SPAGHETTI MAPPING, RELATED LEAN TOOLS, AND POWERFUL ANALYTICS:

SMART WAYS TO STREAMLINE WORKFLOW IN NEW AND EXISTING CLINICAL, MOLECULAR, AND GENETIC LABORATORIES

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What are We Going to Do and Why?

- In this hands-on session, we will train on and use powerful lean tools to generate quantitative data for use in management and executive business cases.

- In the first 2/3 of the session, we will be explaining & using 3 lean tools/methodologies (spaghetti mapping, process mapping & laboratory layout design) focused on creating data in ways you've never dreamed!

- The last 1/3 of the session will focus integrating the data into one, consolidated report.

After Today, It's My Goal You Will...

- Understand common Lean tools used to generate data

- Confidently use 3 Lean tools
  - Spaghetti Mapping
  - Process Mapping
  - Laboratory Layout Design

- Possess the ability to convert observations & workflow mapping into quantitative data used for management and executive business cases

Spaghetti Mapping

- Defined as:
  - "Visual representation using a continuous flow line tracing the path of an item or activity through a process"
  - "A method of viewing data to visualize possible flows through systems"
  - "A simple tool to visualize movement and transportation"

- Why is it called a spaghetti map?
  - Results often look like a bowl of noodles

- Use?
  - Determine where time and energy is wasted
  - Identify and reduce inefficiencies within the flow of a system

Available Tools

CAUTION
WATCH FOR OCCASIONAL FLYING TOOLS IN THIS AREA

- Notebook paper and pen
- Fireplan on wall / PowerPoint
- iOS
  - RoomScan
  - RoomPlanner – Chief Architect
- Google SketchUp
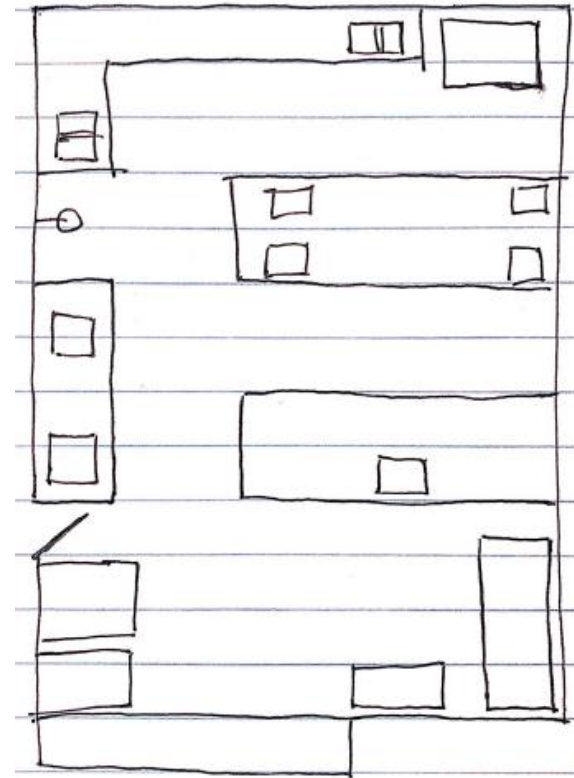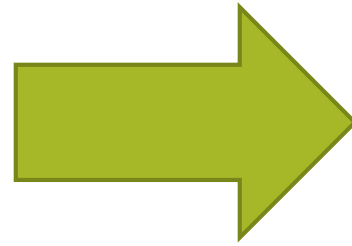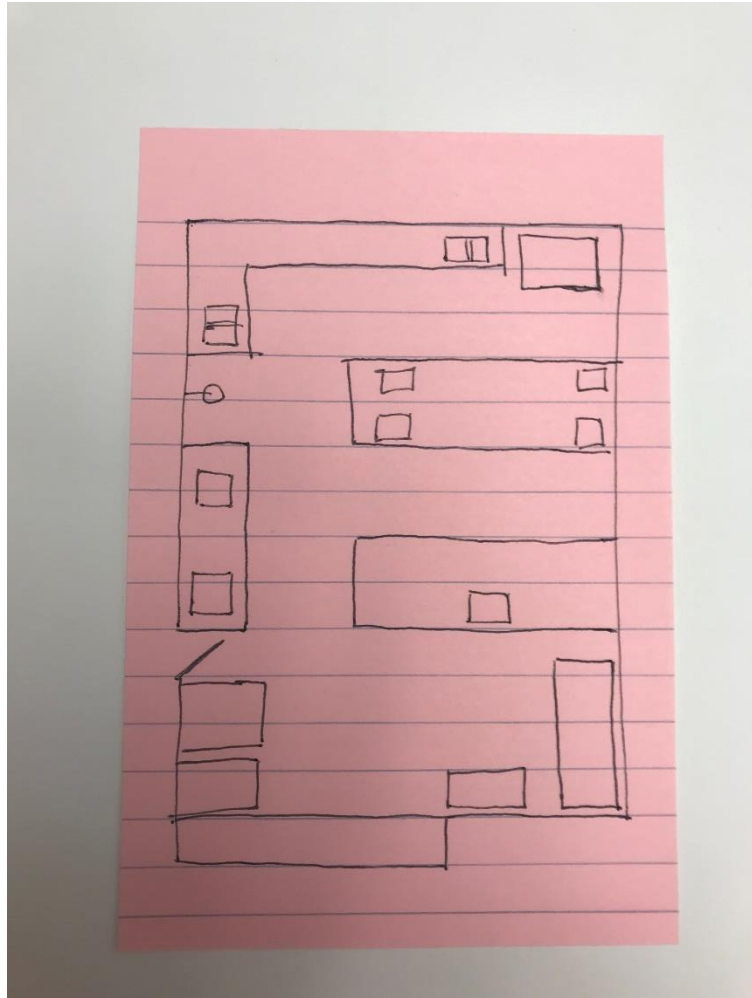
Step 1 – Spaghetti Map
Build your Environment

1. Sketch the laboratory

- Ensure to capture:
    - Periphery of your area (build your walls)
    - Major cabinetry, benchtops and instrumentation
    - Windows! Those are quite important, especially when you're looking to put in a hood

- Don't worry!
    - Anything above the benches
    - The exact size of the centrifuge
    - The correct color of the dish soap

Example

Exercise

- In this exercise, we will be sketching this "laboratory"

  - Grab pen and paper

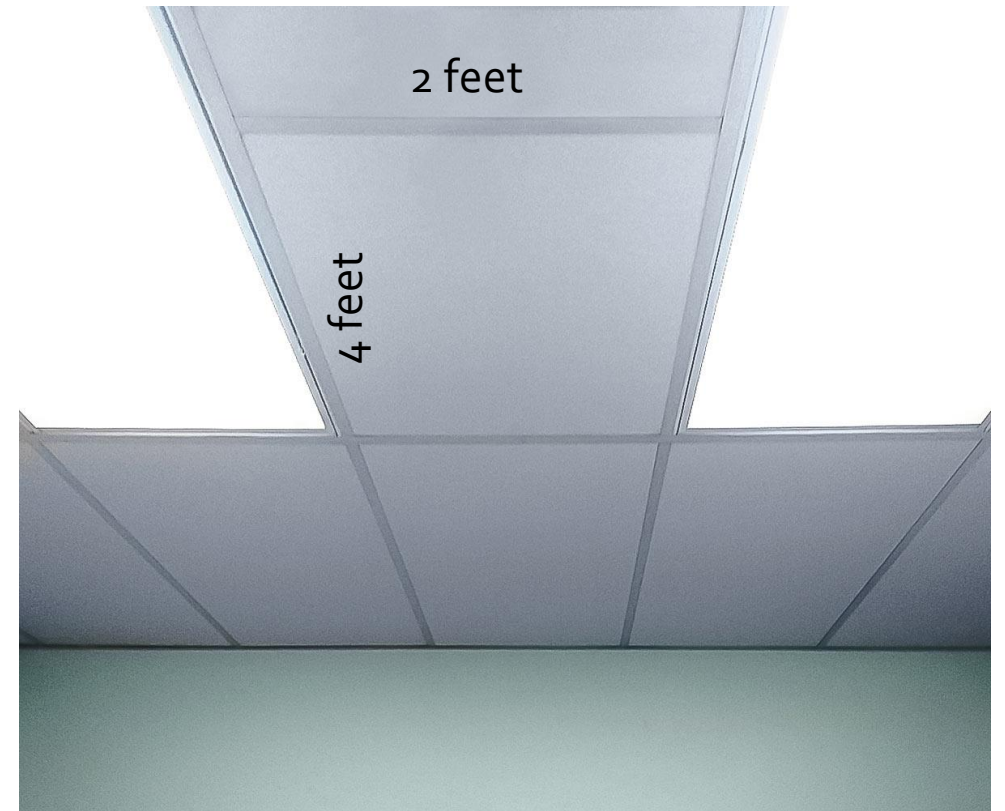 - Take 10 – 15 minutes and sketch out this "laboratory"

