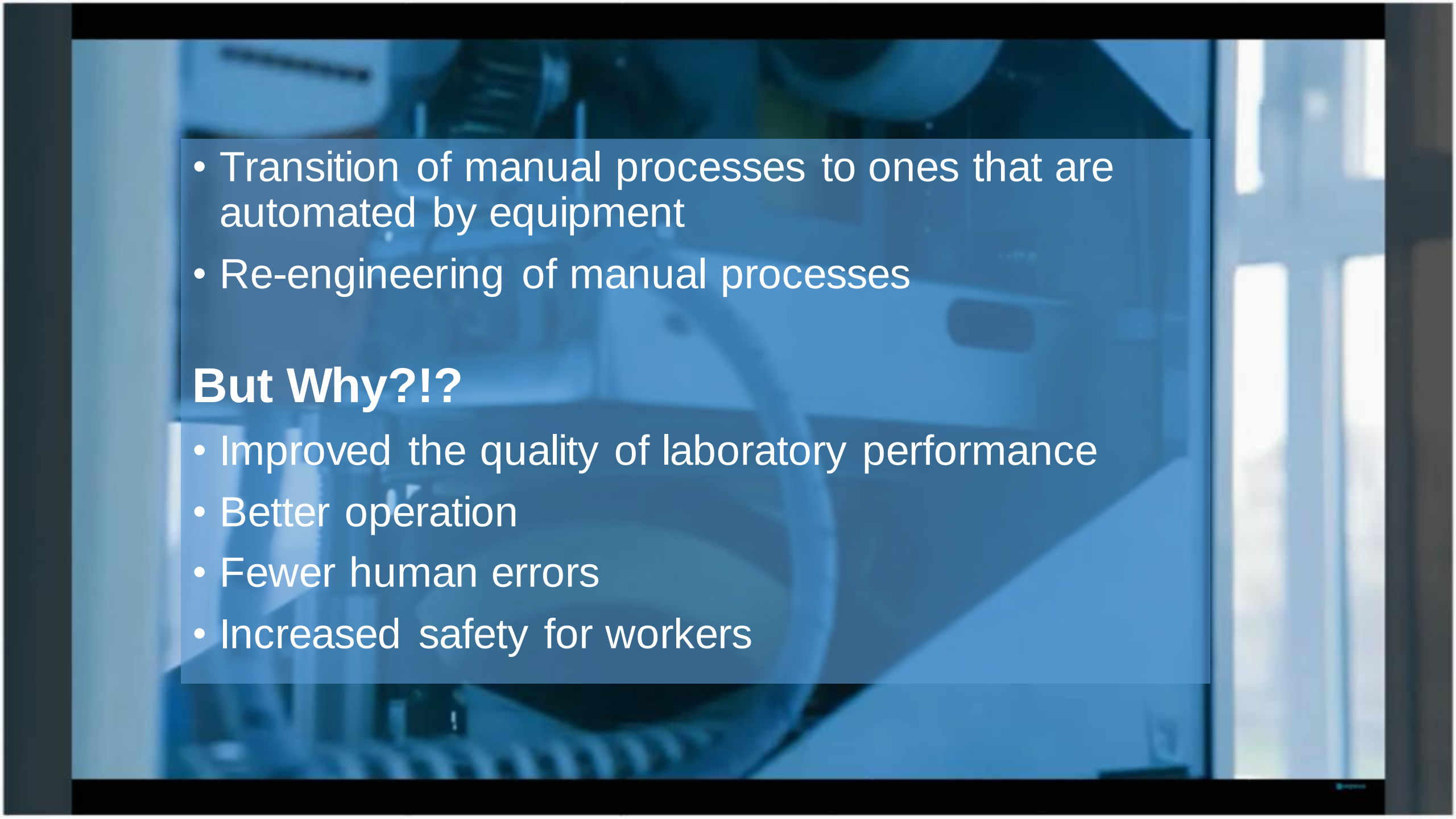
Laboratory Automation: Step by Step


Where do I start?
What about the facility?
What is automation?
What are the benefits?
Where are everyone's gloves and safety glasses?
What are my options?
How much is the cost?
Summary
What about safety?



What is Automation?



- Transition of manual processes to ones that are automated by equipment
- Re-engineering of manual processes

But Why?!?

- Improved the quality of laboratory performance
- Better operation
- Fewer human errors
- Increased safety for workers

What is Automation?

- Expect the use and sophistication of automated systems to increase.
- Automation and process re-engineering are the prime ways to address staff shortages.
- Industry will drive automated solutions – mega ‘factory’ labs.

What is Automation?

- Ability to maintain a close connection between the search for efficiency through automation and consolidation of services.

- Breaking down traditional silos using laboratory metrics to optimize workflow and the assurance of effectiveness both within the lens of quality, cost, and utilization.

Courtesy of CDC/ Public Register

Automation Pitfalls

- Incomplete understanding of current environment
- Constrained financial or spatial resources
- Loss in flexibility due
- Unrealistic expectations of system
- Unplanned and poorly developed “workarounds”
- Unclear expectations of system functionality
- Overbuilt and unnecessarily complicated system design
- Inadequate technical support

Automation Pitfalls

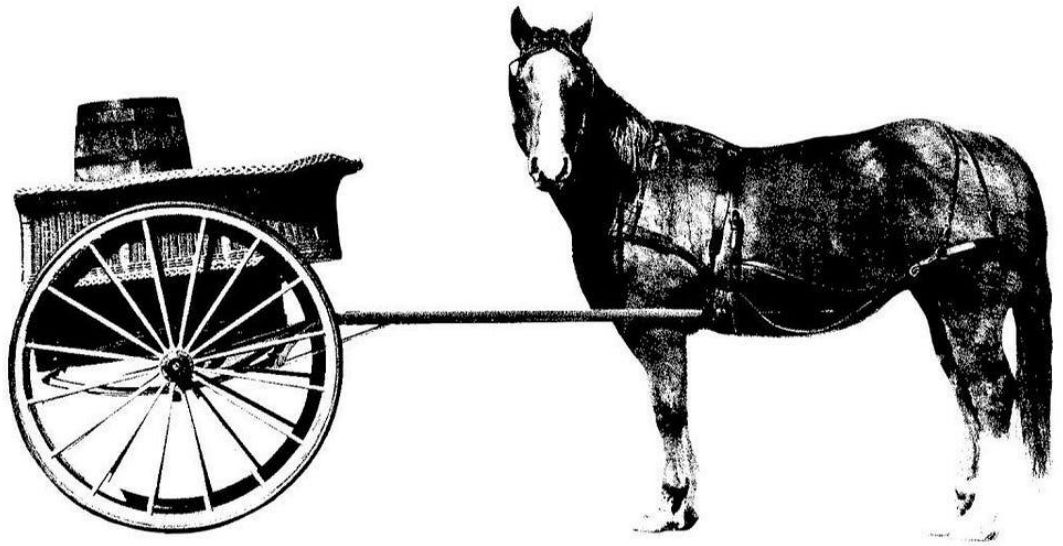
- Credible and realistic impact analysis never conducted
- Hidden costs
- Failure to optimize current processes
- Vendors overstating the benefits and elevating expectations
- Pandemic is over


Where do I start?

Before You Buy-In

Before You Put the Cart Before the Horse….

- Needs Assessment
- Cost-Benefit Analysis
- Workflow Analysis
- Scalability and Flexibility Requirements
- Technology Compatibility
- Vendor Research
- Stakeholder Consultation
- Regulatory Compliance
- Training and Support



Identify Solutions

Identifying Possible Solutions to Meet Needs

Use quality and turn-around time measures, workflow, and timing studies to find bottlenecks and potential areas for re-engineering.

Re-engineering of processes should precede the introduction of automation.

Automation is not always the solution. Check-in with other labs.

Examine performance-based re-engineering projects; these may have more impact on laboratory performance than an expensive automation project.

Automating a poor process is not the answer.

