Laboratory Safety & Ergonomics

Crossover Roundtable Session

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Photos taken at Purdue's Bindley Bioscience Center

http://www.purdue.edu/discoverypark/bioscience/

Safety and Ergonomics in the Laboratory

- *Because of the increasing complexity in laboratory protocols and the length of time for executing these protocols the chances for "incidents" (accidents), are increasing.*
- *Because laboratories are designed more on form (to yield the correct analytical result), than function (in harmony with the musculoskeletal aspects of the laboratory worker), ergonomic related musculoskeletal disorders are increasing.*

The Goal of this Presentation is to:

- *Demonstrate the relationship between safety and ergonomics in the laboratory*
- *Highlight the causes and cures of musculoskeletal injuries and illnesses in the laboratory*
- *Focus on safety in the laboratory from a work organization and work flow perspective.*
- *Conclude by showing a step by step approach to a safer and more efficient laboratory that not only protects laboratory workers but those they serve.*

Strong growth in the Laboratory Sciences is expected over the next 20 years because there is a need and it pays well.

CNN Money U.S. + Business Markets Tech Media Personal Fina

BEST JOBS IN AMERICA *CNNMoney/PayScale.com's list of great careers* 2012

48. Clinical Laboratory Scientist

48 of 100 « BACK NEXT »

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Median pay: $68,000
Top pay: $105,000
10-year job growth: 36.4%
Total jobs*: 100,000


PHOTO: THINKSTOCK

What they do all day? When a person has an illness, whether it's relatively mild like strep throat or serious like cancer, medical tests of organ, tissue, or cell samples are usually used to confirm it. Clinical laboratory specialists conduct those tests, as well as a variety of others, and analyze them. They can also evaluate the effect of drugs on certain diseases in order to come up with treatments. --*J.A.*

Laboratories can be a dangerous place to work if you have poor work practices and lack the required skills.

Worst Lab Accidents in History

Labs Are Dangerous

1 of 10

An Explosive Situation ››

Laboratories are dangerous places. Most of them come fully stocked with nasty chemicals of all sorts, from strong acids to neurotoxins. They also come equipped with natural gas-guzzling Bunsen burners and high-pressure cookers called autoclaves. Additionally, physics labs often have lasers; chemistry labs have explosives; and biology labs often have infectious organisms. Literally, everywhere you turn, there is something that could seriously injure you... or worse.

One of the editors of this website had a particular penchant for damaging tabletop centrifuges. He also once burned off some arm hair with a Bunsen burner, while a labmate burned off eyebrow hair. Another colleague acquired impetigo from *Staphylococcus aureus*. Thankfully, these were all rather minor accidents. But, anyone who has spent considerable time in a laboratory has either fallen victim to an accident or known someone who has. And some of these accidents can be catastrophic.

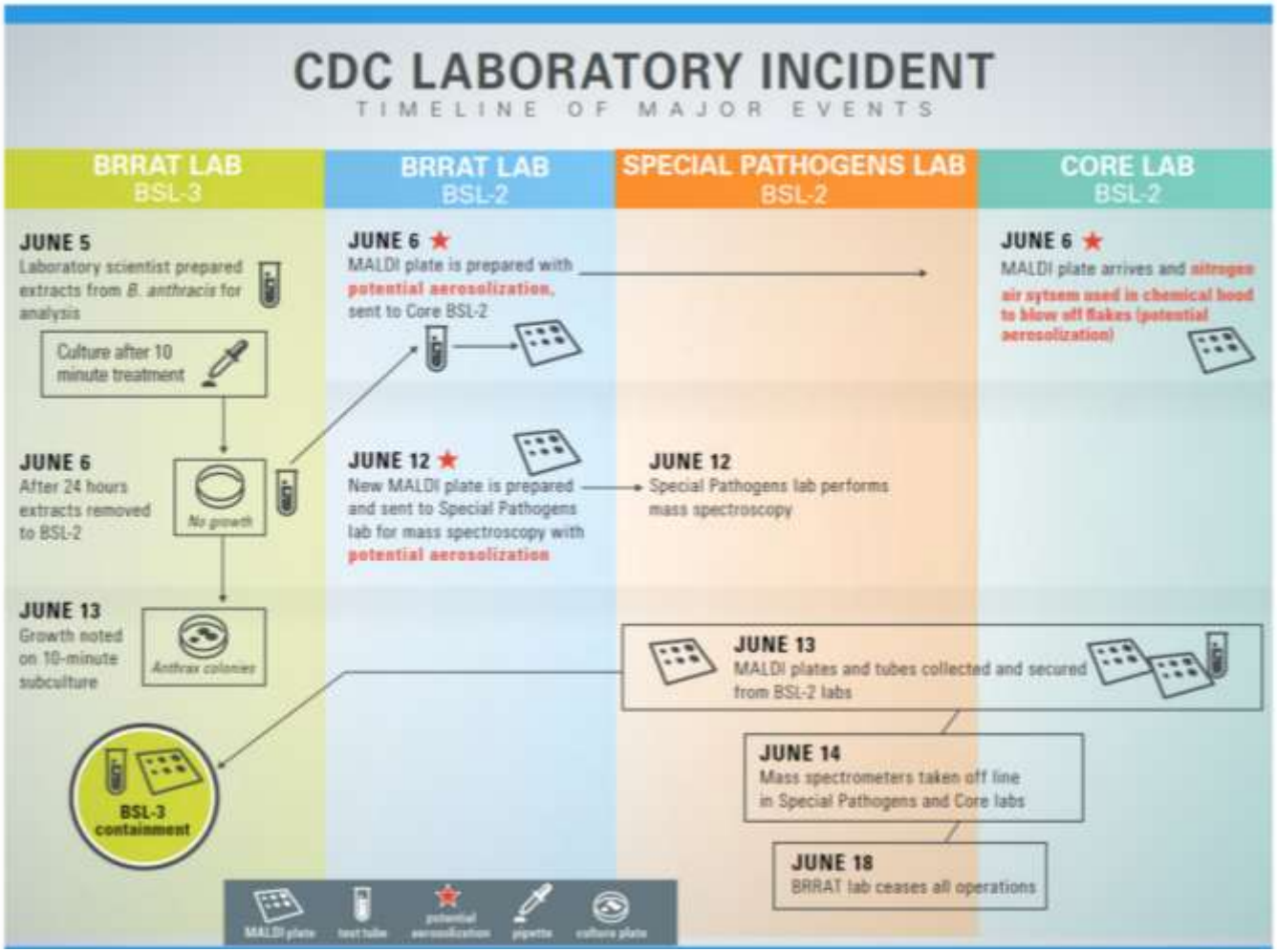
Read on to discover some of the worst lab accidents in history.

(AP Image)

They are not only dangerous to laboratory workers but…

http://www.realclearscience.com/lists/worst_lab_accidents_in_history/

They can be dangerous to the public.



May 2014: Near disaster by CDC Anthrax Release.

Then the Pentagon did a similar thing as the CDC.

Pentagon sends live anthrax to 51 laboratories by mistake

3 June 2015 Last updated at 23:57 BST

The Pentagon has confirmed that live samples of live anthrax have been sent to 51 laboratories across the US and to three foreign countries.

http://www.bbc.com/news/world-us-canada-33001771

April 2016 Article – Safety Problems Persist for the CDC. So, what is happening?