Step 2 – Spaghetti Map Identify and Label

2. Identify and label key pieces of instrumentation and cabinetry/benchtops

- Be sure to capture:
  - Rough dimensions
  - Major pieces of laboratory equipment
  - Things that cannot be moved (i.e. safety shower, cabinetry, etc.)
  - Equipment essential to the workflow
    - LIS CPU terminals
    - Centrifuges
    - Instruments

- Don't worry!
  - That one piece of equipment that you use 1x year
 - Pipets
  - Paper towel dispensers

Hints, Tips and Tricks

- Don't waste too much time measuring…and don't measure to the $1/8^{th}$ of an inch
  - Ceiling tiles are usually 2' x 4' or 2' x 2'
  - Floor tiles are often 1' x 1'

- Caution (based on experience):
  - When you are walking down the laboratory, shuffling your feet and clearly counting to yourself, there is a 100% chance someone will start trying to confuse you by saying random numbers…jot some numbers down along the way so you don't have to start over

2 feet

4 feet

Example
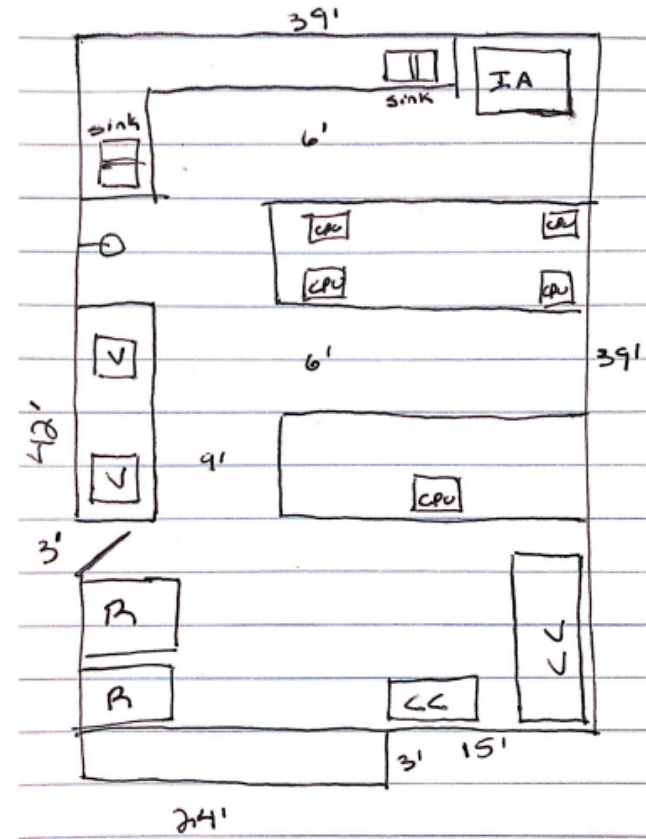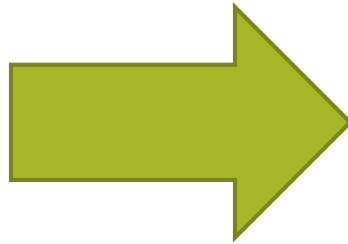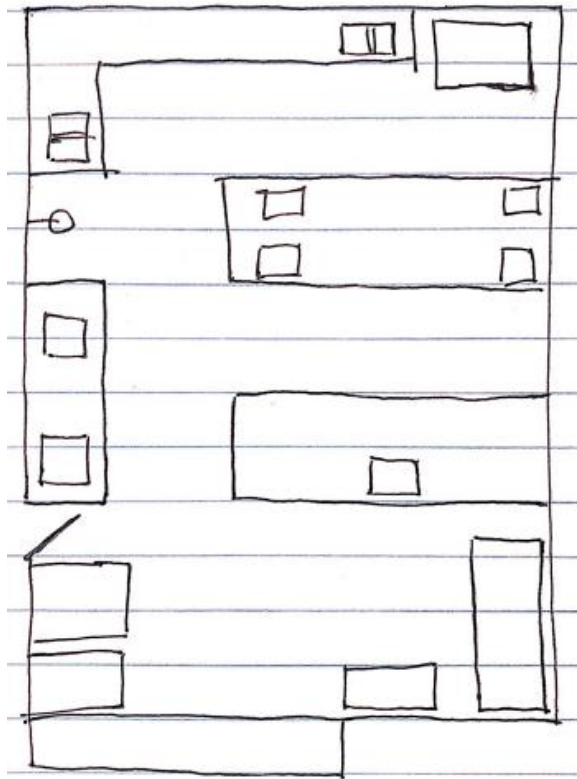
Exercise

- In this exercise, we will be identifying key pieces of equipment in the "laboratory"

  - Take 5 minutes and identify critical equipment, dimensions and cabinetry throughout this "laboratory"

Step 3 – Spaghetti Map Observe & Map

3. Pick a sample/specimen and follow the process, from beginning to end and draw a line for every motion or movement
   - Lather, rinse & repeat ☺

   - Ensure to:
     - Draw a line every time your chosen specimen is moved while being processed
     - Identify wasted or unnecessary movements
     - Facilitate staff involvement…a key factor in a positive approach to transitioning teams and organizations from current sate to an optimized future state

- CAUTION CAUTION CAUTION: NEVER follow a "person"…this isn't about people, it's about process

Hints, Tips and Tricks

- Show the team your data while you are collecting it…get them on-board!
  - It can be super scary to see a manager in the laboratory watching "you" and writing things down…be an open book

- While observing your team performing work processes, use visual cues to ensure you don't get in people's way…
  - Stand in the area where the floor is shiniest
  - Look inside trash cans for full cans vs. empty ones and stand close to the empty one

- Never identify people! Never, never, never!

- Use different colors of lines for different functions / resources
  - Do the same for supply replenishment, trips to the walk-in, etc.

- Perform process mapping 2x…once being obvious what you are mapping and again, picking a spot in the room where people don't know what you're looking at
  - Eliminate dreaded Hawthorne Effect; The alteration of behavior by the subjects of a study due to their awareness of being observed
  - Spend time near one workflow/specimen while actively benchmarking a completely different workflow/specimen…don't even collect info on the workflow/specimen you are with!

