Seven Basic Quality Tools

The 7 Basic Tools

- Checklists (checksheets)
- Pareto diagrams
- Histograms
- Run Charts
- Scatter diagrams (scatter plots)
- Control charts
- Cause-and-effect (fishbone) diagrams

- See slide showing the tools
- Notice that there seems to be some disagreement on what exactly the 7 are!

What are these tools?

- Simple techniques to
  - Track quality performance and trends
  - Identify the existence of quality problems
  - Analyze and gain insights into the causes and sources of quality problems
  - Figure out which problems to address
  - Help eliminate quality problems
    - Defect prevention, not just detection and correction
- Basic knowledge for anyone interested in quality, engineering problem solving & systems design
  - Probably already familiar with most of these

Why exactly 7 tools?

- Ishikawa promoted the notion of 7 basic tools that could be used to address quality
  - Designed for manufacturing environments, but applicable to engg & management
- There are other very useful tools too
  - Templates, workflow automation
  - Pie charts and other graphical representations
  - Relationship diagrams, tree diagrams etc. ("7 new quality tools")
  - System dynamics diagrams (influence diagrams)

- We learn a basic subset here, others left to "lifelong learning" ☺
  - Corporate training often introduces/uses quality tools & techniques

What to learn about each tool

- What is the tool? How is it used?
- For what purposes is it useful?
- What value does it add?
- What are its limitations?
- How can it be used effectively?