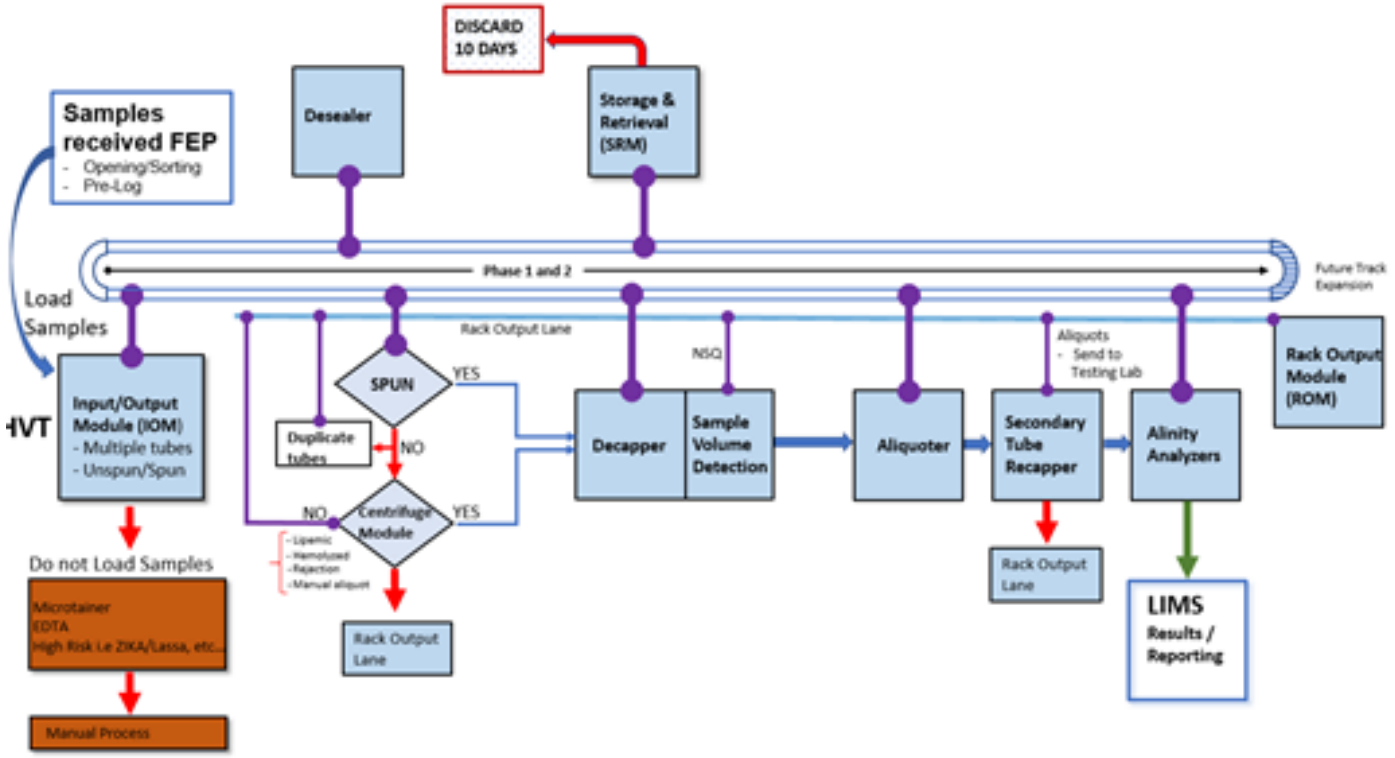
Re-Engineering Needs

- Use continuous quality improvement (CQI) tools to foster process improvements.
- Standardize processing procedures to ‘best practice’ solutions with the fewest hand-offs.
- Reduce or eliminate non-value added handling and sorting.
- Eliminate checking many locations to find shared specimens.
- Redesign workstations so that individuals process orders from start to finish.
- Maximize the number of specimens at test run start times.

Laboratory Needs

Determining the Laboratory's Needs

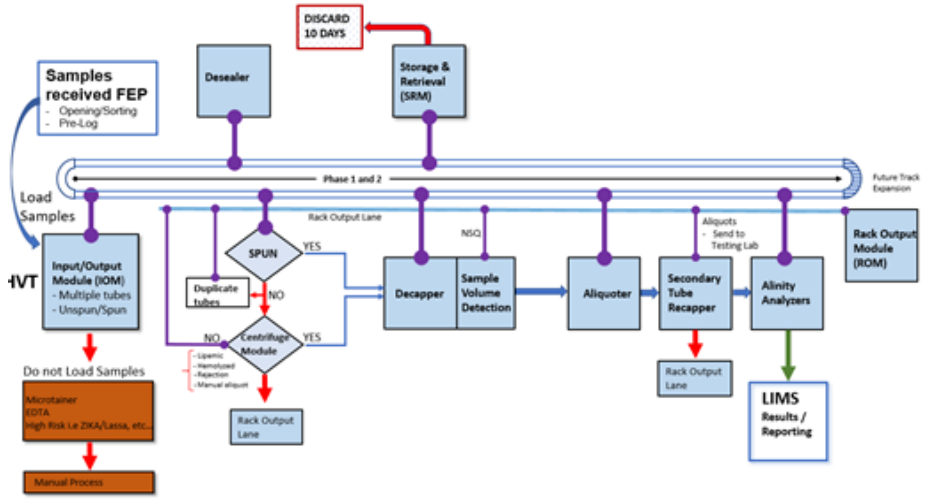
- Automated systems must match the specific work volumes and needs of each laboratory.
- In a fully automated laboratory, the layout of the laboratory and the shape of the spaces are critical for maximizing the return on investment.



Laboratory Needs

Determining the Laboratory's Needs

- What is the laboratory's specimen volume?
- Chart specimen count by hour of day and day of week.
- What percentage are centrifuged?
- What percentage are aliquoted?
- What percentage of specimens are shared between two lab sections?
- What percentage of specimens are refrigerated or frozen?