Example
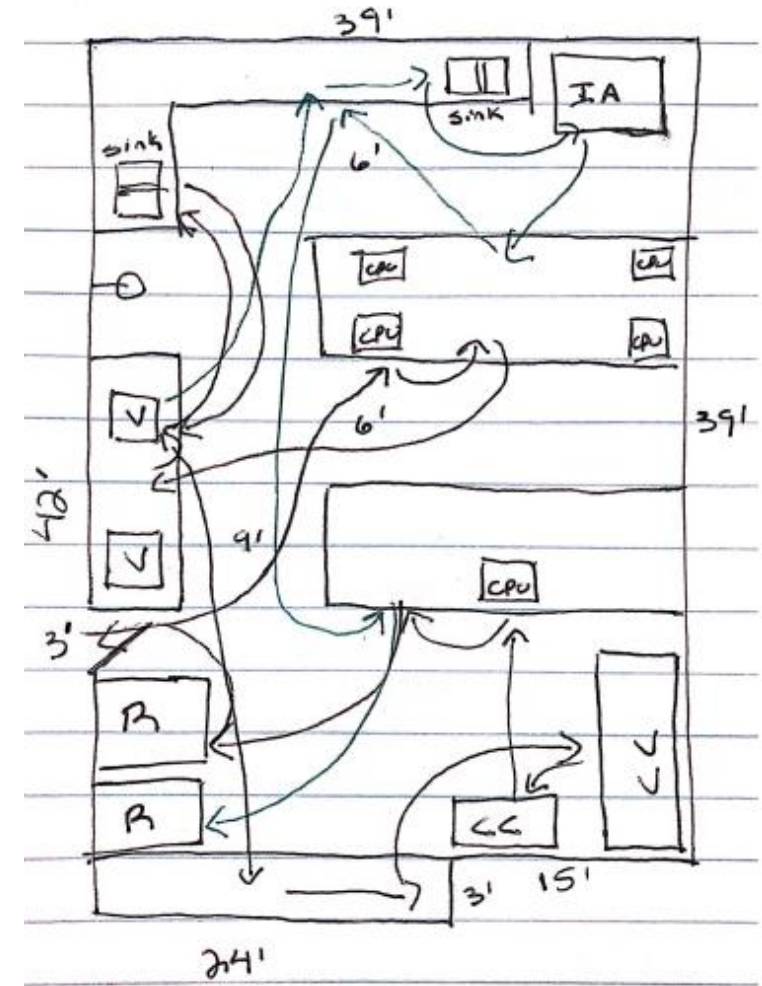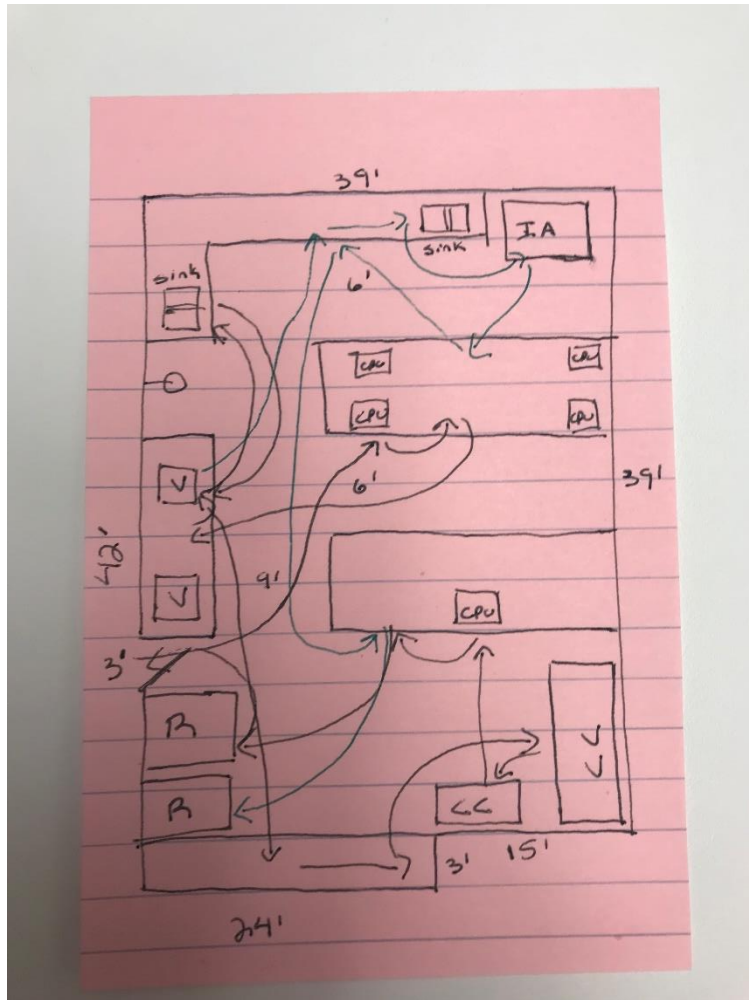
Exercise

- In this exercise, we will be processing the "specimen"

  - Benchmark the process and start to create your spaghetti map
    - Assumptions:
      - The door is in the front left (next to the cryostat)
      - Nothing is along the wall on the left or the wall across the back
      - The specimens get dropped off in the white bin on the front of the bench

Step 4 – Spaghetti Map
Identify Waste and Potential Changes

4. Identify changes to improve workflow

- Focus on the following:
  - Identify and remove wasteful practices related to staff, reagents, samples, supplies and equipment
  - Identify and remove process variation

- Ensure to:
  - Utilize other lean tools to help assist
  - Look for small, incremental changes first…gain momentum before making any radical changes
  - Facilitate staff involvement…a key factor in a positive approach to transitioning teams and organizations from current sate to an optimized future state

Step 4 – Spaghetti Map
8 Lean Wastes

- Waiting; Specimens sitting for prolonged periods of time

- Overproduction; Labels peeled & reapplied

- Rework; Running specimen through same instrument multiple times (without additional orders)

- Motion; Forgetting something, leaving area and returning (differentiator from "transport": no specimen)

- Processing; Heating all tubes even though they don't all require heat step

- Inventory; Too many or too little supplies where they are needed

- Intellect; Decision of where to send specimens

- Transportation; Moving specimens excessively

Example

Motion: Bottleneck exists by sink
Action: Potential to relocate centrifuge?

Waiting: Specimens wait by centrifuge for "xx" minutes
Action: Reduce batch size and spin in smaller batches

Inventory: Supplies on shelf would last for 3 weeks
Action: Reduce storage to 1 week
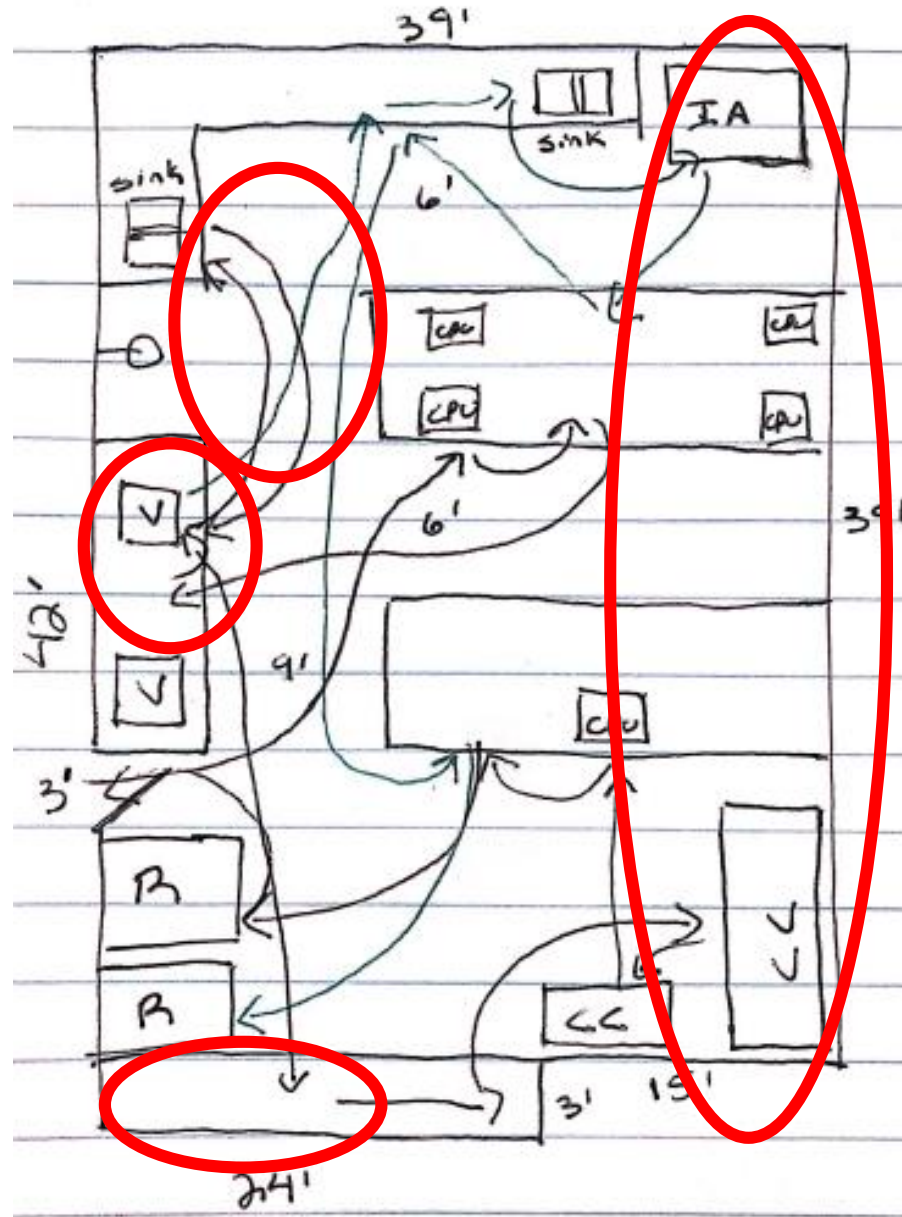
Intellect: Decision must be made of where to send specimen
Action: Integrate instrumentation