CDC lab safety weaknesses in spotlight again

4 April 2016 Rebecca Trager

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A potential laboratory-acquired infection at the US Centers for Disease Control (CDC) was announced on 31 March, following several similar failures at the agency and other US government research bodies.

The CDC is currently investigating whether one of its workers diagnosed with a *Salmonella* infection acquired it due at a lab where research is undertaken on common and treatable pathogens. Preliminary lab tests indicate that the researcher was infected with a strain of *Salmonella* that matches that being worked on in the lab. The worker is well and has returned to work. No other agency staff were exposed or sickened, and there was no release of the bacteria outside the lab, the CDC said.

Laboratory protocols are becoming more complex and take longer to complete.

→ **This can lead to:**
- increased manual handling
- unsafe practices
- other ergonomic challenges.

→ **The goal is to:**
- improve Safety
- reduce stress and strain
- improve work efficiency
- reduce errors.

Brief Primer on Ergonomics: Definition of musculoskeletal Disorders

- **Musculoskeletal disorders (MSDs) can affect the body's muscles, joints, tendons, ligaments and nerves**
  - Most work-related MSDs develop over time and are caused either by the work itself or by the employees' working environment.
  - Typically, MSDs affect the back, neck, shoulders and upper limbs; less often they affect the lower limbs.

Common Musculoskeletal Risk Factors

- **Upper Limbs (with a focus on laboratory workers):**
  - High Rates of Manual Repetition
  - Excessive Manual Force
  - Awkward Postures
  - Insufficient Recovery Time
  - Sustained (Static) Muscle Loading
  - Vibration
  - Temperature

Back and Neck Posture

Challenge: Work surface height for taller laboratory researchers results in them working in awkward postures resulting in prolonged static loading of the spine and neck.

A shorter laboratory researcher may not have these challenges but may have to raise their arms causing static loading on their shoulders.

Force and posture of the hands

Challenge: High forces, static loading, and awkward postures of the hands can lead to musculoskeletal disorders.

Extended reach Static loading of the shoulders.

Challenge: Extended forward reaches can lead to musculoskeletal disorders of the shoulders. Also, biomechanical loading of the shoulders and back can occur if the objects being lifted are heavy.

Static loading and Precision work

Challenge:
Injecting precise amounts of fluid into cartridge .
Static loading of hands and shoulders.

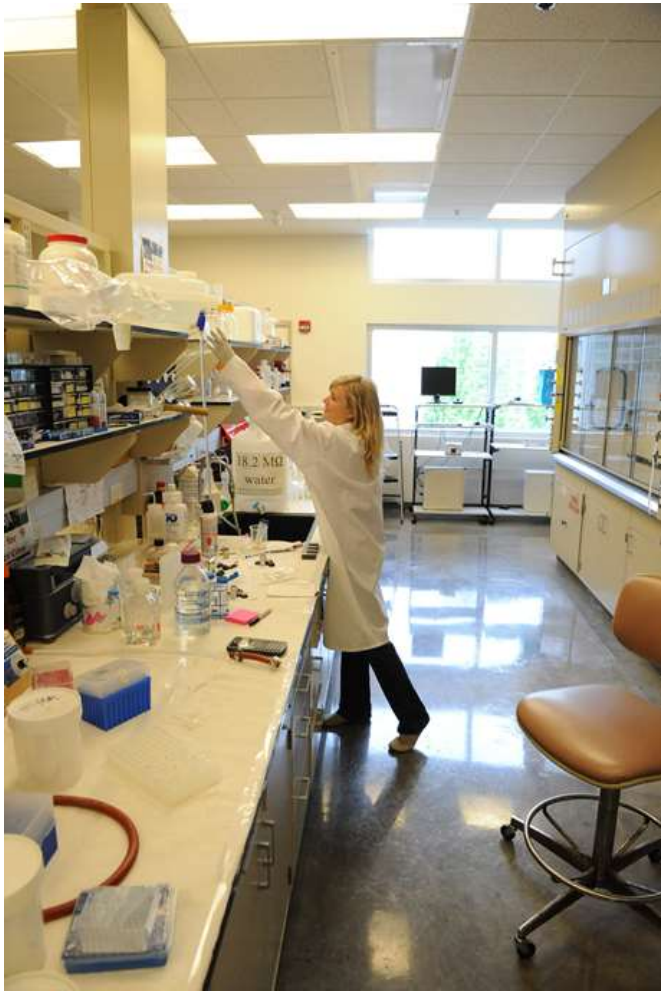
High forces and torque from cartridge assembly

Challenge: Pinch forces from right hand using small screw driver to seal cartridge and use of left hand as a “bio-clamp” can lead musculoskeletal disorders.

Loading “liquid Concentrator” Unit.

Challenge: high static loading forces needed to hold vial holding device for liquid concentrator

Reach to high shelves



High shelves – opportunity for tall researchers and a challenge for shorter researchers

