

best practices for laboratory design

INCORPORATING LAB BEST PRACTICES & WORKFLOW INTO THE DESIGN

by Steve Kimball



introduction

A clearly defined and properly implemented laboratory workflow plan includes processes that boost efficiency, productivity, and quality. Subsequently, an architectural space plan that reflects a defined workflow will:

- Improve Space Allocation
- Improve Efficiency
- Increase Adaptability
- Increase Cost-Effectiveness
- Minimize Movement
- Increase Safety
- Reduce Errors (including cross-contamination)

When working with an architect to design a new laboratory space, be prepared to provide a concise overview of your lab's workflow that addresses laboratory type, experiments, processes, process activities, quantity of processes, equipment requirements, key functions of the equipment, and shared activities and equipment.

The workflow plan should reduce the time and cost of sample handling, preparation and data collection while ensuring the quality of the sample and any associated data is maintained. Laboratory workflows are typically driven by standard operating procedures (SOP), and are most effective when addressing real-world practices

Beginning the design with a clear understanding of workflow requirements will inform the programming and planning process to achieve an optimal and efficient layout.

best practices

A crucial key in successful laboratory design involves implementing laboratory workflow and related best practices that incorporate the following key elements.

PURPOSE-DRIVEN DESIGN

Ensure specific goals and objectives of the laboratory are clearly communicated providing the underlying fundamental guidance for the project design. What drives a medical laboratory can be dramatically different than a research organization or a testing facility.

STANDARD OPERATING PROCEDURES (SOP)

Communicate and incorporate clear SOPs for all lab processes as a fundamental consideration in design development.

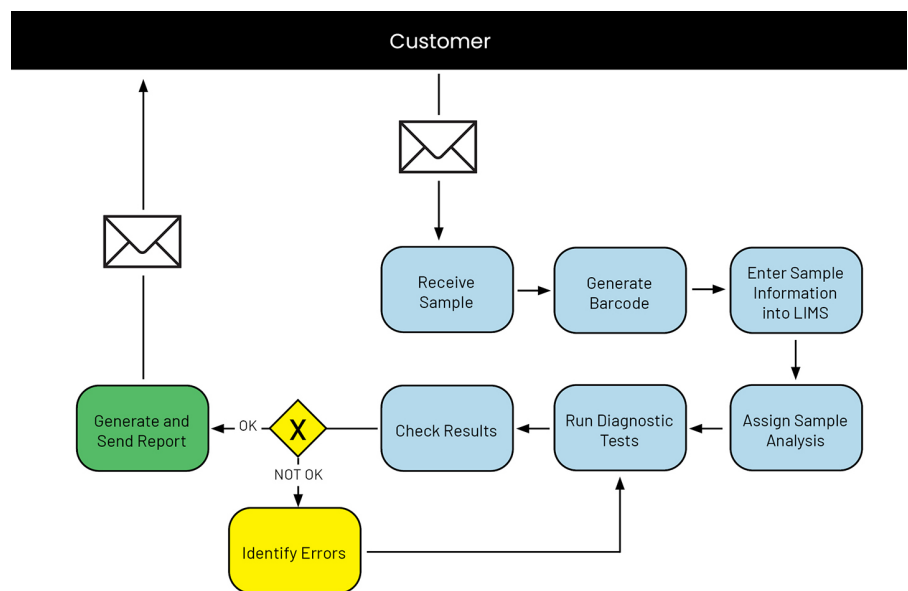
WORKFLOW

Workflow design should support staff movement, materials, and equipment to maximize efficiency. Consider throughput, separation of clean & dirty activities, shared & dedicated work zones, and incorporation of technology & automation where appropriate.

Dedicated work zones for multiple types of typical laboratory activities provide opportunities for efficiency, collaboration, and focused processes. Proper programming and planning of each work zone and their relative adjacencies will ensure that processes can be performed without interference or cross-contamination.

Typical workflow types are linear workflow and modular workflow. Linear workflow design is well suited for laboratories with standard step-by-step processes that are logical and sequential. Fixed laboratory environments work well with this protocol. Modular workflow design can accommodate laboratories with changing or multiple processes that require a great deal of flexibility.

Waste management flow, including hazardous waste handling and disposal are critical elements of the overall workflow process to ensure regulatory compliance and efficient laboratory operations.