Transportation: Specimens must travel to separate areas of laboratory
Action: Optimize laboratory layout

Exercise

- In this exercise, identify and label waste

  - Look at your spaghetti map and circle 5 different forms of waste

  - For each circle, identify type of waste and potential corrective action / change

Step 5 – Spaghetti Map
Implement Change & Observe New Process

5. Implement change & observe new process

- Focus on the following:
  - Look for small, incremental changes first…gain momentum before making any radical changes
  - Facilitate staff involvement…a key factor in a positive approach to transitioning teams and organizations from current sate to an optimized future state

- Don't worry!
  - Being perfect…try things that can easily be put back if they don't work. Half the fun is trying out new solutions
  - If everyone isn't totally on-board right away…change is hard!

Example

- Changes incorporated:
  1. Move IA next to CC
  2. Reduced size of centrifuges to enable smaller batch sizes without impact to overall numbers
  3. Moved CPU station next to door
  4. Moved LIS terminals closer to instruments
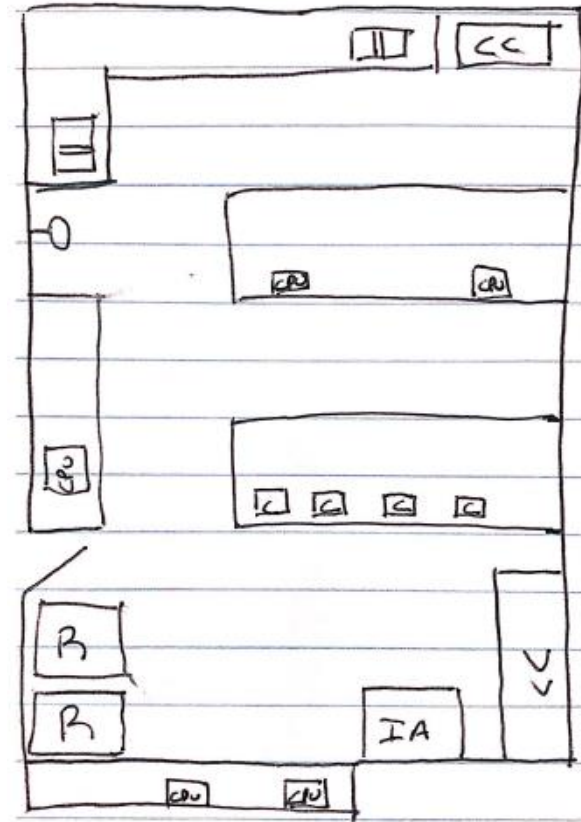
Example

- Changes incorporated:
  1. Move IA next to CC
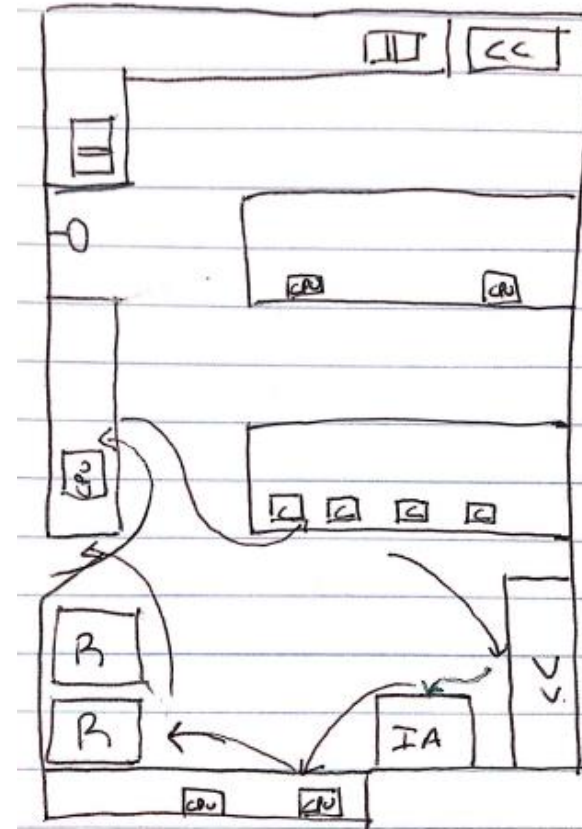 2. Reduced size of centrifuges to enable smaller batch sizes without impact to overall numbers
  3. Moved CPU station next to door
  4. Moved LIS terminals closer to instruments

Step 6 – Spaghetti Map
Compare Before and After
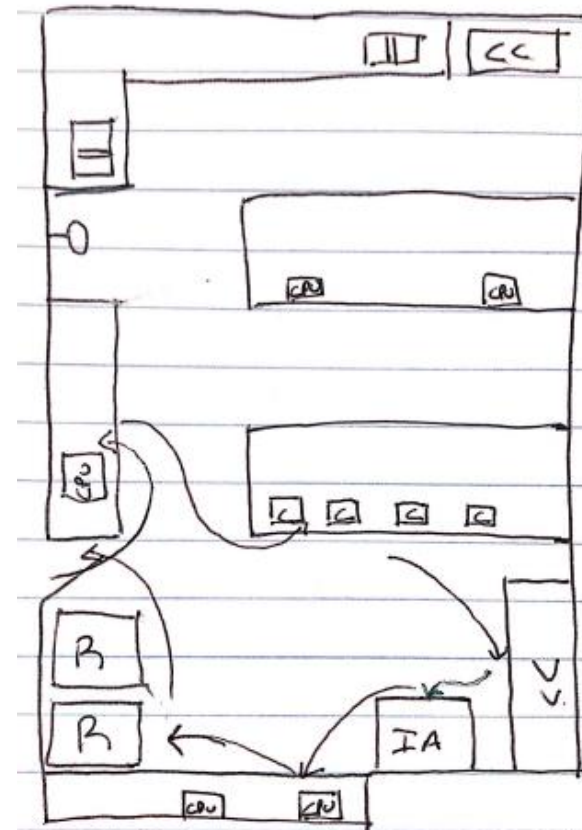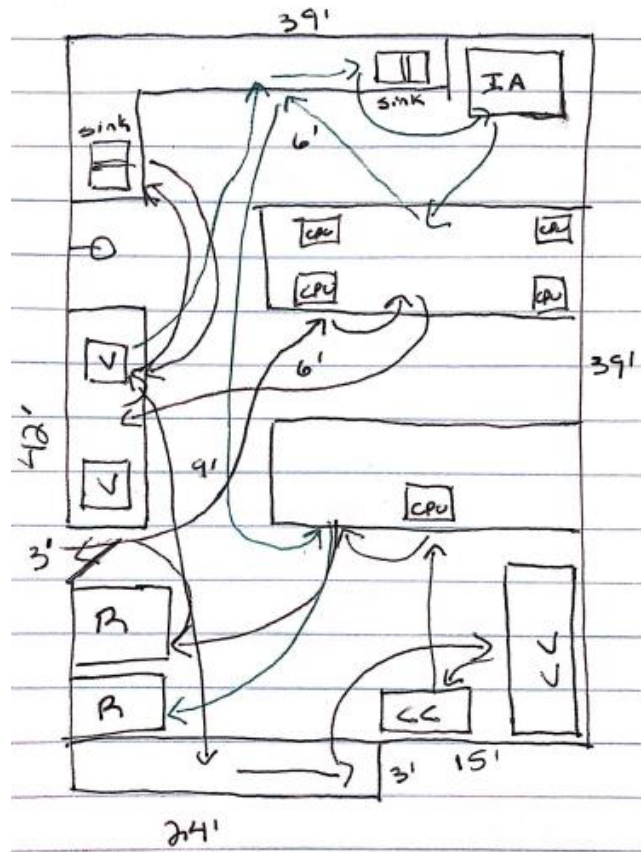
Step 7 – Spaghetti Map
Turn "Qualitative data" into "Quantitative"