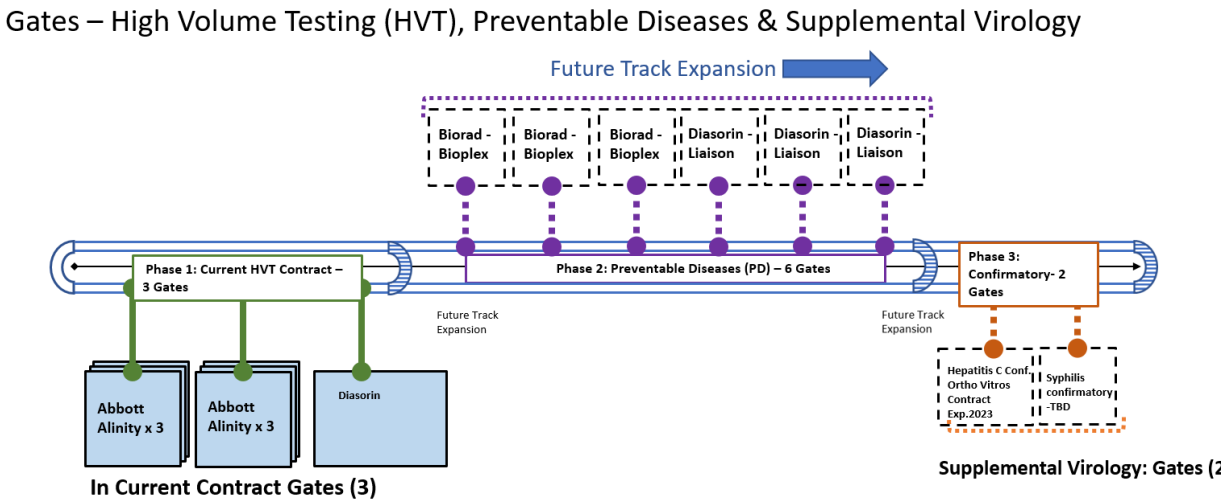


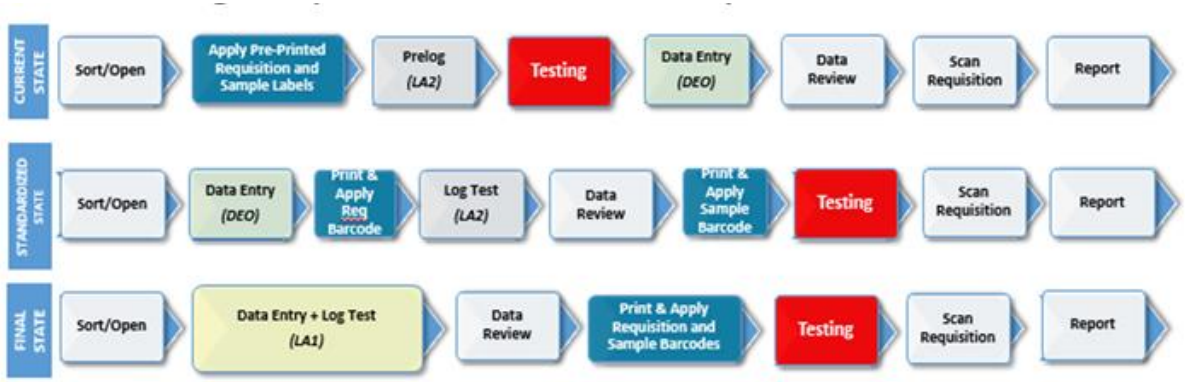
Systematic Approach to Automation

- Workflow Analysis
- Technology Assessment
- Integration Planning
- Training and Change Management
- Quality Assurance
- Continuous Improvement
- Supply Chain Issues

Workflow Mapping Pre-Automation

- Material flows (specimens)
- Process flows
- Data flow diagram - done at different layers of detail
- Workload map - can be used in simulation studies





Timing

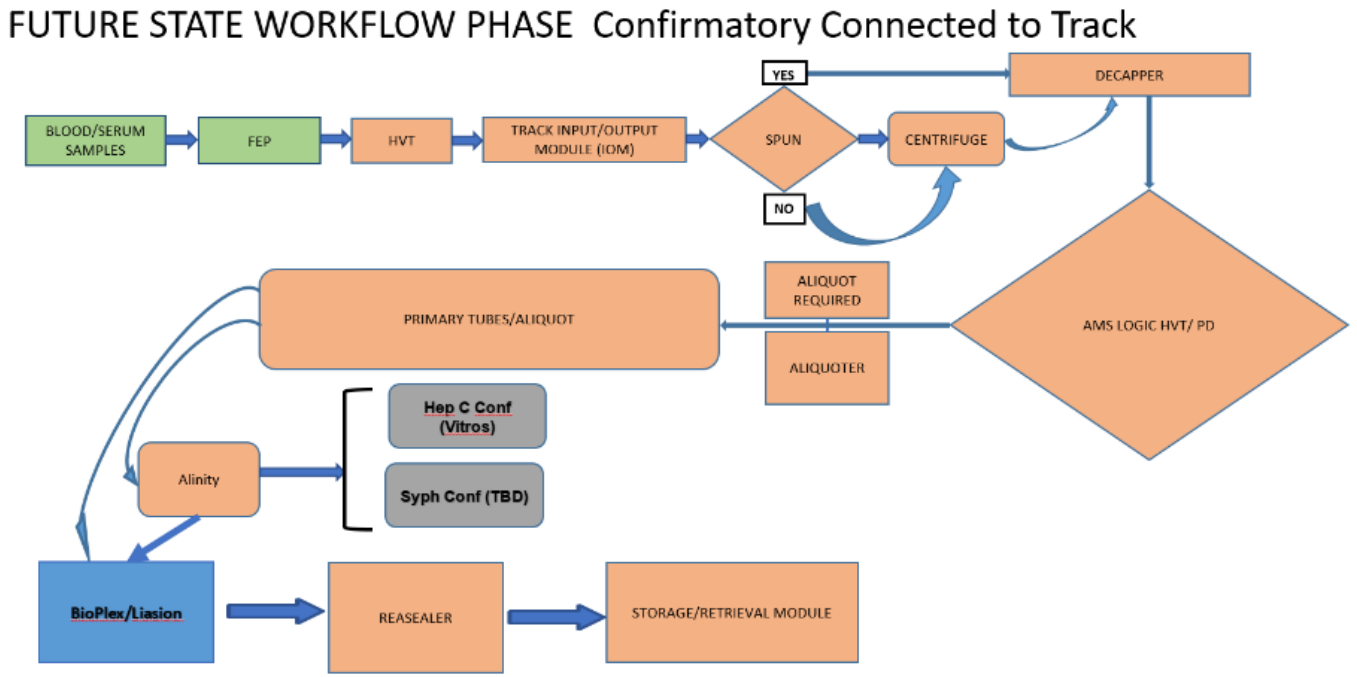
- Purpose is to count and time everything in relation to the workflow map.
- Specimen arrival v. accession time. Note the date & time of each step, the number of tubes in each batch, and the dwell time for each batch.
- Analysis should be done at different times of the day.
- Identify bottlenecks, idling time, and re-work (multiple handling).

Handling Considerations

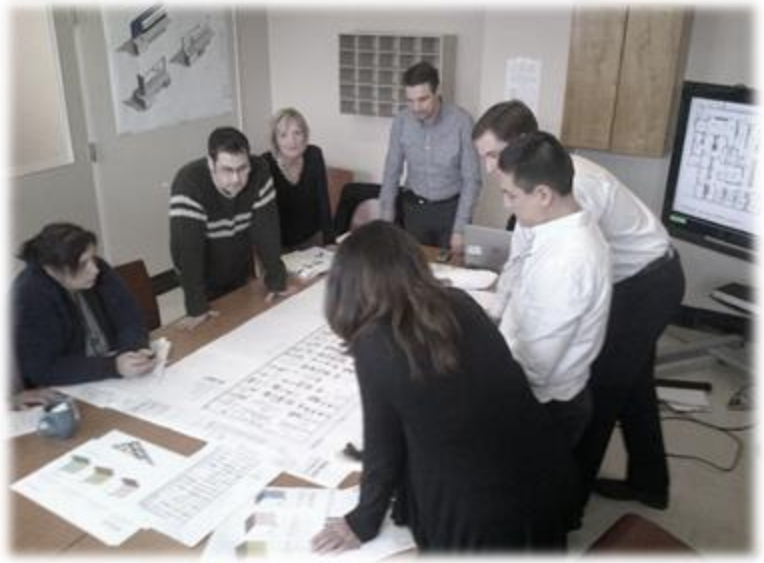
- Pour-offs and aliquoting – what is the workload?
- Sorting - how much sorting of specimens occurs - in Specimen Processing and in lab sections?
- Transport - delivery by Specimen Processing or pick-up by labs? What are the distances covered?
- How, where, and for how long are archived specimens stored?

Handling Considerations

- Sample management- centralized or decentralized?
- Using a manual system, paper requisitions, or QR codes?
- What is the percentage of repeat testing? Reflex algorithms?
- What is the percentage of additional testing requested to be added to archived specimens?



Evaluation of Alternatives



Define and rank objectives (needs to be filled).

Identify alternative solutions, some of which may not involve automated equipment.

Match the key features of alternative solutions to the most important needs of your lab that are solved by those solutions.

Emphasis in any solution that is selected should be on process control and process improvement.

A solution with several small steps sometimes is better than a major implementation of automation.

There are several options available, from stand-alone integrated systems to pre- and post-analytical modules that can be used with analytical units, modular systems to total laboratory automation.