DIRTY / CLEAN SEPARATION

Separating dirty and clean workflows is crucial to prevent cross-contamination and ensure safety. Best practices include:

- **Unidirectional Workflow:** Workflow design should ensure a clear travel path and a one-way flow of materials and personnel from dirty to clean areas to minimize cross-contamination.
- **Physical Separation:** Include appropriate physical barriers to separate dirty and clean areas
- **Waste Management:** Separate dirty/hazardous waste from clean storage. Colocate dirty/hazardous waste materials and disposal areas. Avoid travel through clean work zones.
- **Signage:** Provide signage designating dirty work zones. Train staff on lab protocols for movement between clean and dirty work zones.
- **Dedicated Equipment:** Dedicate work zones for dirty and clean equipment to avoid cross contamination.
- **HVAC Systems:** HVAC systems and controls should provide negative pressure in dirty zones and positive pressure in clean zones.
- **Cleaning & Maintenance:** Establish protocols and regularly scheduled cleaning and maintenance of dirty and clean work zones.



SAFETY AND CONTAINMENT

Identify current code/regulatory requirements. Key considerations include:

- **General:** Include hazard identification, HVAC systems controls, and emergency overrides. Identify required containment areas, their proximity, and how they affect workflow, .
- **Eyewash/Shower:** Identify requirements; incorporate appropriately.
- **Fume Hoods:** Locate fume hoods and ventilation in appropriate locations for efficiency, travel, and operational safety.
- **Flammable Materials Cabinets:** Source cabinetry for chemical types and quantities for daily use & storage. Establish requirements for ventilated vs. non ventilated cabinets.
- **Chemical Waste Disposal:** Establish design requirements for sanitary disposal locations.
- **First Aid & AED:** Determine quantity and strategic location(s) to provide easy identification and access.
- **Emergency Lighting & Exits:** Provide clear visibility and unobstructed pathways.
- **Fire Extinguishers:** Provide unobstructed and clearly visible locations per code.
- **PPE:** Plan and locate personal protection equipment (PPE) to accommodate clean and dirty gowning activities.



FLEXIBILITY AND ADAPTABILITY

Incorporate a standard lab module layout utilizing modular lab benches with flexible strategically placed overhead utilities to address current and future lab process and activities demand. Modular design provides flexibility to address demand adaptability while reducing and eliminating future renovation costs.

- **Modular Furniture:** Design based on lab furniture that is easily moved or reconfigured. Lab benches and furniture on locking wheels provide ease of relocation.
- **Overhead Utilities:** Distribute utilities overhead. Include spacing within the lab module that allows ease of access for reconfiguration as needed. Ceiling Interface Panels (CIP) provide power, phone, data, and service outlets. Umbilical cords enable mobile benches to move freely in the lab without having to redirect services.
- **Multipurpose spaces:** Provide space and opportunities for informal and formal collaboration. Incorporating multi-purpose space that can facilitate use for meetings and analysis creating opportunities for efficiency and an open plan with visibility into segregated spaces will improve communication and efficiency.
- **Storage:** Materials flow is key to maintaining an organized lab. Consider how supplies, samples, and equipment will be stored relative to their use in the lab. Maximizing storage efficiency helps keep the lab organized and prevents workflow disruptions.
- **Travel Distance:** Supplies and workstations should be placed close to where they are used. Consider location relative to lab module placement and future reconfiguration considerations. Locate common storage areas in a central location.



ERGONOMICS

Understanding activities and process that allow staff to work comfortably and efficiently is fundamental to lab design. Easy access to utilities, benches, stools, keyboards, and other items improves efficiency and productivity. Design elements to consider:

- **Flooring:** Resilient flooring systems or anti-fatigue mats for standing.
- **Seating:** Provide adjustable seating (height, armrests, seatback).
- **Benches / Workstations:** Include "sit-to-stand" workstations to accommodate movement and a variety of workstyles.

Well thought out ergonomics will improve productivity, staff satisfaction, and reduce absenteeism.



TECHNOLOGY

High speed secure internet and data networks are essential as laboratories expand automation and incorporate artificial intelligence in workflow. Private or proprietary information might require secure areas with limited access.

- **Wireless Communications:** Understand the appetite for, and technology available to support wireless communications.
- **Data Ports:** The location and quantity of data ports is critical to a well-functioning facility. Assess technology support requirements to include fiber and copper cabling.
- **Lab Information Management Systems (LIMS):** Evaluate LIMS needs to streamline data collection, analysis, and distribution.
- **Automation:** Evaluate the cost/benefit of automating lab processes.
- **HVAC Controls:** Review and implement appropriate control systems that allow management and reporting for each lab HVAC system.
- **Security:** Incorporate card access and other security measures required by certain lab activities.
- **Lighting:** Consider automated lighting systems controls for time of day use to reduce energy expense.
- **Building Management System (BMS):** Review pros & cons of a total BMS that is capable of integrating all lab technology systems for control and reporting.

summary

Paying close attention to stringent laboratory protocols is key for the design of an efficient, safe, and productive work environment. An early detailed planning and programming effort optimizes workflow and space, and provides a space that meets current and future needs. Minimizing travel distance between stations, creating dedicated work zones, and integrating technology will significantly improve day-to-day operations.



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