- 3 easy ways to turn "qualitative" benchmarks into "quantitative" data
    1. Generate measurements in PowerPoint to show optimized transport requirements
    2. Process Maps
    3. Timing studies

- Measure on PowerPoint and show roughly measured distance….it doesn't need to be perfect

- Focus on data to make decisions – tell your story with information, not emotion
    - Six sigma tools are great to effectively gather data used to drive decisions
    - Process maps/flow charts graphically depict activities to define what happens, who does it, how the process should be completed and how the process can be measured

Quantitative Outcomes

- Optimization of laboratory design enabled:
  - Reduced required travel to perform processing steps by 44%
  - Reduced processing steps by 35.2%
    - 17 steps → 11 steps
  - Eliminated 5 cross-over points

Outcomes

35.2% Reduction

44% Reduction

	Original	Revised	Optimized
Processing Steps	17	14	11
Distance	14	11.3	7.3
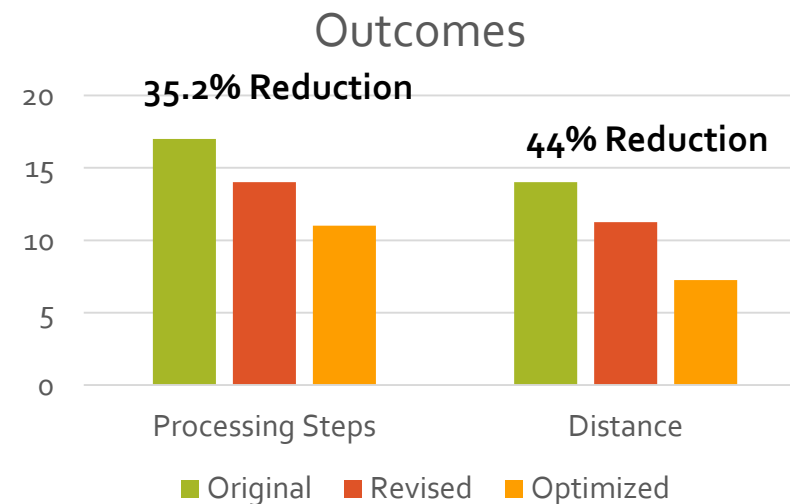
Process Mapping

- Defined as:
  - Planning and management tool that visually describes the flow of work
  - Visual tool to illustrate a series of events that produce an end result

- Use?
  - Describes the flow of materials and information, displays the tasks associated with a process, shows the decisions that need to be made and highlights essential relationships
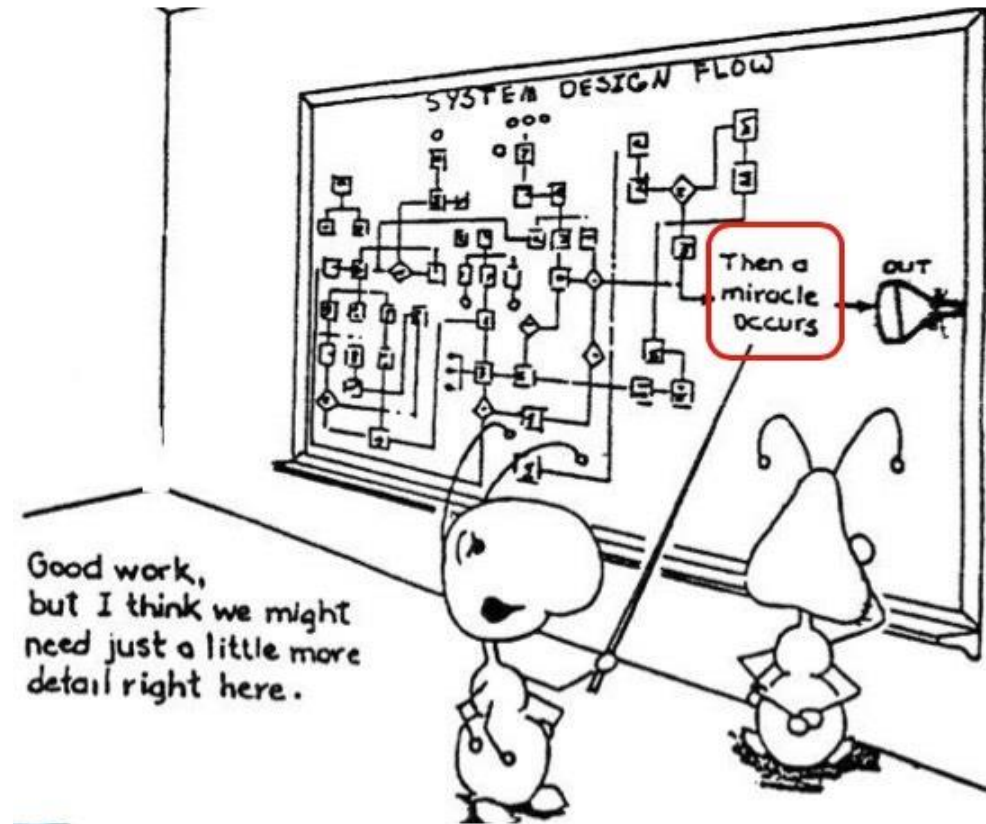
Available Tools

- Notebook paper and pen
- Stopwatch
- Excel
- PowerPoint
- Visio
- Lots of process mapping software out there…personally, I find them all really hard to use

Step 1 – Process Mapping
Identify Process

1. Identify Process

- Focus on the following:
  - Start / Stop of process
  - Level of detail you are looking for
  - Prepare tools

- Don't worry!
  - There are lots of different symbols that mean different things…keep this simple and effective
  - If you don't have fancy software (even if you do)…excel is great!