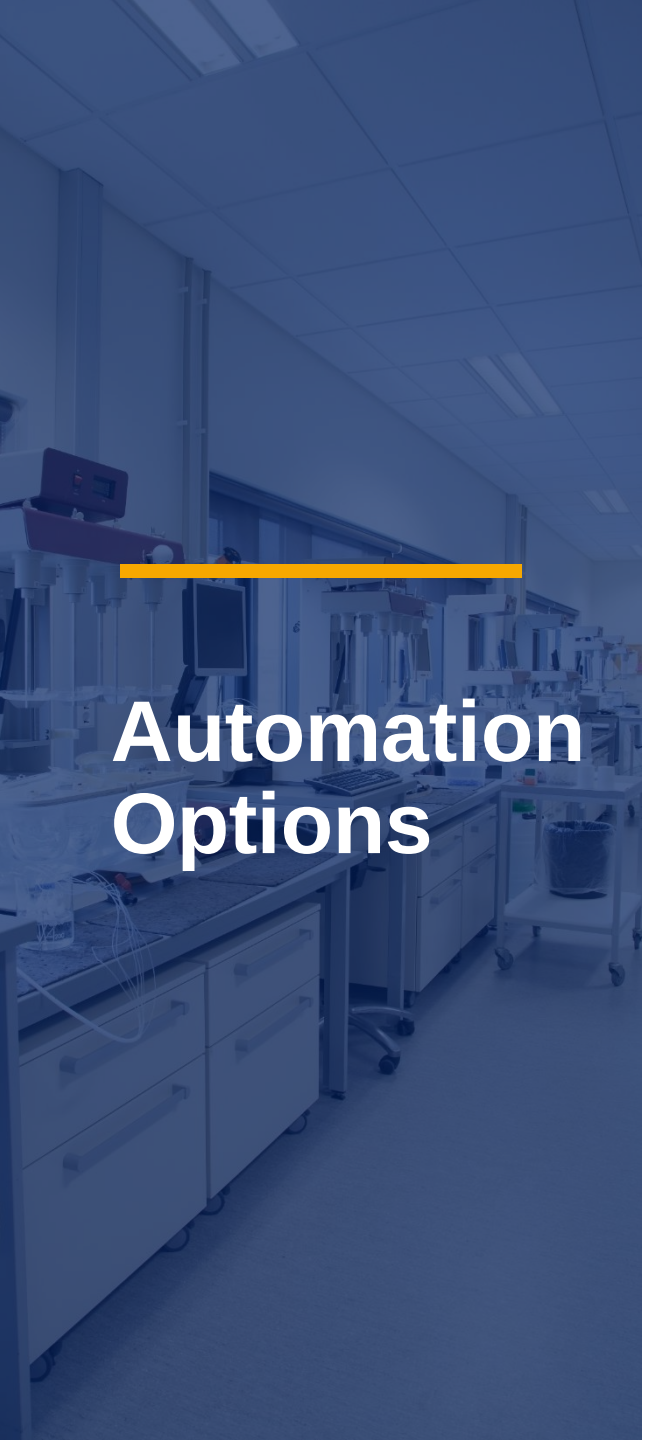

What are my options?

Automation Options

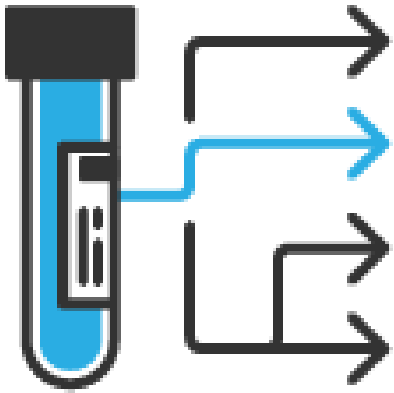
- Robotic Process Automation: Use of robots for repetitive tasks such as sample handling, sorting, and pipetting.
- Automated Sample Processing: Systems for centrifuging, aliquoting, and sorting samples.
- Integrated Platforms: Combining multiple automation solutions into a single, cohesive system to handle various laboratory processes.
- Automated Storage and Retrieval Systems: Efficiently manage and access archived samples.

Automation Options

- Workflow Automation: Software to automate scheduling, task assignment, and result reporting.
- High-Throughput Screening (HTS): Technologies for rapidly conducting a large number of tests.
- Digital Pathology: Automation of slide scanning and image analysis for pathology.
- Artificial Intelligence (AI) and Machine Learning: Enhancing data analysis, predictive maintenance, and decision-making processes.



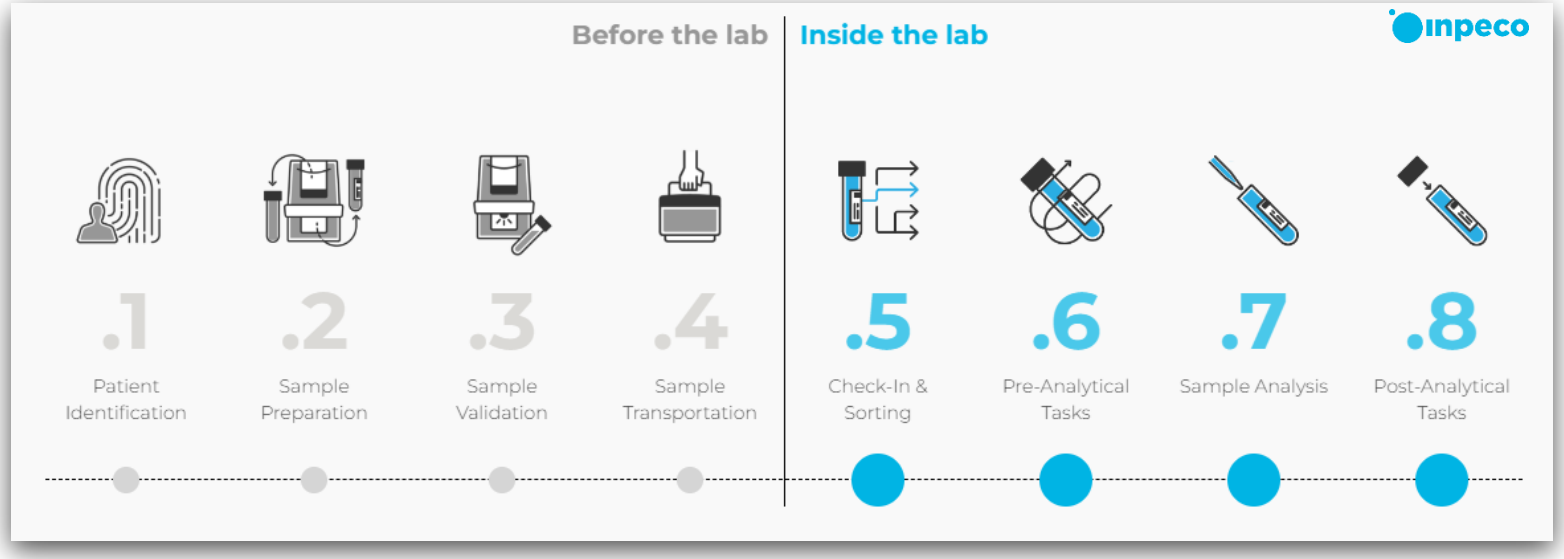
Automation Options



- Barcode and QR Code Systems: For efficient sample tracking and management.
- Automated Microscopy: Systems for high-resolution imaging and analysis.
- Lab Robotics: Advanced robots for complex tasks such as liquid handling, colony picking, and plate handling.
- Remote Monitoring and Control: Systems for managing lab processes remotely.

Automation Options

- Lab Automation Workstations: Modular robotic systems that can perform multiple tasks, including sample preparation, nucleic acid extraction, and PCR setup.
- Liquid Handling Robots: Perform tasks such as dispensing, mixing, and transferring liquids, often used in high-throughput screening and assay development.



What about the facility?