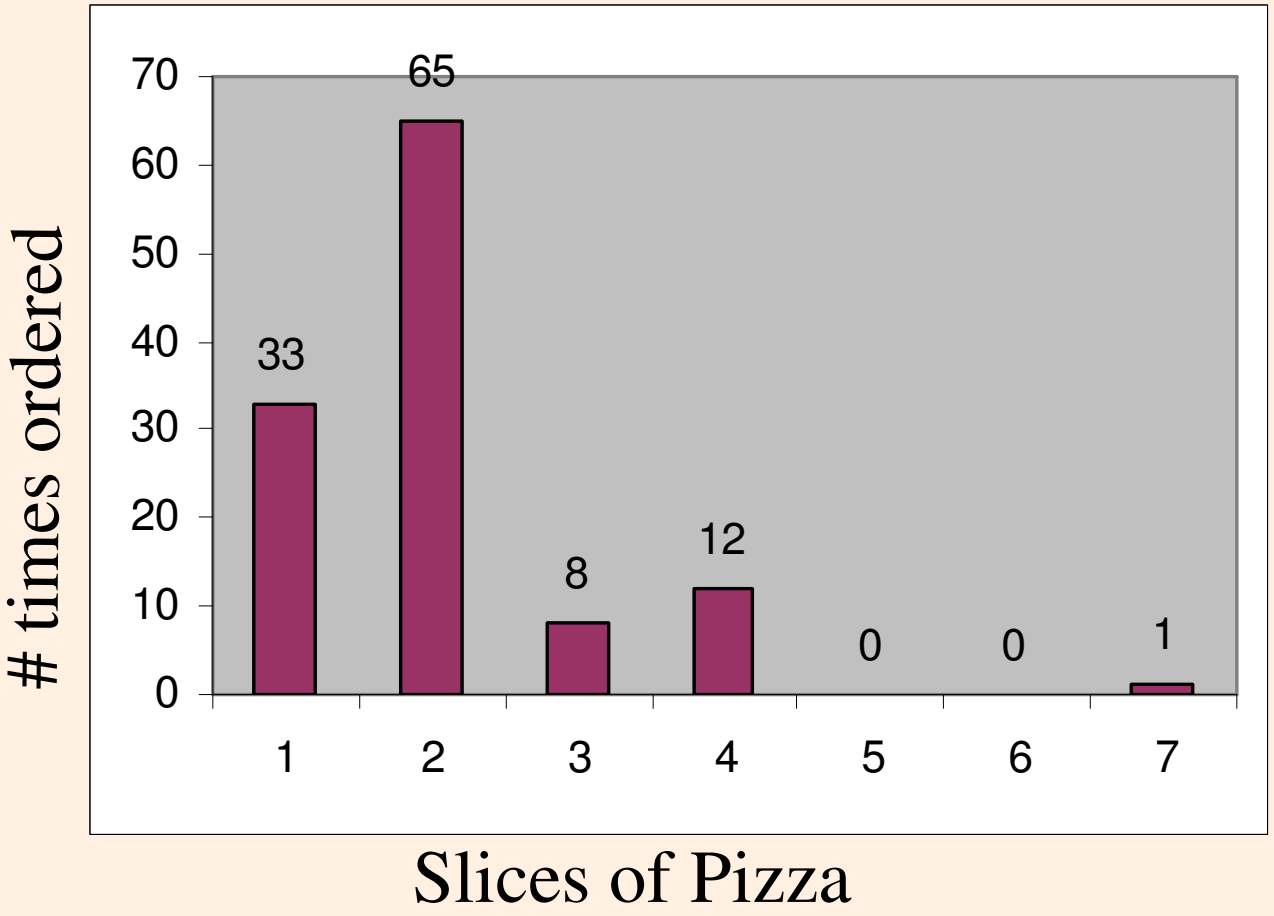
Histogram

- A bar graph showing frequency counts
- X axis often a nominal or ordinal scale
- Use/value: Easy to see relative magnitudes / frequencies
  - Sometimes low frequency items are of interest e.g. dissatisfied customers: histogram may “minimize” these
    - Can use different color or other ways to highlight these
- Sometimes multiple bars for each item (e.g. last year / this year), to show trends and changes