Example

- Start: Specimen Accessioning

- End: Specimen Ready for Processing

- HINT!!!!
  - If you are using excel, format the timing cells as h:mm:ss

Step	Time	Elapsed Time	Activity
1	0:00:00		
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

Example

- Start: Specimen Accessioning

- End: Specimen Ready for Processing

- HINT!!!!
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Step	Time	Elapsed Time	Activity
1	0:00:00		
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			

Formula for elapsed time =B_3-B_2

Step 2 – Process Mapping Benchmark the Process

2. Benchmark the process

- Focus on the following:
  - Capturing every step of the process within boundaries
  - Timing the sequence of the steps
  - Having your stopwatch easily accessible and viewed while you are entering your data
  - Capture any wait times
  - Capture # specimens in batch (if processing in batch)

- Don't worry!
  - NEVER follow a "person"…this isn't about people, it's about process

Hints

- Perform process mapping at least 2x…once being obvious what you are mapping and again, picking a spot in the room where people don't know what you're looking at
  - Eliminate dreaded Hawthorne Effect; The alteration of behavior by the subjects of a study due to their awareness of being observed
  - Spend time near one workflow/specimen while actively benchmarking a completely different workflow/specimen…don't even collect info on the workflow/specimen you are with!

- Show the team your data while you are collecting it…get them on-board!
  - It can be super scary to see a manager in the laboratory watching "you" and writing things down…be an open book

Example

Reminder:
Formula for elapsed time =B_3-B_2

- Using excel;
  - Timing the sequence of the steps
  - Capture any wait times
  - Capture # specimens in batch (if processing in batch)

Step	Time	Elapsed Time	Activity
1	0:00:00	0:02:14	Step 1 (Batch size 10)
2	0:02:14	0:05:02	Step 2 (Batch size 10)
3	0:07:16	0:01:11	Step 3 (Batch size 10)
4	0:08:27	0:09:52	Wait
5	0:18:19	0:00:17	Step 4
6	0:18:36	0:00:18	Step 5
7	0:18:54	0:00:18	Step 6
8	0:19:12	0:08:02	Step 7
9	0:27:14	0:08:11	Wait
10	0:35:25	0:03:53	Step 8 (Batch size 10)
11	0:39:18	0:02:29	Step 9 (Batch size 10)
12	0:41:47	0:00:12	Step 10 (Batch size 10)
13	0:41:59	0:15:17	Wait
14	0:57:16	0:07:36	Step 11
15	1:04:52	0:12:37	Wait
16	1:17:29	0:05:04	Step 12
17	1:22:33	0:01:44	Step 13
18	1:24:17	0:01:02	Step 14
19	1:25:19		End

Step 3 – Process Mapping Convert to "Process Map"

3. Convert to Process Map

- Focus on the following:
  - Each element should clearly list activity and elapsed time
  - Each element in a process map is represented by a specific flowchart symbol
    - Ovals show the beginning or the ending of a process
    - Rectangles show an operation or activity that needs to be done
    - Diamonds show a point where a decision must be made
      - Arrows coming out of a diamond are usually labeled yes or no
      - Only one arrow comes out of an activity box
      - If more than is needed, you should probably use a decision diamond

Step	Time	Elapsed Time	Activity
1	0:00:00	0:02:14	Step 1 (Batch size 10)
2	0:02:14	0:05:02	Step 2 (Batch size 10)
3	0:07:16	0:01:11	Step 3 (Batch size 10)
4	0:08:27	0:09:52	Wait
5	0:18:19	0:00:17	Step 4
6	0:18:36	0:00:18	Step 5
7	0:18:54	0:00:18	Step 6
8	0:19:12	0:08:02	Step 7
9	0:27:14	0:08:11	Wait
10	0:35:25	0:03:53	Step 8 (Batch size 10)
11	0:39:18	0:02:29	Step 9 (Batch size 10)
12	0:41:47	0:00:12	Step 10 (Batch size 10)
13	0:41:59	0:15:17	Wait
14	0:57:16	0:07:36	Step 11
15	1:04:52	0:12:37	Wait
16	1:17:29	0:05:04	Step 12
17	1:22:33	0:01:44	Step 13
18	1:24:17	0:01:02	Step 14
19	1:25:19		End

Step 1
0:00:00

Step 2
0:02:14

Step 3
0:07:16

Wait
0:08:27

Step 4
0:18:19

Step 3 – Process Mapping Convert to "Process Map"

- If you don't have Visio or a process mapping software, PowerPoint works wonders
  - Smart Art
    - Repeating Bending Process
      - Pros; Super easy to use & generally looks like a process map. Great for simple and easy processes.
      - Cons; Read left to right, top to bottom, no flexibility in shapes (all rectangles). Not good for complex or lengthy processes.
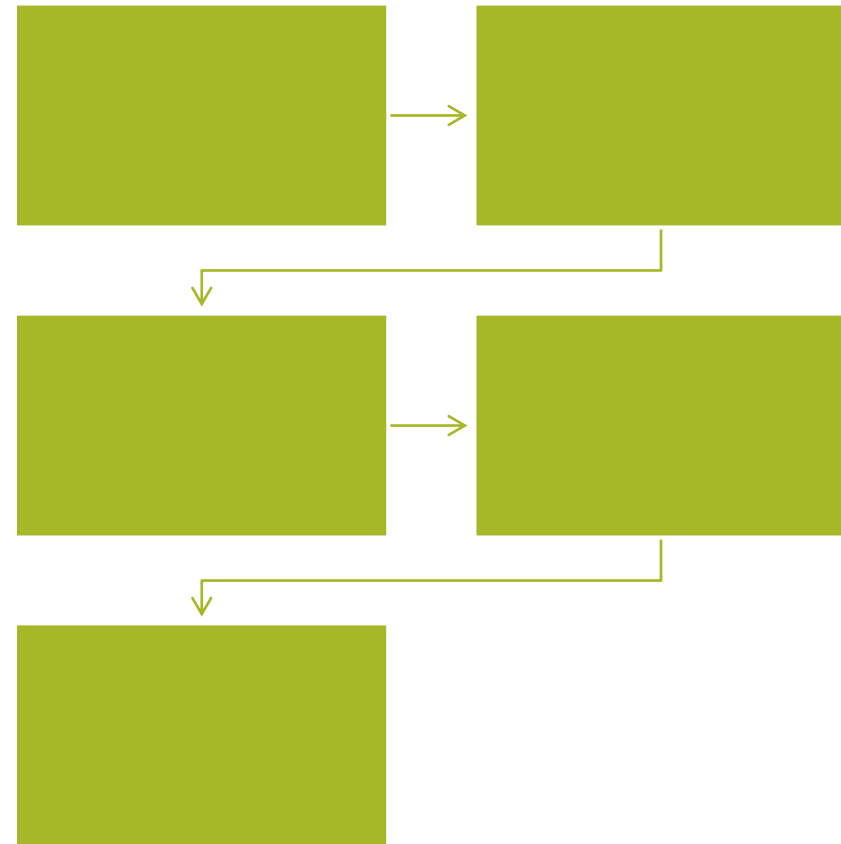
Step 3 – Process Mapping Convert to "Process Map"

- If you don't have Visio or a process mapping software, PowerPoint works wonders
  - Smart Art
    - Vertical Bending Process
      - Pros; Super easy to use & generally looks like a process map. Great for simple and easy processes.
      - Cons; Read top to bottom in odd columns and bottom to top in even, no flexibility in shapes (all rectangles). Not good for complex or lengthy processes.