Fixed counter height sight lines and machine function

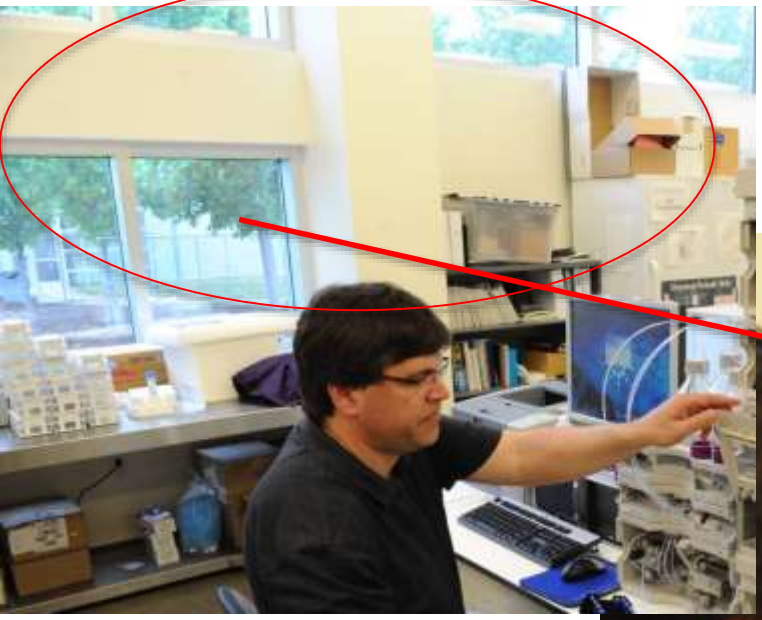
Trade-offs have to be assessed

Stackable units: Saves on Shelf space but…

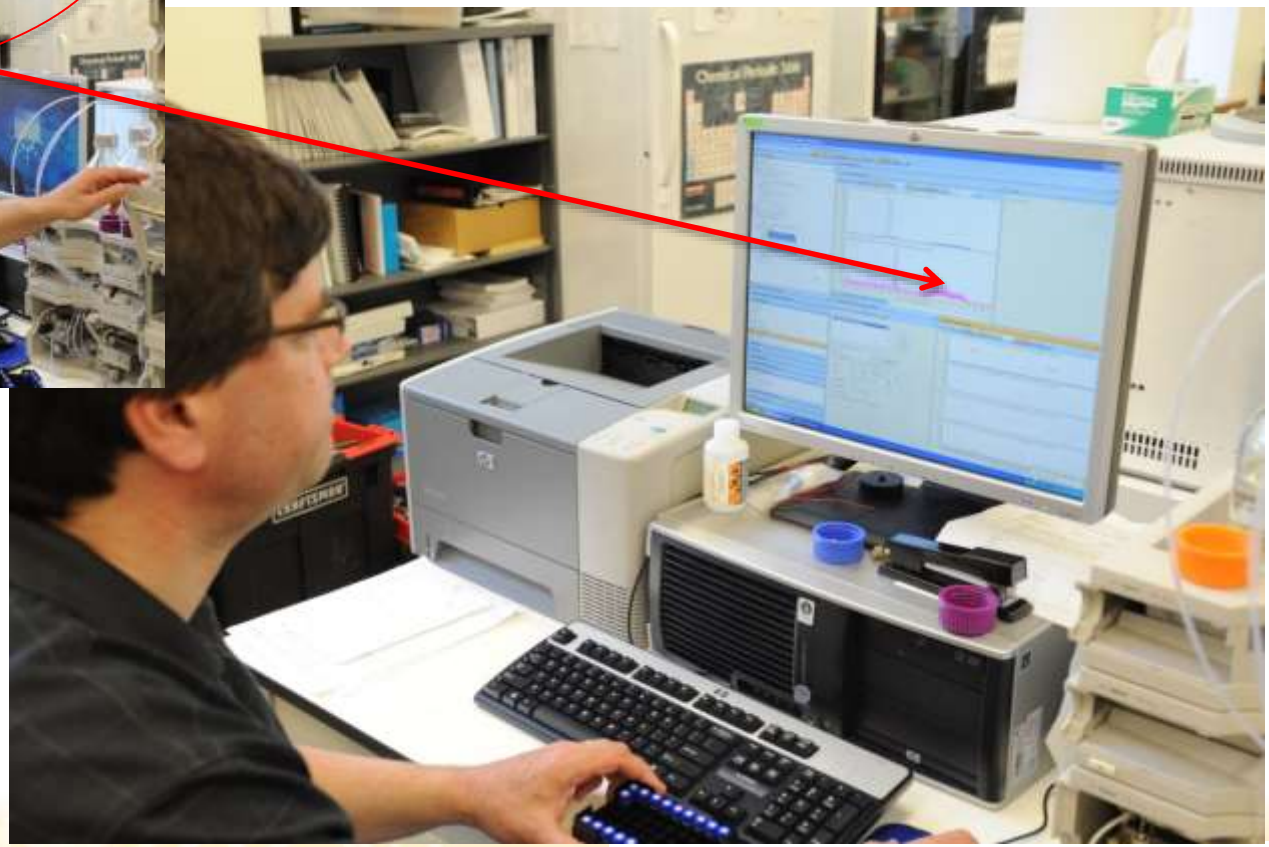
Units can be stacked next to each other, but…

Easy access to samples to be analyzed.

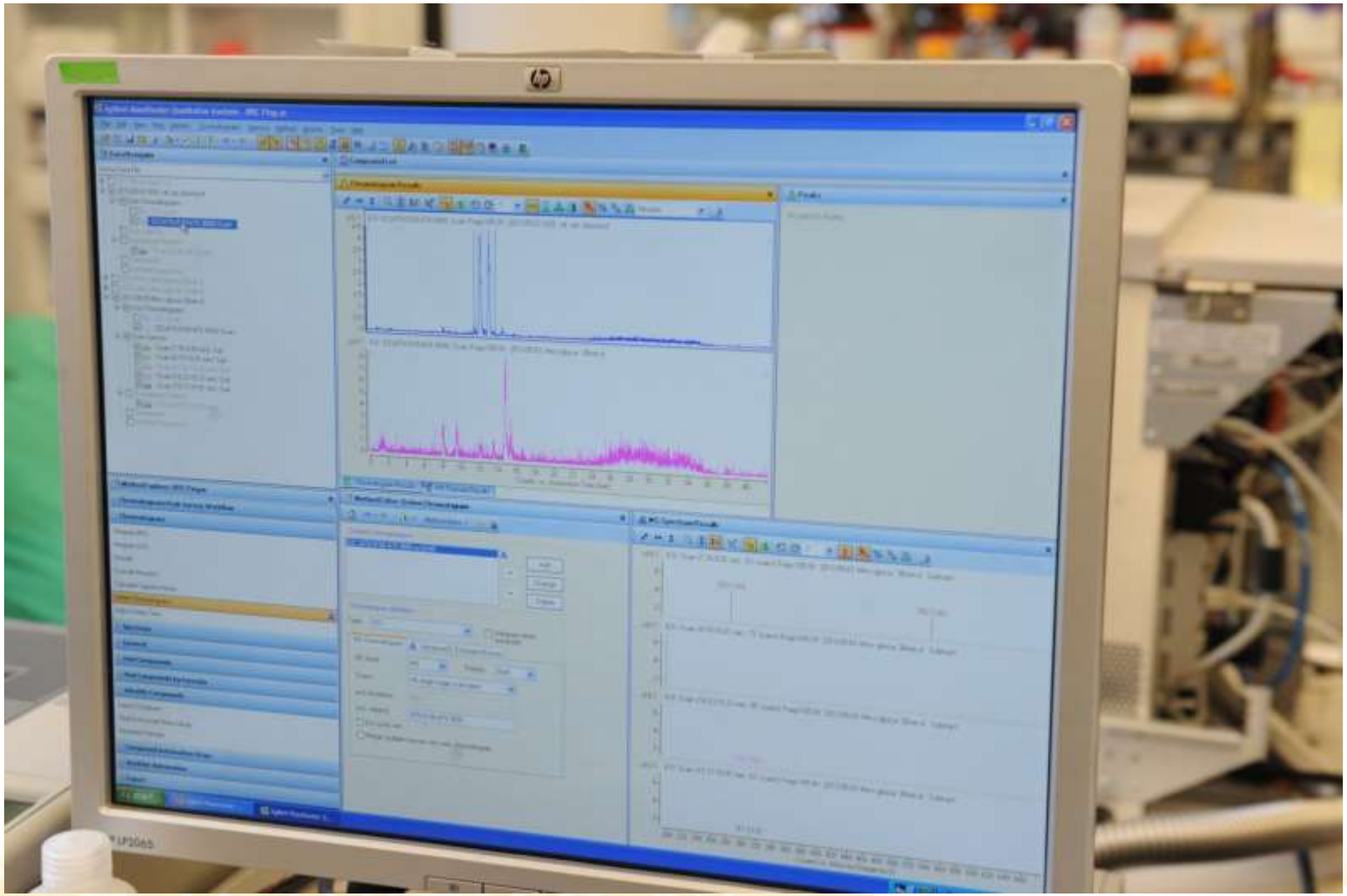
Output should be clear and without glare



90 degree angles to windows okay, 180 degree angles to windows not okay – excessive glare possible.



High resolution screen: easy reading



Complex laser unit ; glare resistant glass would help researchers see unit more easily.