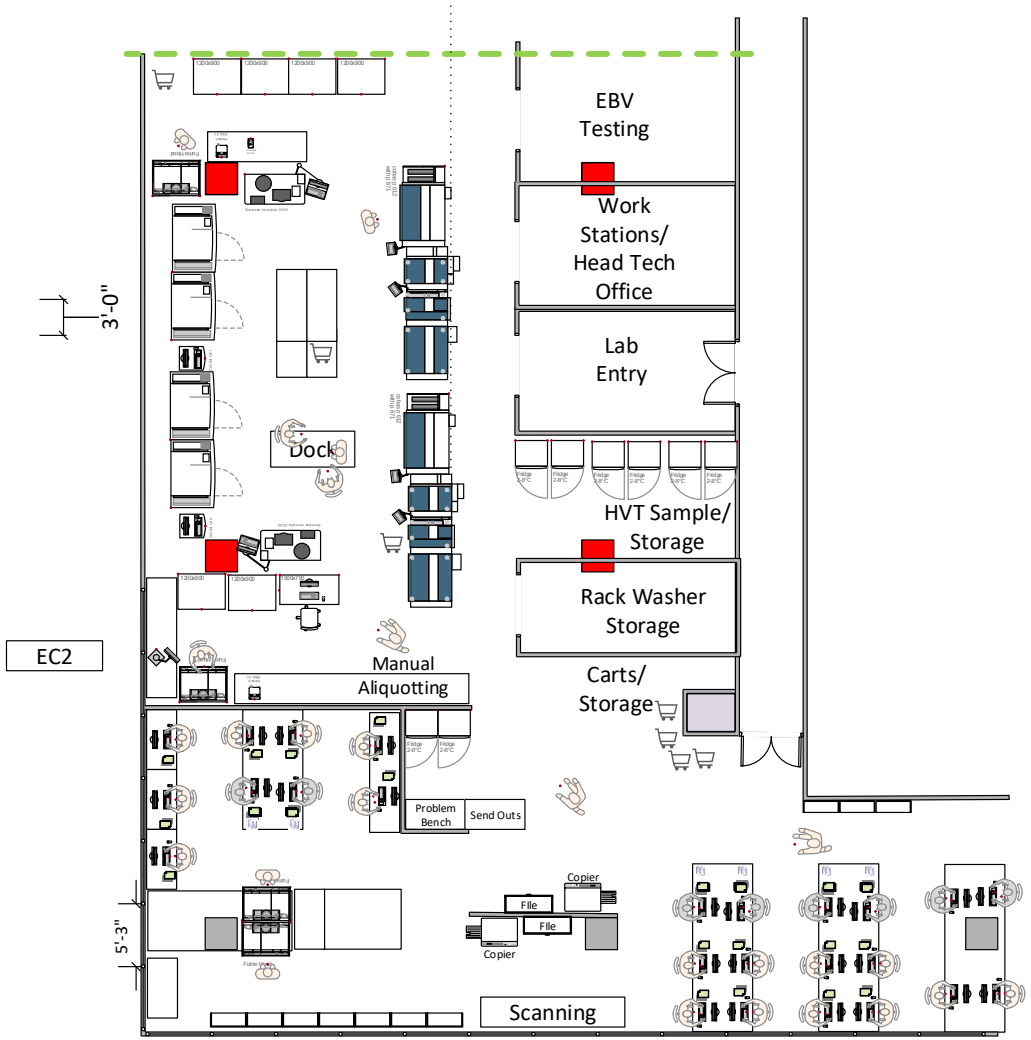
Self-Driving Laboratories

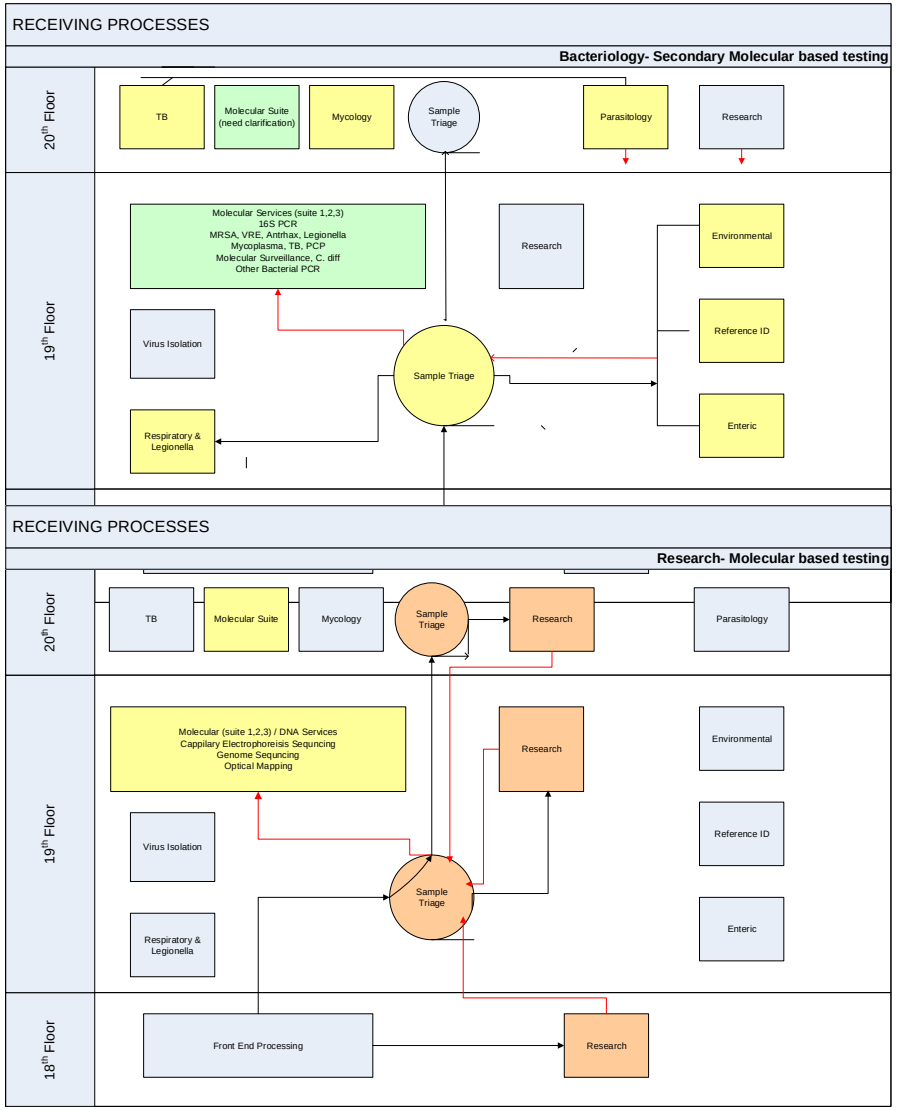
- Automation of Routine Tasks
- AI and Machine Learning
- Integrated Systems
- Real-Time Monitoring and Control
- Data Management
- Adaptability and Scalability
- Enhanced Safety and Reliability
- Predictive Maintenance

When designing new space or renovating existing facilities:

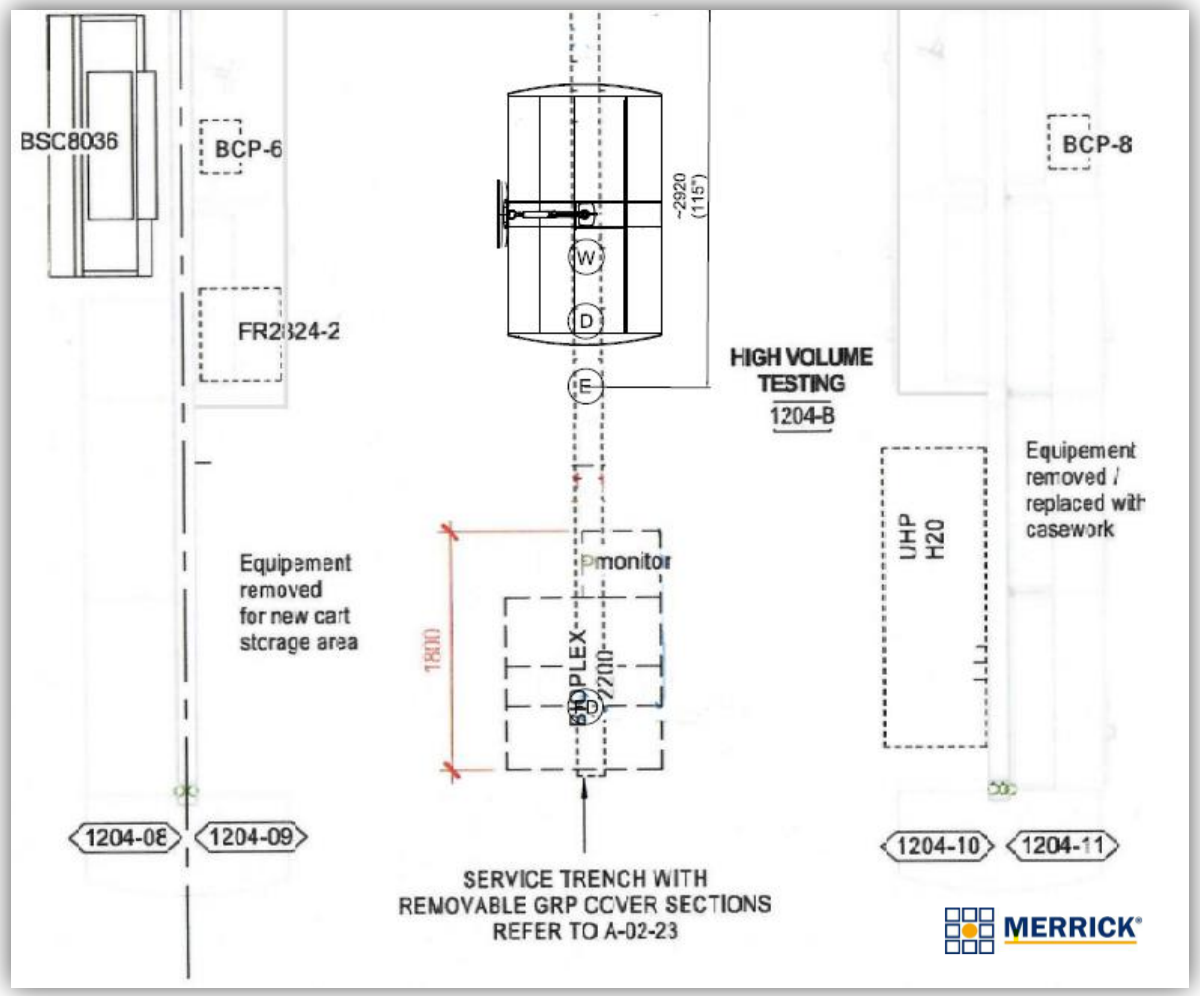
- Organize facilities to align with the flow of specimens.
- Place high-volume testing areas (e.g., chemistry, hematology) nearest to Specimen Receiving and low-volume testing areas farther away.
- Minimize traffic congestion by avoiding routing all lab activity through critical areas like Specimen Receiving.
- Locate client service and exception handling activities within or near Specimen Receiving.
- Consider future design considerations to control costs while strategically positioning for future needs.