- Pie chart representation useful if these are parts of a whole
  - Not very good if there are several low-frequency items of interest

- Sometimes cumulative frequency line added to show “total at or below this level” – useful if X axis is ordinal scale

Histogram Example



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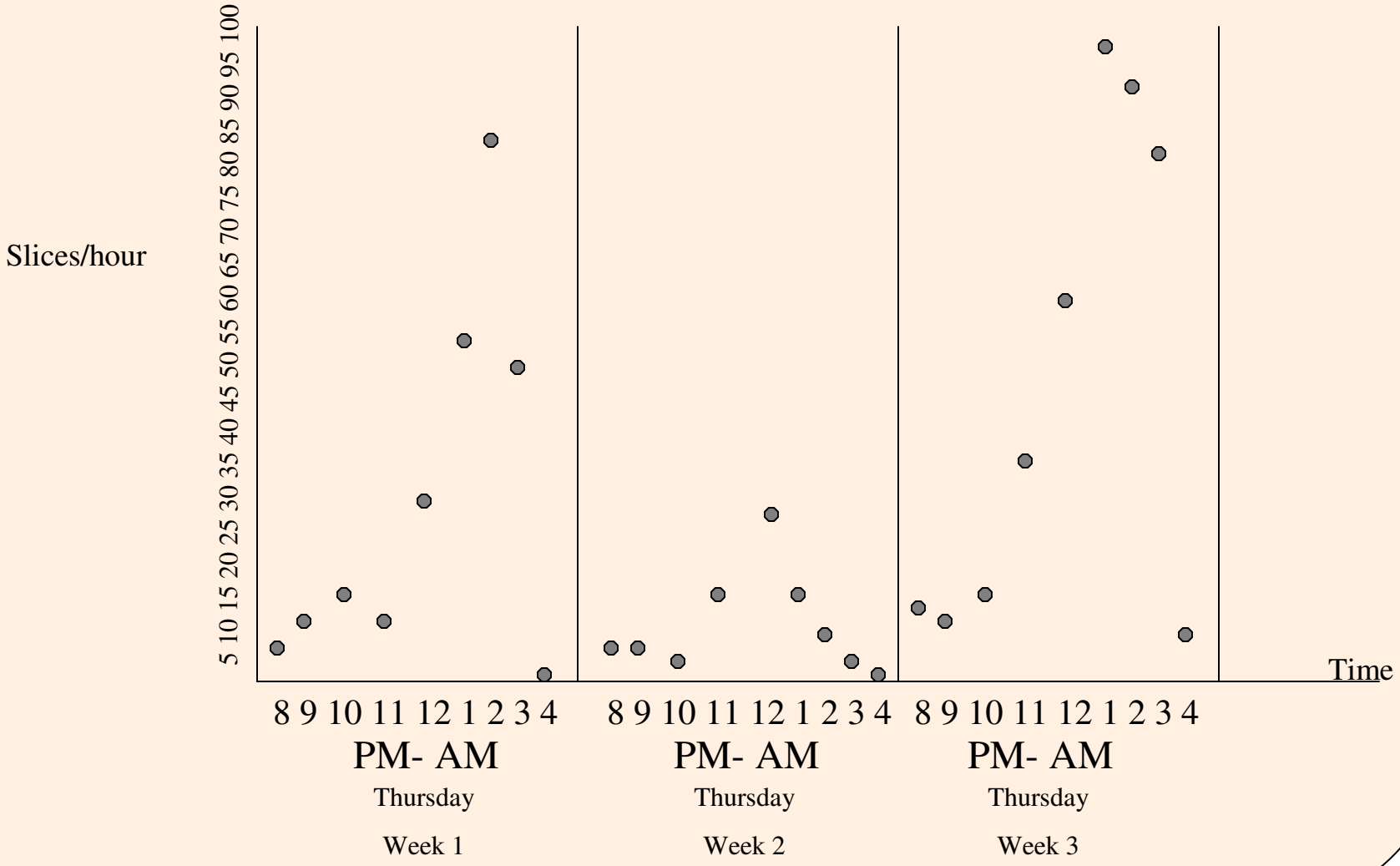
Run charts