Specimen storage and organization

Especially the deep freeze:

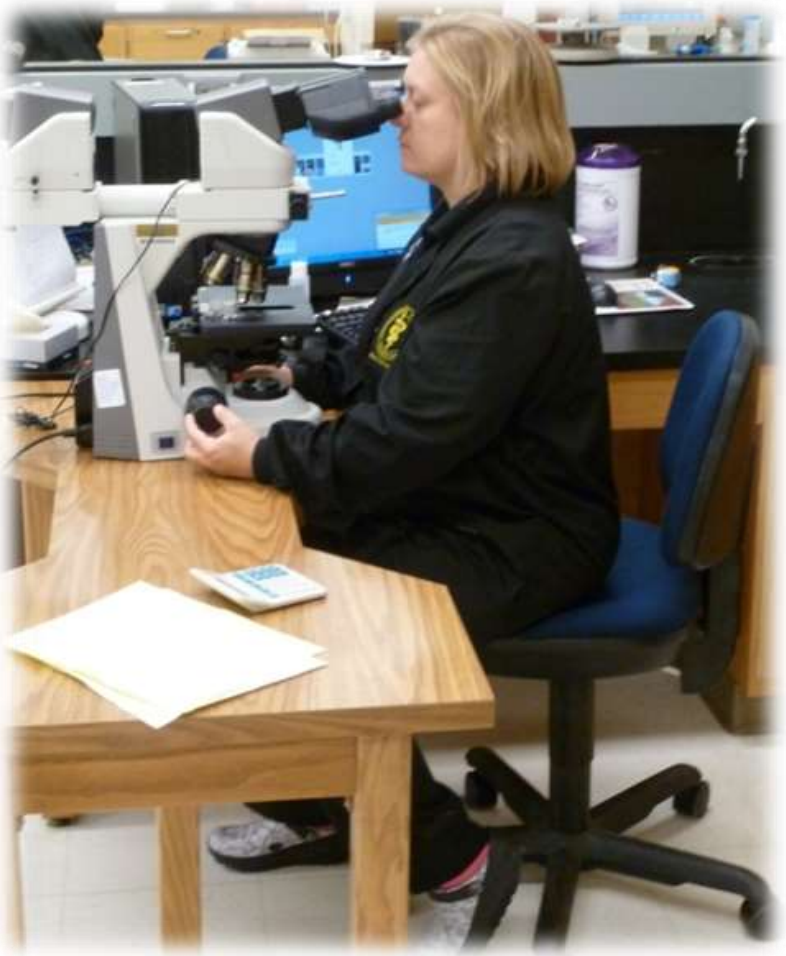
See through cold storage

Pipettes come in all shapes and sizes

Male vs. female hand size and pipette diameter.

Ejection of pipette tips can cause musculoskeletal disorders

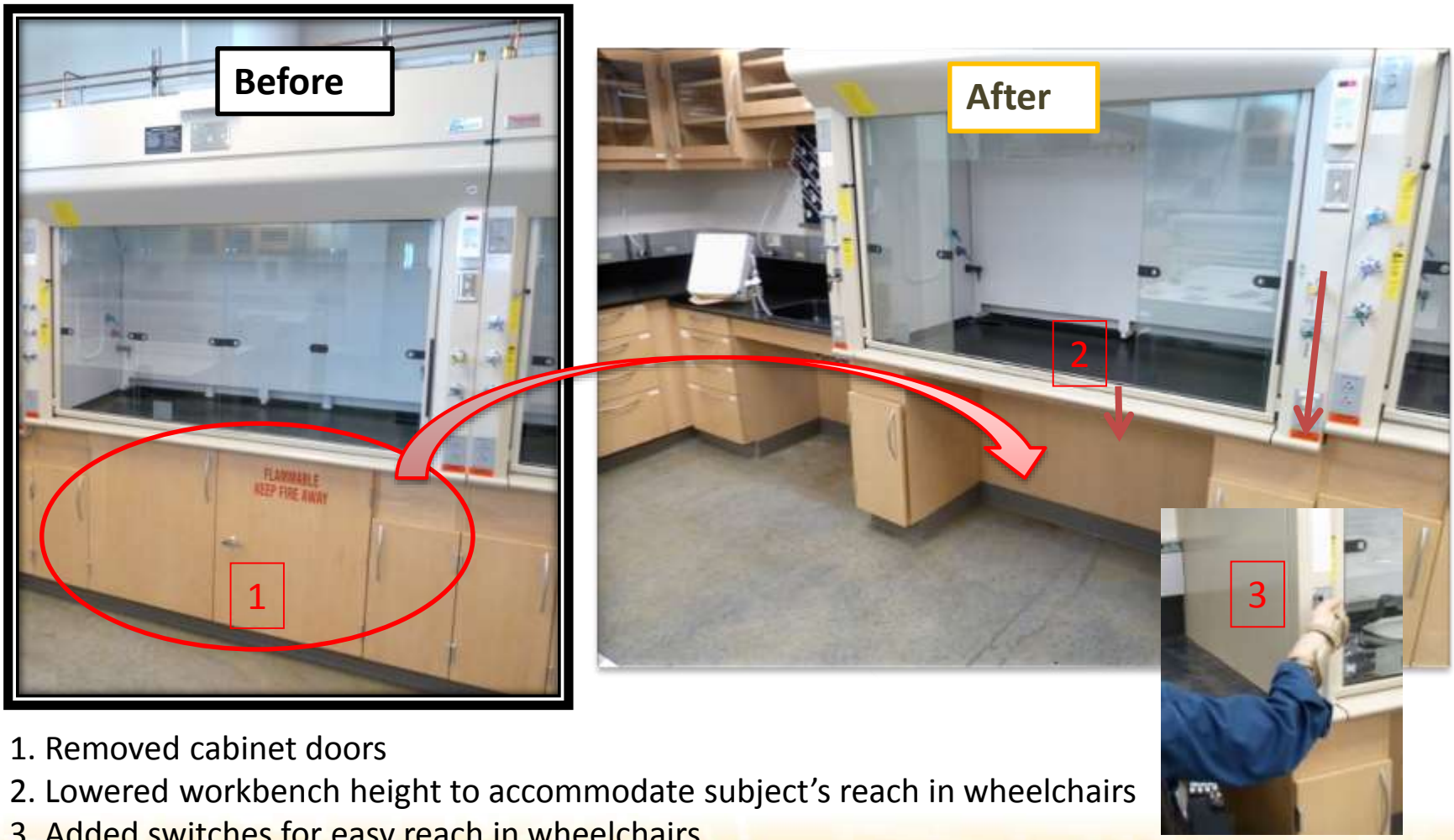
Microscope work: static loading of neck



Lack of leg space below vent hood

Awkward seating posture – back and neck pain

Redesign of Purdue's Discovery Laboratory



1. Removed cabinet doors
2. Lowered workbench height to accommodate subject's reach in wheelchairs
3. Added switches for easy reach in wheelchairs

Faculty Member simulating use of Ventilated Hood and Sink area

Sink area adapted for wheelchair: note shallow sink and easy access handles.

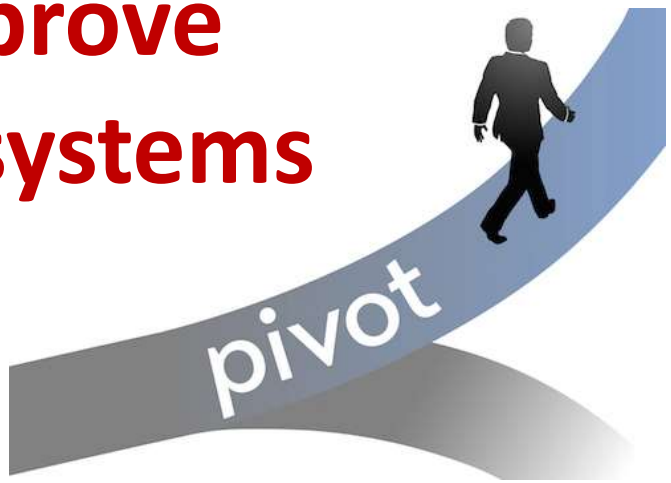
Pivot from

Ergonomic Hazards and Solutions

to

Laboratory Design for Safety

to decrease injuries, improve workflow, and prevent systems errors.