Workflow Analysis/Process Mapping





Equipment Layout



Maintenance & Upkeep

- Plan for routine maintenance of automated systems and infrastructure.
- Ensure easy access for repairs and upgrades.

Maintenance and Upkeep: Planning!!!

- Collaboration is crucial!!!

- Open lines of communication

Automation Integration & Infrastructure

- Incorporate robotic workstations with adequate bench space and connectivity for automated equipment.
- Plan for overhead service carriers or tracks for robotics movement, ensuring safety and accessibility.
- Design infrastructure to support the electrical, plumbing, and HVAC needs of automated equipment and robotics.
- Provide sufficient power outlets, data connections, and backup power sources.
- Consider specialized infrastructure, such as vibration-resistant flooring for sensitive instruments.

Lab Layout and Space Allocation

Design	Design the layout to accommodate automated equipment, robotics, and workflow efficiency.
Allocate	Allocate space for sample preparation, analysis, storage, and robotics operation.
Consider	Consider the need for separate cleanrooms or controlled environments, depending on the type of research.

Data Management & IT Infrastructure

- Establish a robust IT infrastructure for data storage, transfer, and analysis.
- Implement cybersecurity measures to protect sensitive research data.
- Ensure network connectivity for remote monitoring and control.

Instrumentation & Equipment

- Design spaces to accommodate analytical instruments, storage, and maintenance areas.
- Plan for equipment access, maintenance, and calibration.
- Consider centralized instrument management systems for scheduling and data collection.

Flexibility & Scalability

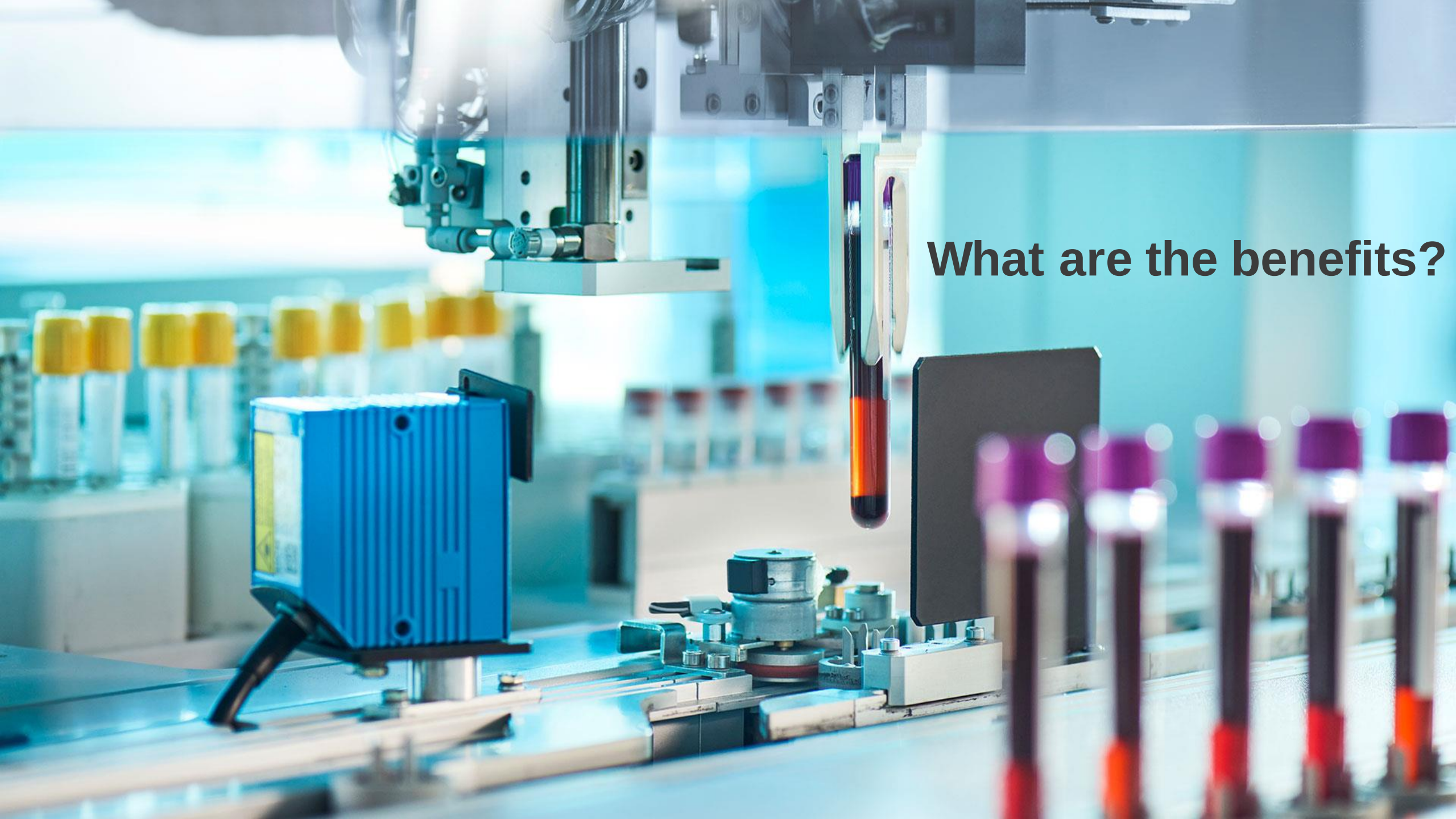
- Design the facility to be modular and adaptable to changing research needs.
- Allow for the integration of new technologies and the reconfiguration of lab spaces.

Collaboration Spaces

- Include areas for collaboration, meetings, and data analysis to encourage interdisciplinary teamwork.
- Consider shared spaces for researchers from different labs or organizations.

Environmental Sustainability

- Incorporate sustainable building materials and energy-efficient systems.
- Plan for waste management and recycling solutions.
- Consider green building certifications, if applicable.



What are the benefits?

Robotics – Initial Design – COVID-19

Risk Assessment

What is the strategy ?