Step 3 – Process Mapping
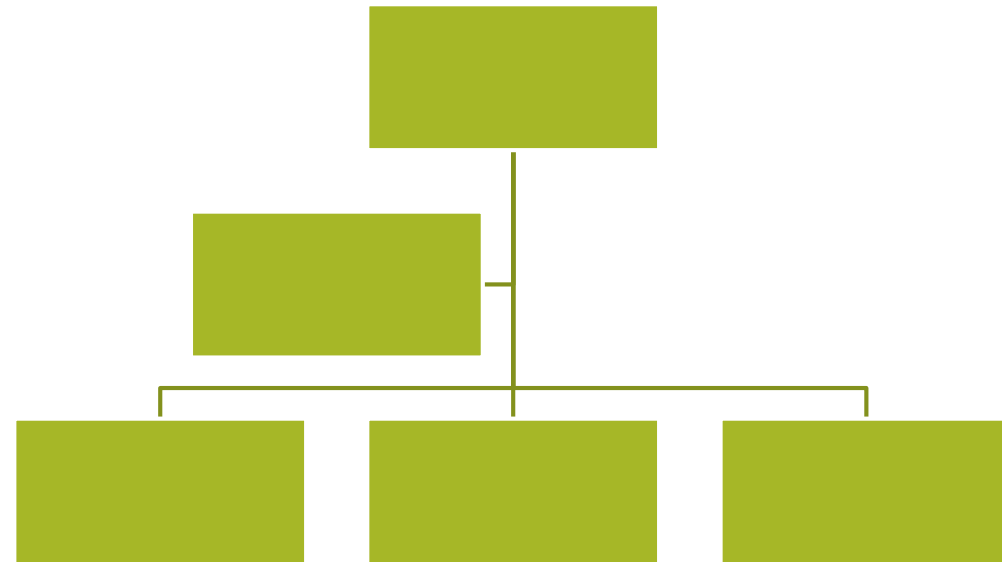# Convert to "Process Map"

- If you don't have Visio or a process mapping software, PowerPoint works wonders
  - Smart Art
    - Organization Chart
      - Pros; Super easy to use & generally looks like a process map. Great for simple and easy processes.
      - Cons; Lots of editing is required, no flexibility in shapes (all rectangles). Not good for complex or lengthy processes.

Step 4 – Process Mapping Identify Waste

4. Identify waste

- Focus on the following:
  - Identify significant delays and abnormalities

- Ensure to:
  - Facilitate staff involvement…a key factor in a positive approach to transitioning teams and organizations from current sate to an optimized future state

Step 1
0:00:00

Step 2
0:02:14

Step 3
0:07:16

Wait
0:08:27

Step 4
0:18:19
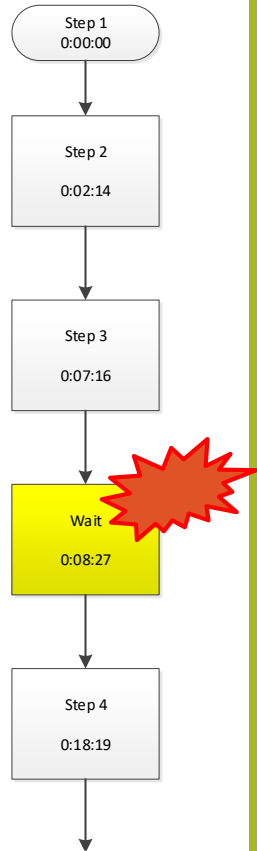
Step 5 – Process Mapping
Stratify process into swim lanes

5. Stratify process into swim lanes to better understand root cause behind the flow

- Focus on the following:
  - Highlight which process steps belong to a department/function
  - Highlight redundancies between different lanes and identify bottlenecks, waste and other inefficiencies
- Ensure to:
  - Facilitate staff involvement…a key factor in a positive approach to transitioning teams and organizations from current sate to an optimized future state

Example

New Question: Does hand off contribute to wait?
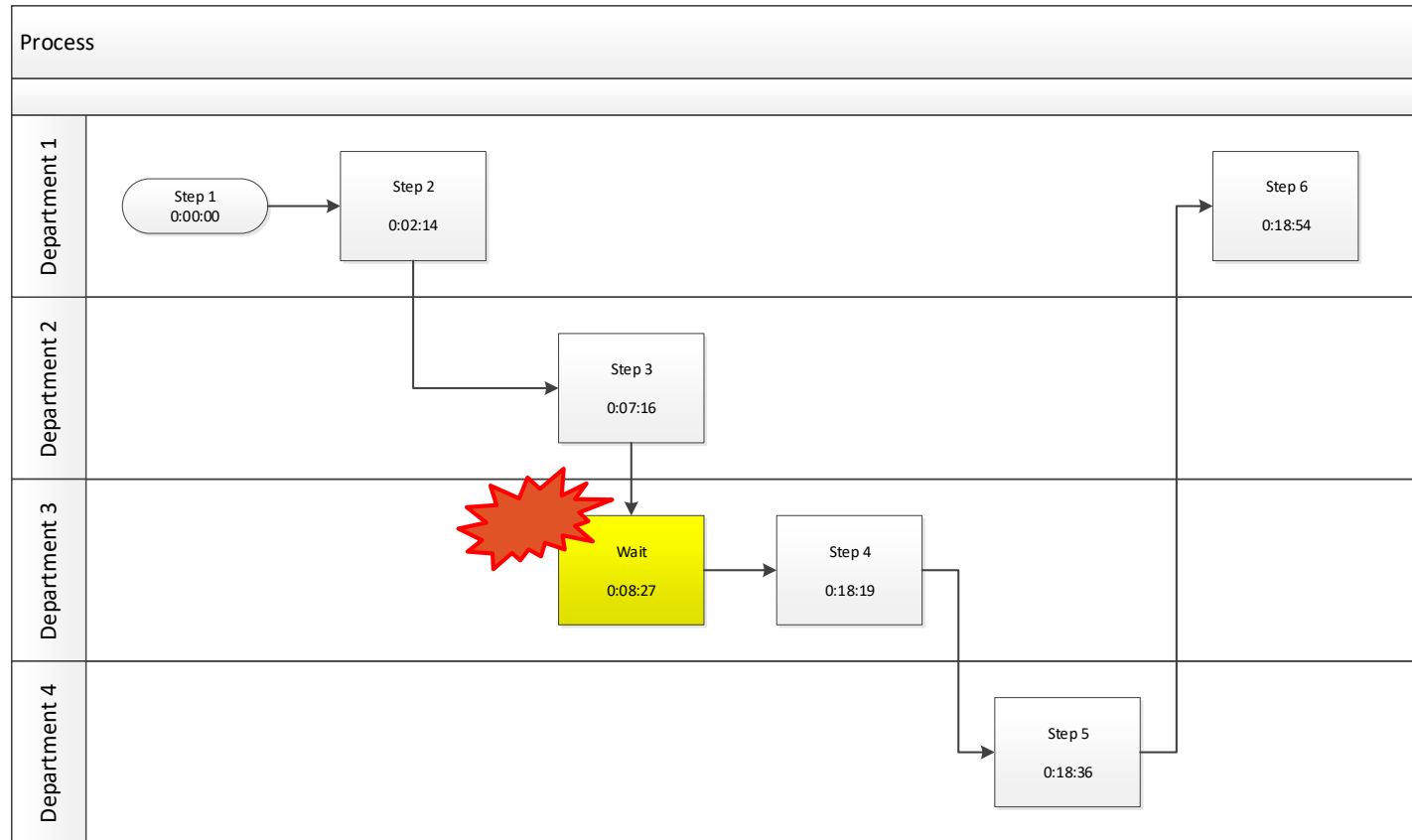
Step 6 – Process Mapping
Overlay Process Map onto Spaghetti Map

- Overlay Process Map next to Spaghetti Map to Illustrate Full Picture

  - Focus on the following:
    - Review the flowchart with other stakeholders (team member, workers, supervisors, suppliers, customers, etc.) to make sure everyone is in agreement

Laboratory Layout Design Keeping in Mind…

- Clearances – floor, ceiling, venting, etc.