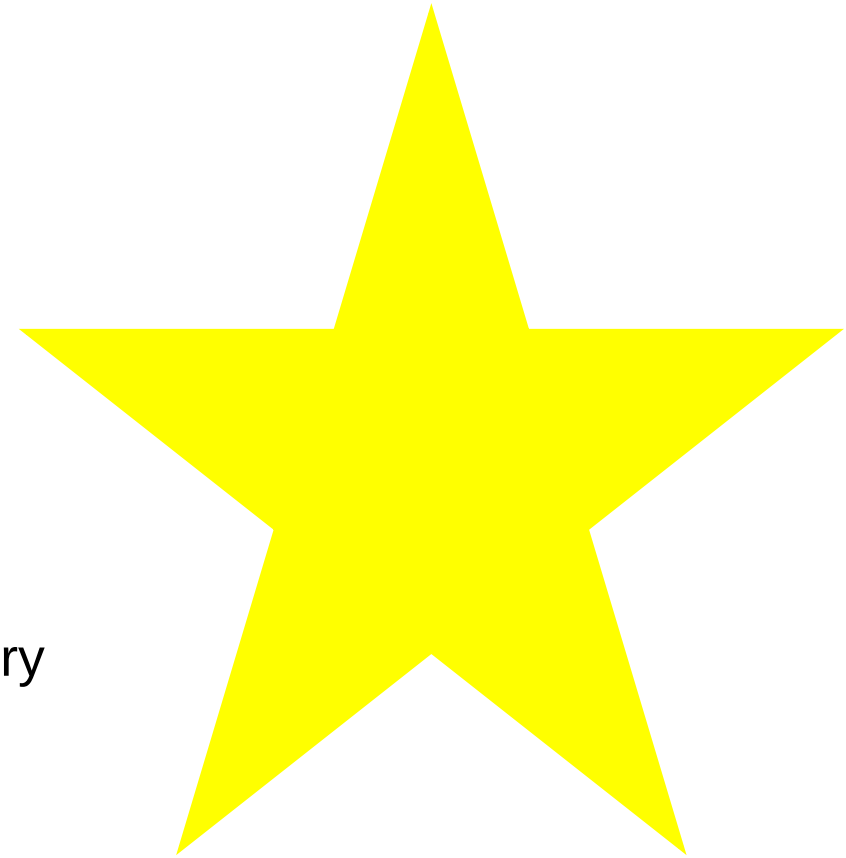


Work organization and work flow

Thanks to Adam Walter of Becton Dickinson for his slide contributions to this presentation.

Laboratory Design "Perfect State"

- **Gold standard**
  - Movable, variable height benches
  - Ability to move benches and redesign on moments notice
  - Ergonomically "friendly"
- **Business Case**
  - Life expectancy of lab equipment is 5 years…
  - Life expectancy of a laboratory is 20 years
    - Expect to change your lab 4 times!



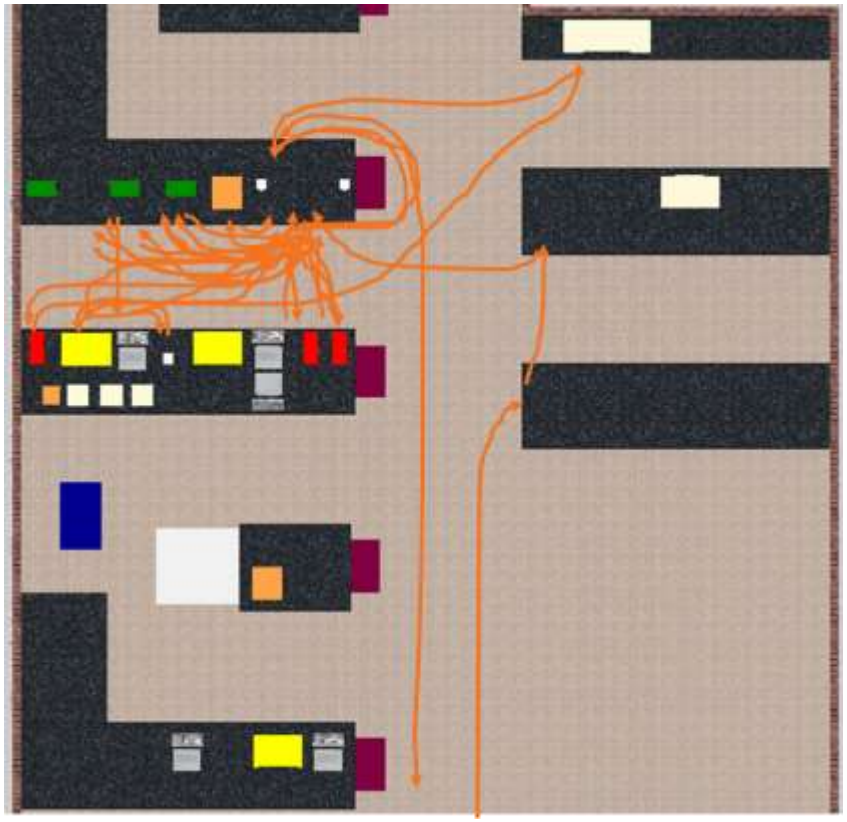
Match Workflow to Layout

→**Ensure physical layout is matched to processing workflow**

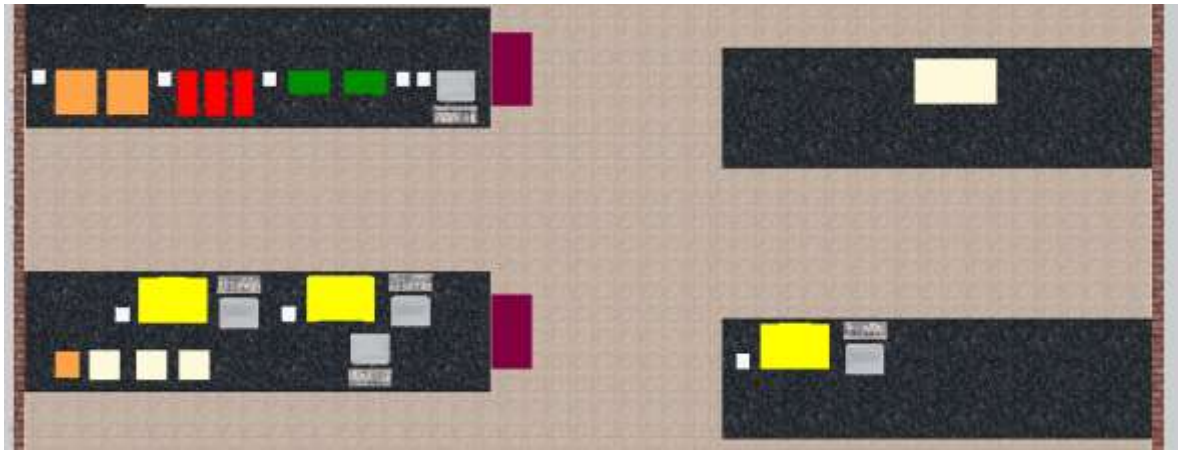
- Create testing areas appropriate to the workflow
- Review the workflow when new equipment or processes change

Match Workflow to Layout

- **Benchmarked state**
  - Substantial opportunity existed to improve laboratory layout, and therefore, linear flow
    - Specimens were placed in queue outside of processing area
    - Sub-optimal layout caused increased artificial stress on processor
      - Instrumentation not arranged in order of use, but rather the “best fit” at the time
      - Required significant amount of repetitive motions and movement.