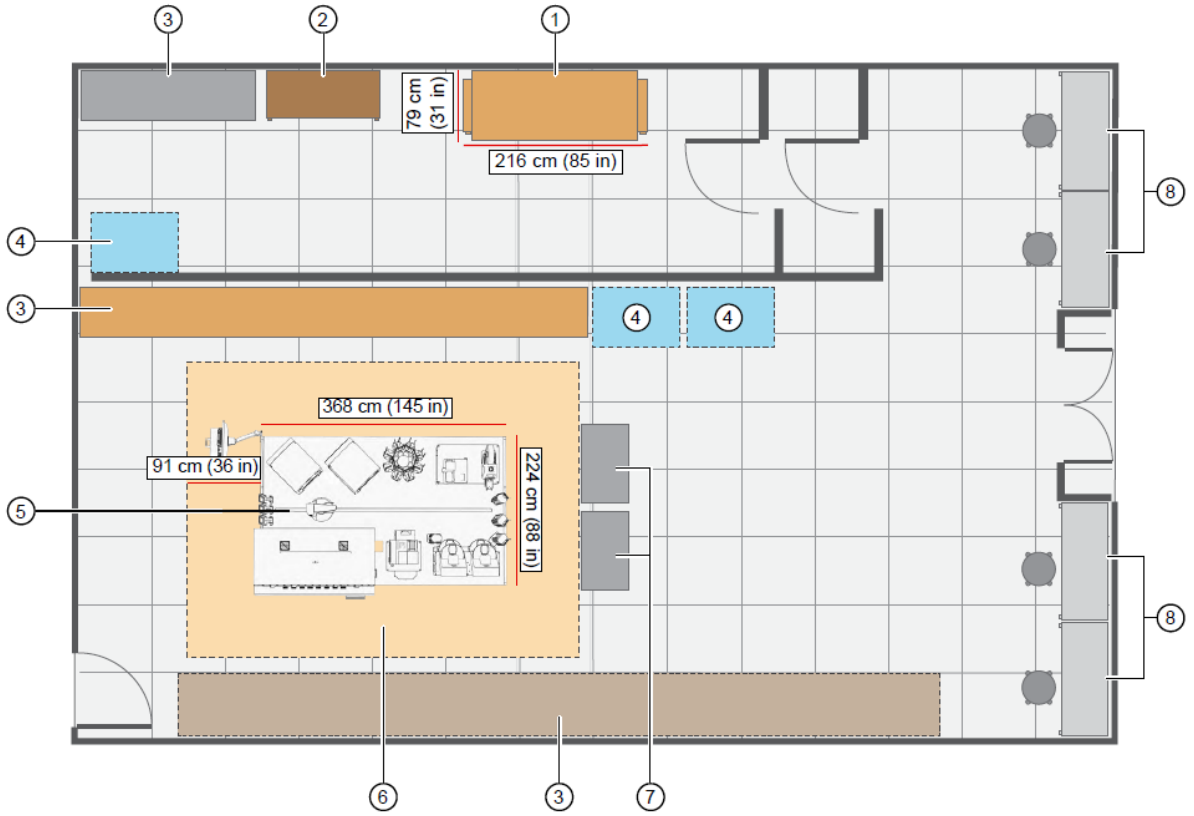


Figure 1 Example BSL-2 + BSL-1 laboratory layout with one Amplitude™ Solution system

1. Module 1 in BSL-2 room
2. Biological safety cabinet
3. Workbench/cabinet storage
4. Refrigerator/freezer
5. Module 2 in BSL-1 room
6. Minimum 91 cm (36 in) working clearance around Module 2
7. Support tables
8. Desk space

Benefits

COVID-19 Testing Ramp-Up

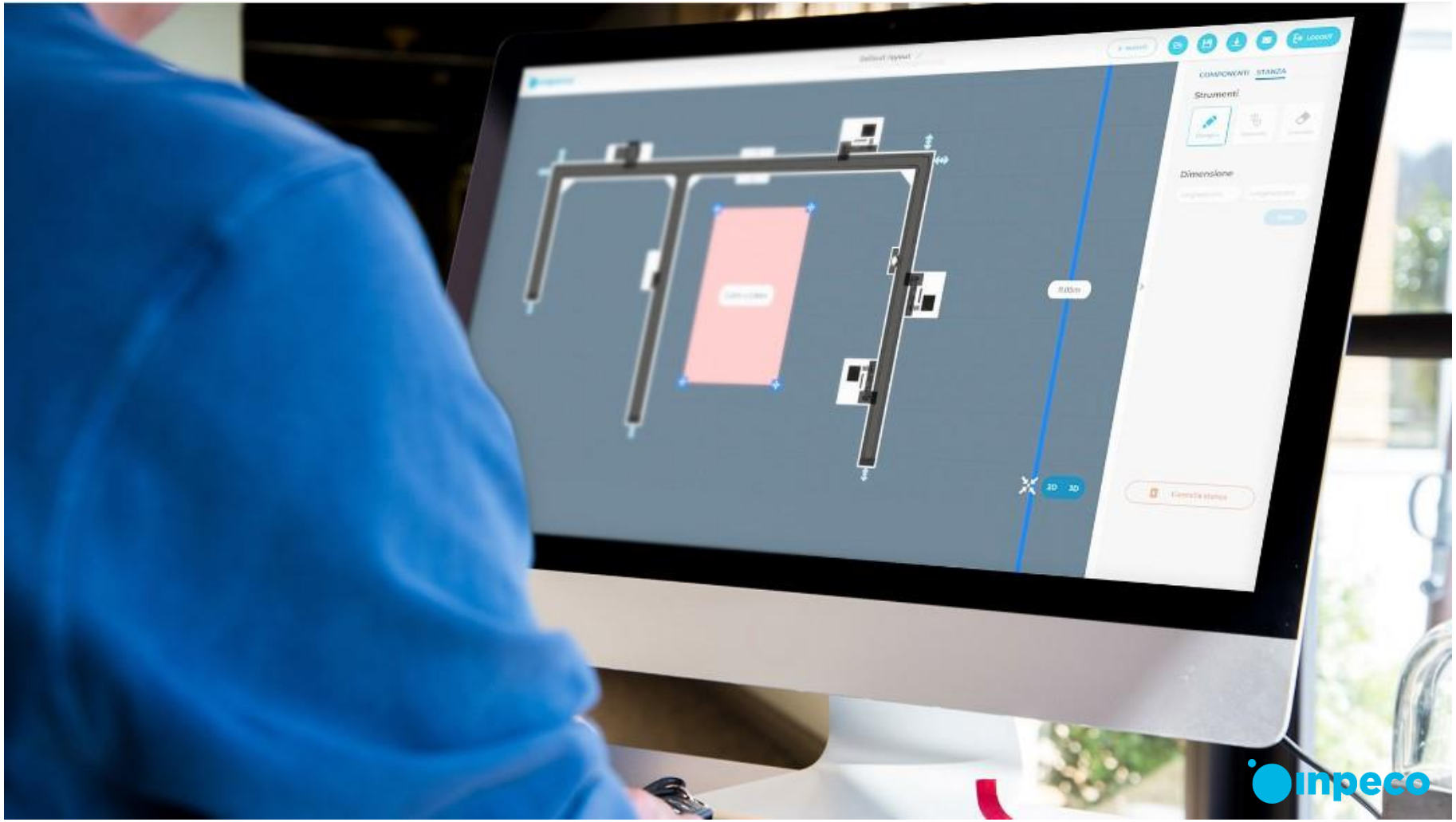
High-throughput PCR assays

Continuous Testing

Efficiency and Quality

Public Health

Flexibility and Scalability



Flexibility and Scalability

- Modular Design
- Interoperable Systems
- Flexible Software
- Remote Monitoring and Control
- Scalable Infrastructure
- Regular Upgrades
- Vendor Partnerships