- Optimize reagents and supplies stored at the bench
  - Saves money as the $$$ needed for storage in the lab space is incrementally more expensive than in storage rooms/warehouses

- Safety
  - Eye wash stations, safety showers, etc.
    - Regulations (OSHA, etc.)
    - Ensure builders or facilities check local codes to make sure that is addressed
      - Nothing worse than to have to ADD plumbing after everything is built out
    - Pay special attention for new build-outs, even if you don't know where they go, at least be cognizant that they will have to go somewhere

- Departmental specific needs
  - Sample Processing
    - Placement is key – close to where the specimens arrive is optimal
    - Automated lines should initiate in close proximity to sample processing
    - Pneumatic tube system drop points
  - Clinical
    - Space determined from equipment, workstations and local codes
    - Current trend: Large, open laboratory that supports cross-training, large instrumentation and automation

Citation: CLSI. Laboratory Design. 3rd ed. CLSI guideline QMSO4. Wayne, PA. Clinical and Laboratory Standards Institute; 2016

Laboratory Layout Design Keeping in Mind…

- Departmental specific needs (cont)
  - Molecular
    - Uni-Directional workflow
    - Install equipment away from direct sunlight, dust, direct airflow or excess ventilation
    - Easily get behind everything to clean
    - Sink in close proximity
    - Separate from rest of laboratory (contamination)
    - Put it in the back!!!!
      - Maximize the distance between accessioning and molecular in case there is a contamination….low volume enough that extra transport is worth the safety factor

- Departmental specific needs (cont)
  - Genetics
    - Similar to molecular
    - Several rooms are required (specifically to maintain environment)
      - Clean tissue culture room
      - Harvesting and staining room
        - FISH – separate room with ability to turn lights off and on
      - Image analysis
        - Usually looks like an office
    - Large amounts of storage for files and slides in close proximity to cytogenetics lab

Citation: CLSI. Laboratory Design. 3rd ed. CLSI guideline QMSO4. Wayne, PA. Clinical and Laboratory Standards Institute; 2016

Put it all together

"ANYTHING GOES TODAY: I WANT THIS TO BE A FREE AND OPEN DISCUSSION OF MY ENTRENCHED POSITIONS."

Building Your Executive Deck

1. Be succinct

2. Every slide should have a relevant data point

3. Use two visuals per slide, both telling the same story
   - Reinforce with pictures
   - Example: If you have a spaghetti map on one side, have the process map on the other
   - Rationale: This is likely a new way for your executive team to view this type of information. While a spaghetti map may make sense for some, the process map may make more sense for others.

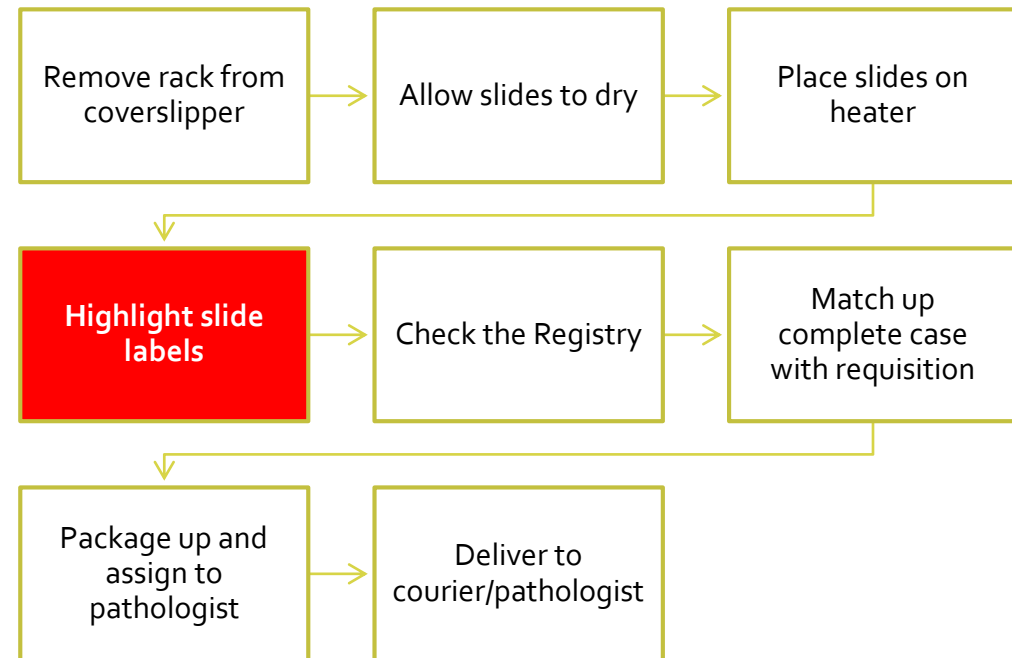4. Use a call-out / summary line for every slide (in the same format)

Example

Observations

- Maintain several days of registries due to lower priority cases that wait

- Extra step of highlighting

Opportunities

- Possible to reprint pending cases vs keeping registry from previous days?

Process Map

```
Remove rack from      →   Allow slides to dry   →   Place slides on
coverslipper                                         heater
                                                        ↓
Highlight slide       →   Check the Registry    →   Match up
labels                                               complete case
                                                     with requisition
    ↓
Package up and        →   Deliver to
assign to                 courier/pathologist
pathologist
```

Reduced hands-on time by XX% through reprinting pending cases, while reducing overall process by XX%
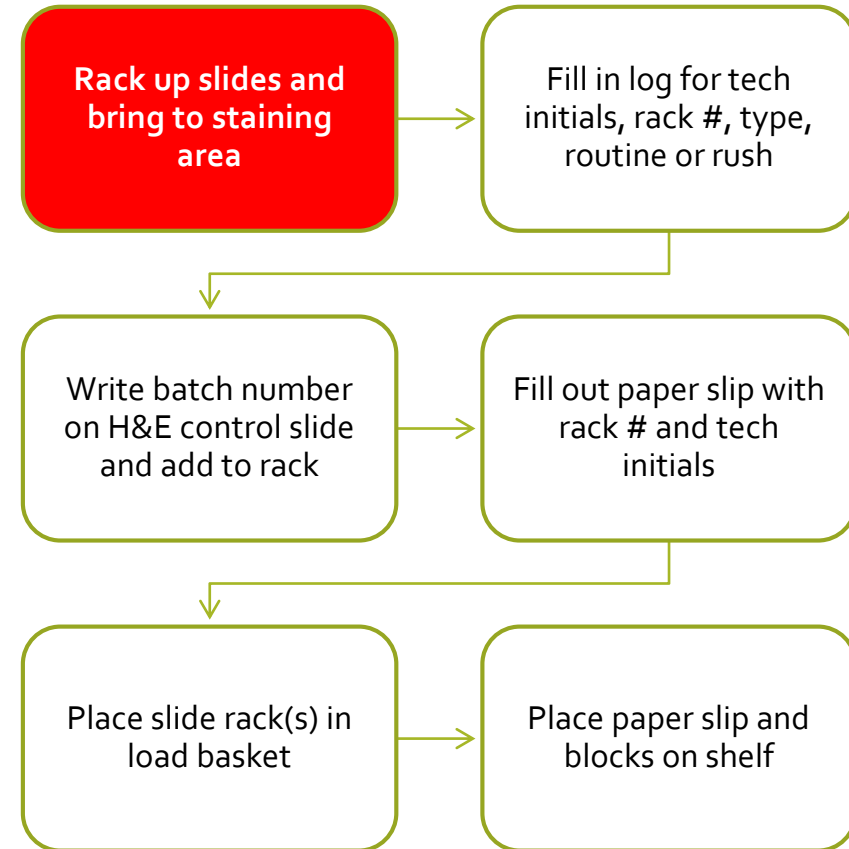
Example

Observations

- Time spent filling out logs for prepared slides
- 56.14 Seconds per event
- 37% Racks are signed in log as singles

Process Map

Rack up slides and bring to staining area → Fill in log for tech initials, rack #, type, routine or rush

Write batch number on H&E control slide and add to rack → Fill out paper slip with rack # and tech initials

Place slide rack(s) in load basket → Place paper slip and blocks on shelf

Automating process to complete logs will enable a savings of $XX,XXX

Hopefully, We Have Achieved…

- Understanding of common Lean tools used to generate data

- Confident use of 3 Lean tools
  - Spaghetti Mapping
  - Process Mapping
  - Laboratory Layout Design

- Possess the ability to convert observations & workflow mapping into quantitative data used for management and executive business cases