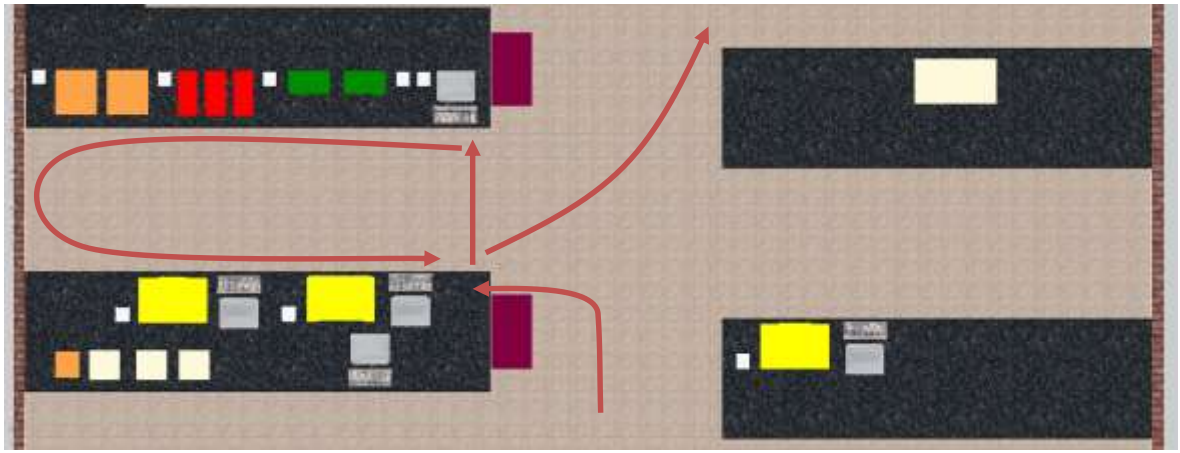
Match Workflow to Layout



→Recommendations

- Improve linear flow & reduce repetitive motions
  - Relocate specimen queue to inside active processing area
  - “Floater” can easier assist the process using spatial cues
  - Relocate computer & label printers to inside active processing area
  - Locate stock directly under area of immediate use
    - Ideal for stock to match time period to replenishment

Match Workflow to Layout



→**Outcome**

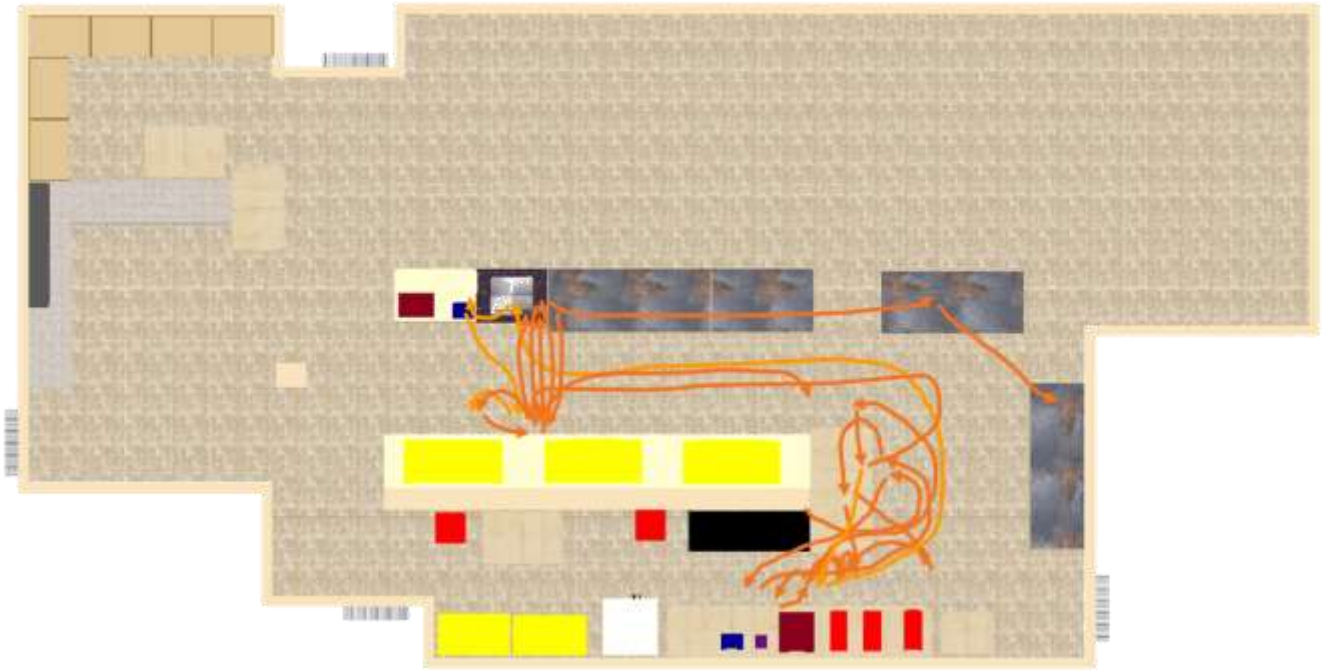
- Consolidated testing area
- Instrumentation arranged in order of utilization
- Decreased repetitive movements
- Reduced turnaround time by over 4 hours

Work Benches Should Direct Specimen Flow

→**Work benches should be laid out to direct the samples through the testing process**

- Laboratory testing staff must all utilize the same processes
- Ensure bench setup follows ergonomic guidelines

Work Benches Should Direct Specimen Flow



→Benchmarked state

- Crowded, non-standardized benches created artificial bottlenecks
- 3 FTEs made it difficult to prep the amount of specimens required to not cause a backlog in existing layout
- Lack of standardized work cells

Work Benches Should Direct Specimen Flow

- **Recommendations**
  - Redesign laboratory to incorporate 3, identical processing configurations
    - Ensure each FTE processes utilizing their own workcell to increase efficiency and ensure accountability
    - Minimize employee cross-over
    - Eliminate artificial bottlenecks