- Plot of some measurement/metric vs. (usually) time
  - Use this when X axis is interval or ratio scale e.g. “team size”
- Shows trends over time
  - Easier to spot overall upward or downward trend, or even cyclical variations
- Visually separate random from significant variation
  - Major spikes / valleys triggers for explanation / investigation / action
- Value: Identification of problems, trends, unexpected good results (may learn a lot from these)

Run Charts



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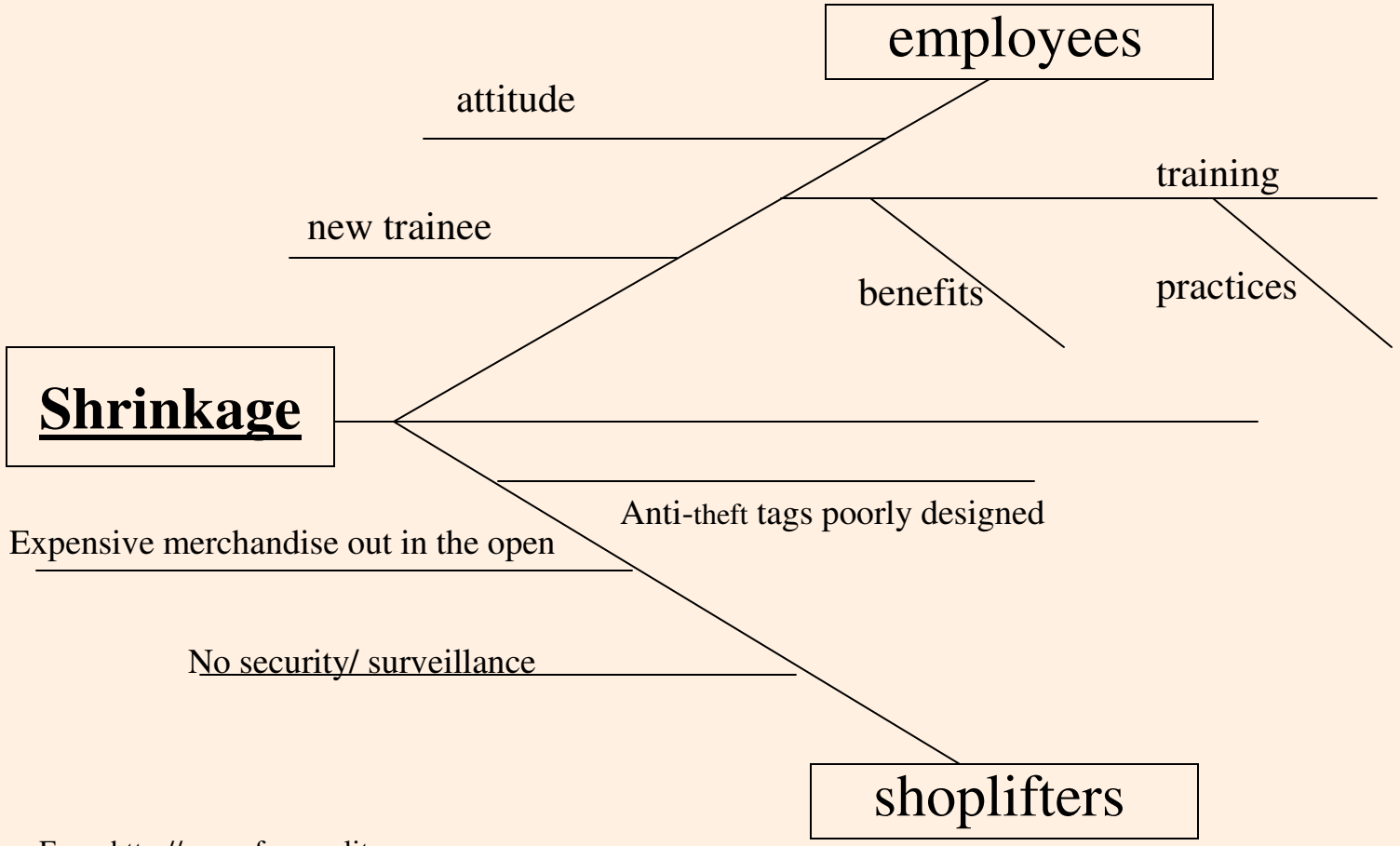
Cause-and-effect (fishbone) diagram

- Diagram showing hierarchical structure of causes that contribute to a problem or outcome
  - Problem of interest forms the backbone
  - Spines are causes that contribute to the problem
  - Spines may have bones that represent its contributory factors and so on
- Used in brainstorming to diagram and identify various possible factors contributing to a problem, and to identify causal sequences (A causes B causes C)
  - Very simple but extraordinarily useful tool
- At this stage, both minor factors (that occur rarely or contribute very little) and major causes may all get listed