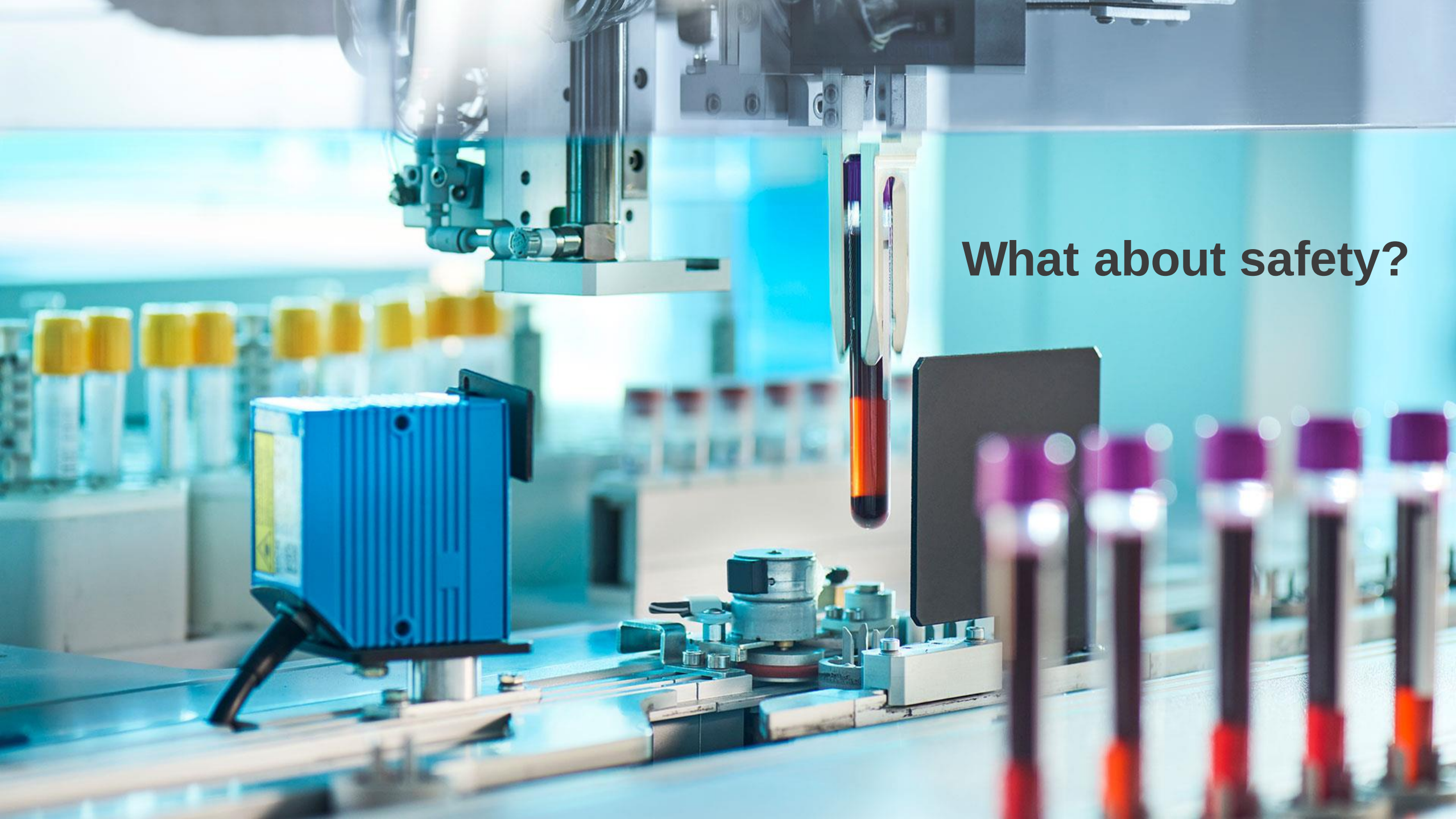

How much is the cost?

Cost Considerations

- Installation and Setup
- Training
- Maintenance and Service Contracts
- Consumables and Supplies
- Software Licenses
- Facility Requirements
- Return on Investment (ROI)

Cost Considerations

- Scalability
- Regulatory Compliance
- Energy Consumption
- Lifecycle Costs
- Vendor Partnerships


What about safety?

Automation Safety

Many positive impacts of automation

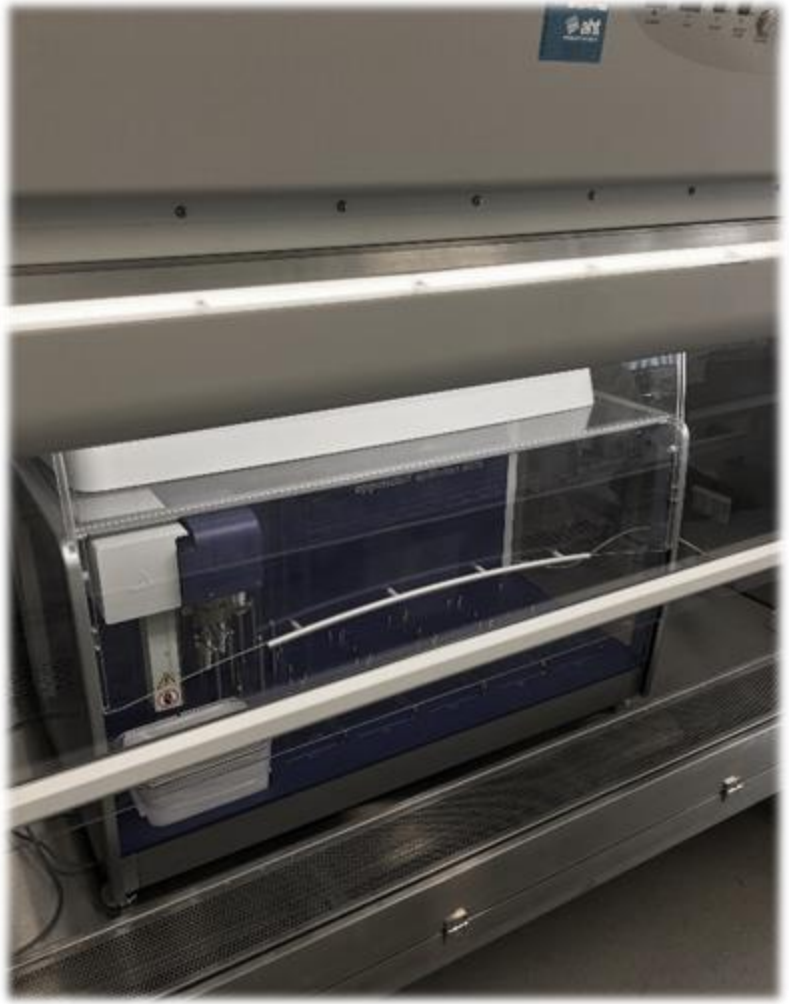
Automation can be worker-focused

Automation Enables Elimination of the Hazard

- Avoid the reliance on manual instruments/tools (e.g., pipettes).
- Minimize musculoskeletal injury by enabling task variation.
- Reduce repetitive tasks – considering the high volume of testing!
- **<u>Let the equipment do the work!</u>**

Automation Enables Elimination of the Hazard

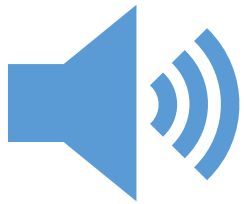
- Create safety enclosures around equipment.
- Remove hazards using local exhaust ventilation directly over equipment ports.
- Waste collection within the system.



Ergonomics

- Design work with workers in mind
  - Efficiency
  - Comfort
  - Safety

Ergonomics



Choose equipment

- Low noise
- Locate carefully away from quieter areas

Ensure automation does not interfere with

- Room temperature
- Overall comfort
- Other equipment

Ergonomic Considerations

- Accessibility and size of knobs, buttons.
- Visual displays w/ options for brightness and contrast control.
- Keyboard & mouse are suitably positioned.

Summary
What did I learn?

Automation Lessons and Take-Home Messages

- Know your laboratory's business!
- Map workflow to find bottlenecks/constraints
- Determine your primary and secondary objectives
- Use your workflow map and objectives to authenticate vendor proposals (where does the truth lie?)
- Focus on process improvement
- Re-engineering processes may have just as much impact on operations as automation
- Maximize use of information technology
- Consider alternatives
- Justify all costs
- Take your time/ consult with those who have real word experience


Questions?
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