Work Benches Should Direct Specimen Flow

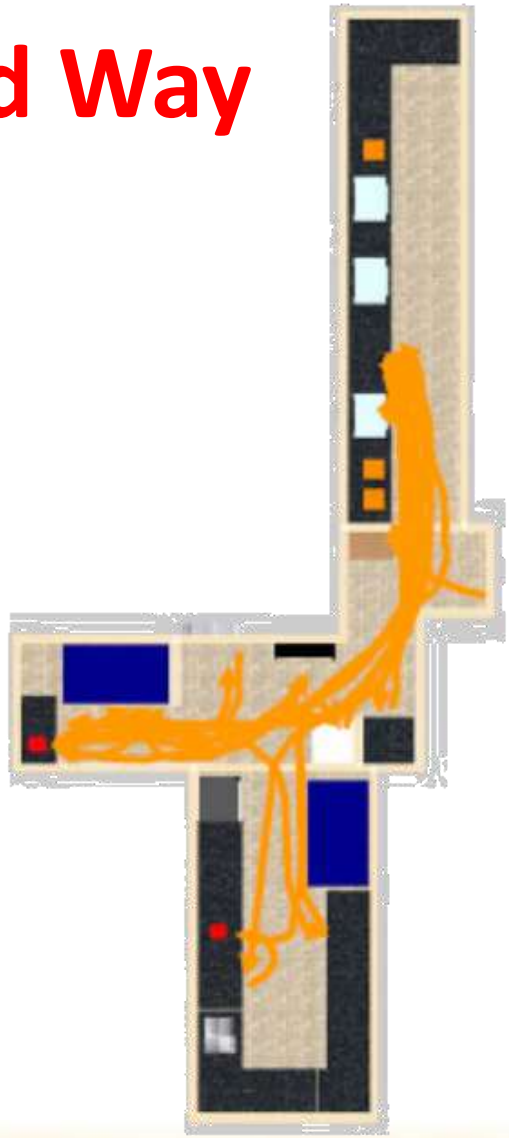
→Outcome

- Reduced processing times by over 8 hours / day
- Decreased errors made while processing & transporting specimens
- Increased employee morale
- Eliminated employee cross-over
- Eliminated artificial bottlenecks

Perform Work in Approved Way

→**All work must be performed in the approved way**

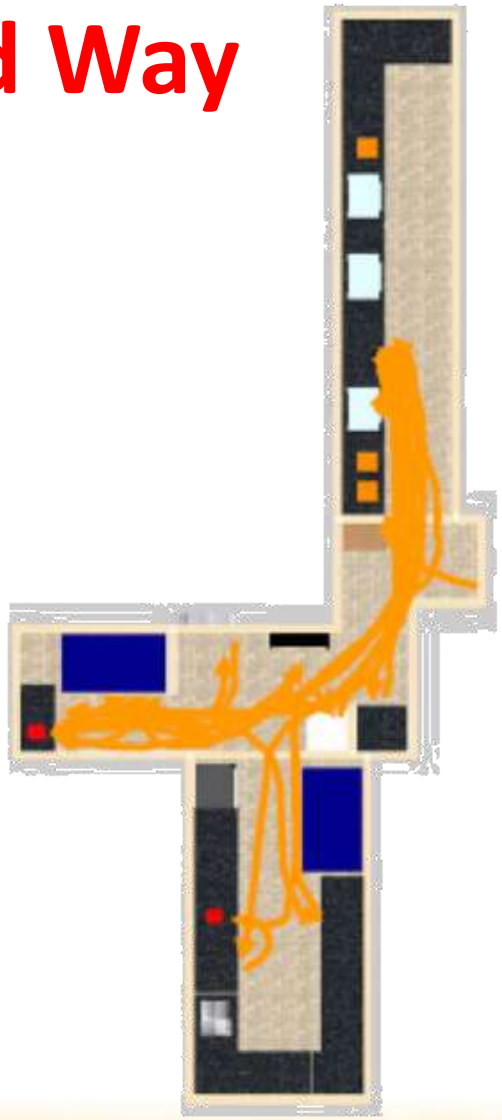
- Everyone should be doing work the same, standardized way (within reason!)
  - i.e. right handed vs. left handed
- Review the effect of process changes (both positive and negative) on the physical laboratory layout



Perform Work in Approved Way

→Benchmarked state

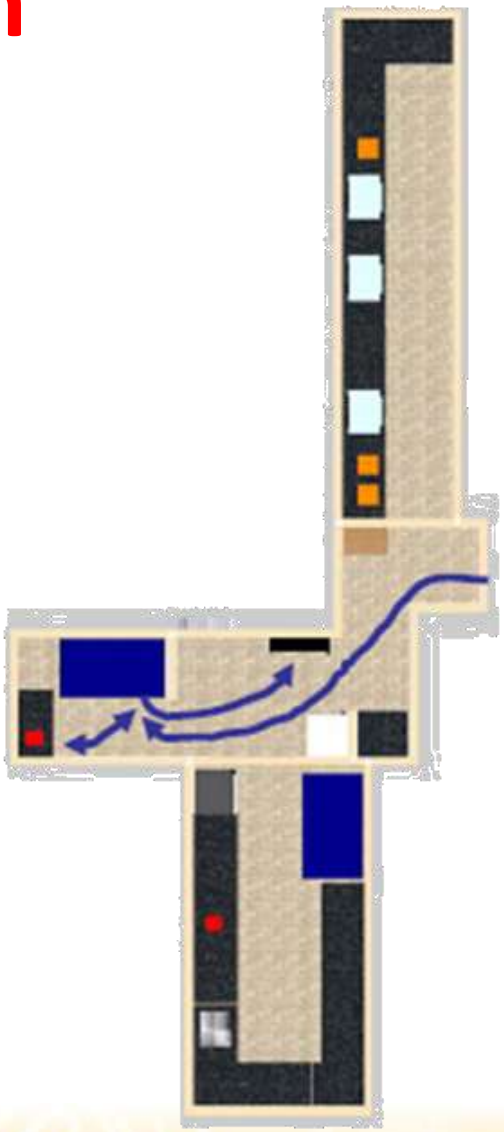
- Inefficient testing and layout resulted from the following
  - Segmented, individualized processing
    - Variable sized batch processing
      - » 1 FTE in charge of accessioning
      - » 1 FTE in charge of centrifugation / preparation
      - » 1 FTE in charge of analyzer operation
      - » 1 FTE in charge of results
    - Limited accountability for each processing technologist
      - » Shared work to produce end result



Perform Work in Approved Way

Recommendations

- Optimize use of space according to work processes
- Decrease & standardize specimen batch sizes
  - Process smaller batches utilizing single-piece flow algorithms
- Increase the accountability of each processing technologist
  - Entire processing run was performed by one (1) skilled operator throughout the entire analytical process



Outcome

- Reduced transport requirements
- Reduced turnaround/ processing time by over 8 hrs
- Increased processing accountability