Example Fishbone Diagram

- Ex. : High Inventory Shrinkage at local Drug Store



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Pareto Diagram

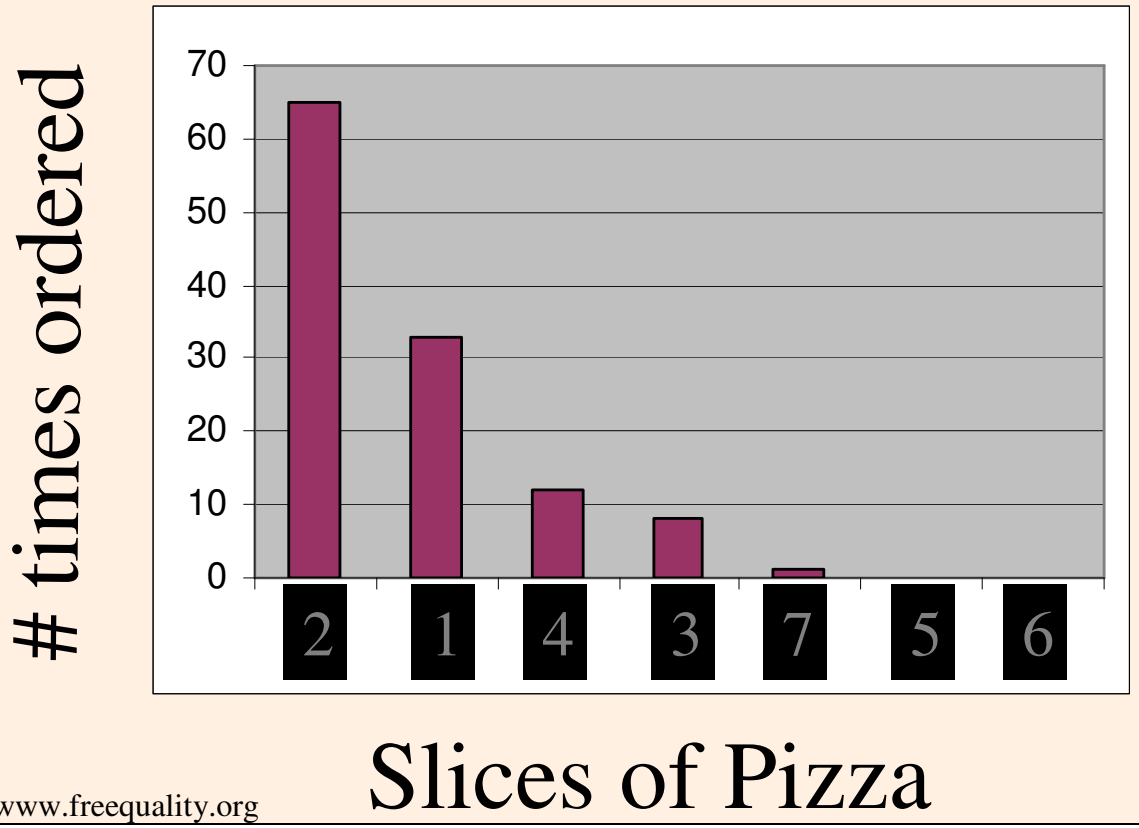
- Histogram arranged by decreasing frequency
- Used to identify causes that contribute most to the problem

- After fishbone analysis, may do data gathering to figure out the frequency with which each cause contributes to the problem
  - In software, review reports are good data sources
- Plot histogram, identify the major causes easily

- Based on 80/20 rule
  - “20% of the causes contribute to 80% of the effects”
  - Indicates general principle that some causes likely to be a lot more significant than others
- Highest cost-benefit from addressing the most significant problems
  - Less significant problems may barely be worth addressing

Pizza Example (part 2)

- The completed Pareto Analysis results in the following graph:



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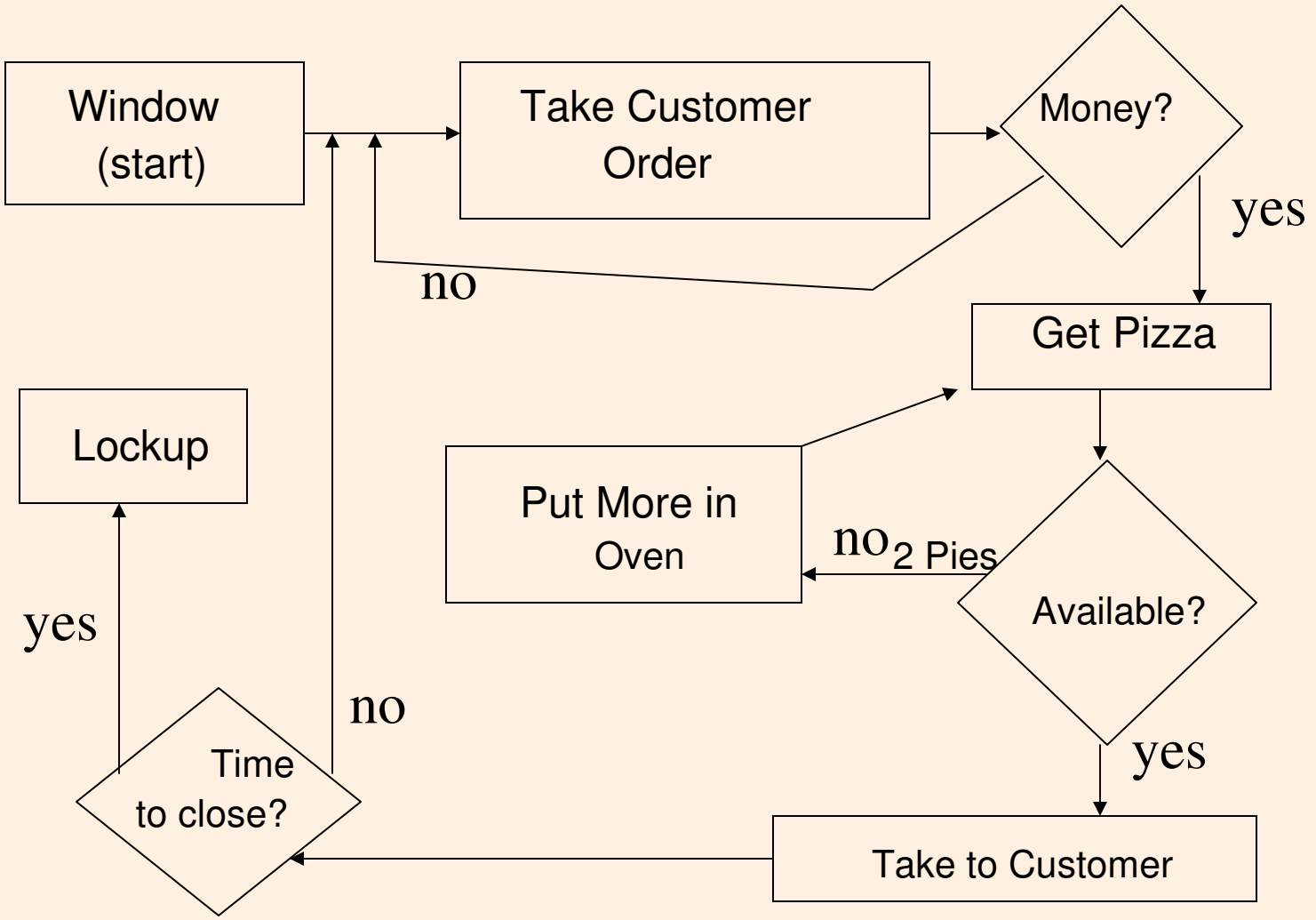
Checklists

- Once we identify the causes of problems, how do we eliminate them?
  - Checklists are simple and incredibly effective at preventing & eliminating defects on repetitive tasks e.g. toDo lists, “did you”s on bill payment envelopes…
- Capture knowledge about common problems & how to avoid them
- Can be used in review processes to identify problems
- Lightweight: low additional effort to use (not zero!)
- Checklists that become too long lose value (use pareto analysis!)

Flowcharts (processes)

- Flowcharts show sequencing of activities & decisions
  - Depiction of processes for doing things
- Streamline the flow of activities
- Capture knowledge about how to perform activity (effectively)
- Eliminate problems due to missed activities and badly sequenced activities
- Can be used to analyze and implement improvement ideas
  - Good processes can save work and avoid problems
    - Less than zero cost for improving quality
    - Should always be the goal of process design

Flowchart example



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Templates

- Templates are another zero-cost defect elimination mechanism
  - Pre-created document structure
  - Often pre-populated with “boilerplate” stuff: standard explanations, disclaimers etc.
  - Avoids problems due to missing information, incompleteness
    - Avoids problems in activity for which the document is the output
    - Need to fill in form, so get the data / do the activity!
- Problem with templates: not all sections are always applicable, may sometimes want different structure
- Can constrain people from doing what they need to
- Can lead to “automaton” mode where people just fill in form without thinking if that’s the most appropriate thing to do
  - Make templates as guidelines, not “set in stone” forms

Workflow Automation

- Creation of computerized tools that streamline activities e.g. online registration, myCourses testing!
  - Implements process, templates
  - Eliminates many kinds of defects
  - Saves effort
- Flexibility is often a major problem
  - If the needs are different from what tool supports, can't do it at all!
  - Designing flexible tools which automate workflow is a major technical challenge!