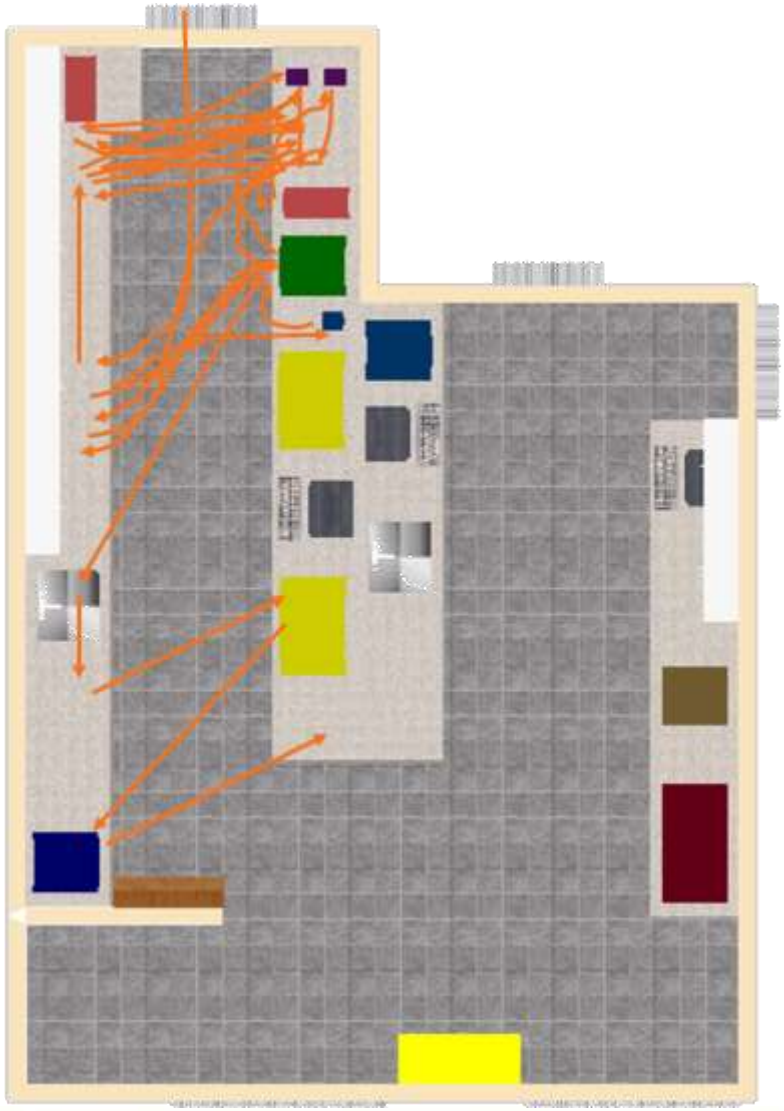
Small, Incremental Changes

→**If changes are necessary, make small, cost-neutral changes before engaging in a major construction project**

- Not necessary to change the physical layout of the laboratory if simple adjustments can be made

Small, Incremental Changes

- Benchmark process
  - Laboratory stated interest in complete redesign to optimize specimen flow
  - Lack of standardized work cells
  - Instrumentation not arranged in order of use, but rather the “best fit” at the time
  - Required significant amount of repetitive motions and movement



Small, Incremental Changes

→Recommendation

- Implement slight modifications to existing laboratory layout to improve linear flow & reduce repetitive motions
  - Relocate vortexes to area which now houses the processing instrumentation
  - Relocate processing instrumentation to area which now houses the vortexes

Moved input and output of analytical results outside the analysis area.

Small, Incremental Changes

→**Outcome**

- Significantly reduced processing times
- Saved capital budget that was applied to higher-priority projects
- Eliminated employee cross-over
- Eliminated artificial bottlenecks

Tools for Ongoing Success

- Utilize Ergonomic & enterprise process improvement tools to ensure *continuous improvement*
  - Ergonomic guidelines
  - Lean / Six Sigma tools
    - Spaghetti mapping

Tools for Ongoing Success
Ergonomic Guidelines

→ **Lab Design Ergonomic Guidelines**

Non-routine, non-procedural tasks

– *Operators should not be:*
- Reaching
- Bending
- "Borrowing" supplies (having to search or travel)
- Transporting heavy / bulk solutions

– *Operators should have:*
- Locate equipment & materials at the point of use, in sequence of use
- Locate consumables / disposables located at the point of use, in adequate supply

Tools for Ongoing Success
Ergonomic Guidelines

- **Benchmarked**
  - Opportunity for improvement
    - Regular maintenance required significant duration of time spent bending / reaching

Tools for Ongoing Success
Ergonomic Guidelines

- **Benchmarked**
  - Opportunity for improvement
    - Analyzer required the regular transporting of heavy, bulk solutions across the laboratory to reagent storage

Tools for Ongoing Success
Ergonomic Guidelines

- **Benchmarked**
  - Opportunity for improvement
    - Significant amount of reaching, bending & transporting necessary to maintaining daily molecular inventory
      - Required searching

Tools for Ongoing Success

Ergonomic Guidelines

→ **Benchmarked**

- Opportunity for improvement
  - Inability to access inventory without bending & reaching
  - Inability to easily access inventory
  - Inventory not located in close proximity to testing area
    - Required transport of heavy materials

Tools for Ongoing Success
Ergonomic Guidelines

- **Benchmarked**
  - Opportunity for improvement
    - Required transport of bulk solutions across laboratory to dispose into sink

Tools for Ongoing Success
Ergonomic Guidelines

- Benchmarked
  - Opportunity for improvement
    - Daily searching & transport of supplies was necessary

Tools for Ongoing Success
Ergonomic Guidelines

- **Benchmarked**
  - Best Practice
    - Syringes located at the point of use in adequate supply

Tools for Ongoing Success
Ergonomic Guidelines

- **Benchmarked**
  - Best Practice
    - All needed equipment & materials located at the processing bench
      - Specimens
      - Specimen transport containers
      - Racks
      - Waste bin

Tools for Ongoing Success

Process Improvement Tools

→ **The focus of Lean in the facility design is:**

- ➢ elimination of waste

→ **The focus of Six Sigma in the facility design is:**

- ➢ elimination of defects

→ **The application of Lean / Six Sigma includes:**

- – Maximizing the utilization of existing space
  - Storage cabinets and shelves are kept open and uncluttered
- – Standardizing work practices
  - All stations are set up identically
  - Everyone performs work identically

Tools for Ongoing Success

Process Improvement Tools

→ Spaghetti Diagrams

- A method of viewing data to visualize possible flows through systems
- Can be used to quantify workflow and objectively analyze the physical laboratory layout
- Visualizing flow in this manner can reduce inefficiency within the flow of a system

Tools for Ongoing Success

Process Improvement Tools

- **Benchmarked**
  - Best Practice
    - Maximized used of space
    - Storage cabinets and shelves are kept open and uncluttered
      - ***Ability to see exactly what is in storage***

Tools for Ongoing Success

Process Improvement Tools

- **Benchmarked**
  - Best Practice
    - Maximized used of space
    - Storage cabinets and shelves are kept open and uncluttered
      - ***Ability to see volume of pending & completed specimens***

Tools for Ongoing Success

Process Improvement Tools

→ **Benchmarked**

- Best Practice
  - Identical work cells enable staff to perform standardized processing at any station
  - Storage cabinets and shelves are kept open and uncluttered
    - ➢ ***Ability to see inventory at a glance***

Laboratory Design & Layout Guidelines

→ **Steps to Success**

1. Ensure physical layout is matched to processing workflow
2. Work benches should be laid out to direct the samples through the testing process
3. All work must be performed in the approved way
4. If changes are necessary, make small, cost-neutral changes before engaging in a major construction project
5. Utilize Ergonomic & Process Improvement tools for continuous laboratory improvement

Reference: CLSI Lab Design Guidelines CLSI GP18-A2 (now QMS04-A2)

Laboratory Safety and Ergonomics

Key Takeaways:

- There is a relationship between safety and ergonomics in the laboratory.
- Improper work practices and work disorganization effect the safety of the staff (and potentially the public), the quality of the analyses, and the productivity of the laboratory.
- Success in the laboratory is everyone's business.
- Safe systems are well designed to prevent injury and illness, but are also continually reviewed for process changes and to identify improvements.

Questions?