4 basic defect elimination tools

- Checklists
- Templates
- Processes
- Workflow automation

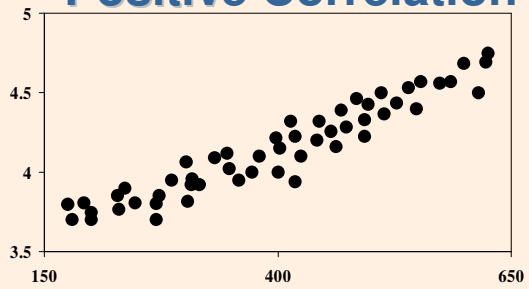
Scatter Diagram

- Used to determine whether there is really a relationship between two variables
  - Fishbone identifies possible causes
  - Doing a scatterplot can show whether the two are correlated
    - Visual plot can show degree of correlation, non-linear correlations
    - Linear correlations if most points along a straight line
    - Poor (linear) correlation if points scattered all over
- Remember: correlation does NOT imply causal relationship!

Scatter Diagrams

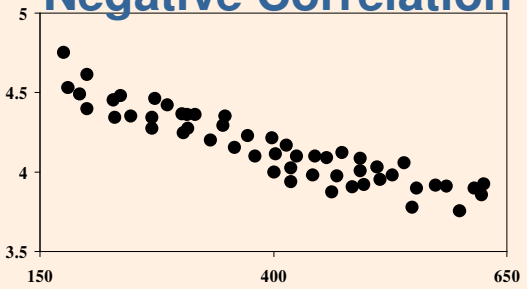
Measuring relationships between variables

Positive Correlation



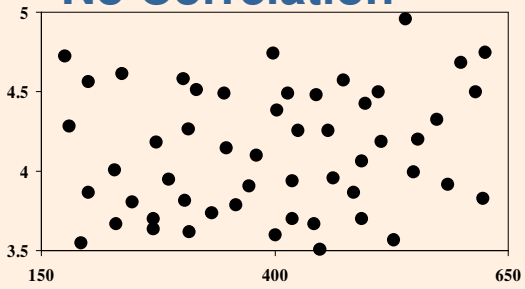
An increase in y may depend upon an increase in x.
E.g.

Negative Correlation



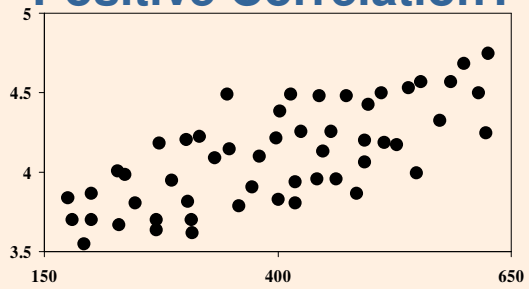
An decrease in y may depend upon an increase in x.

No Correlation



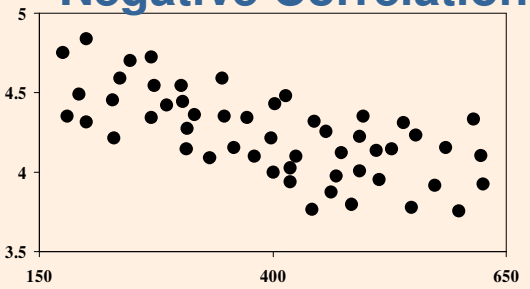
There is no demonstrated connection between x and y.

Positive Correlation?



If X is increased, y may also increase.

Negative Correlation?

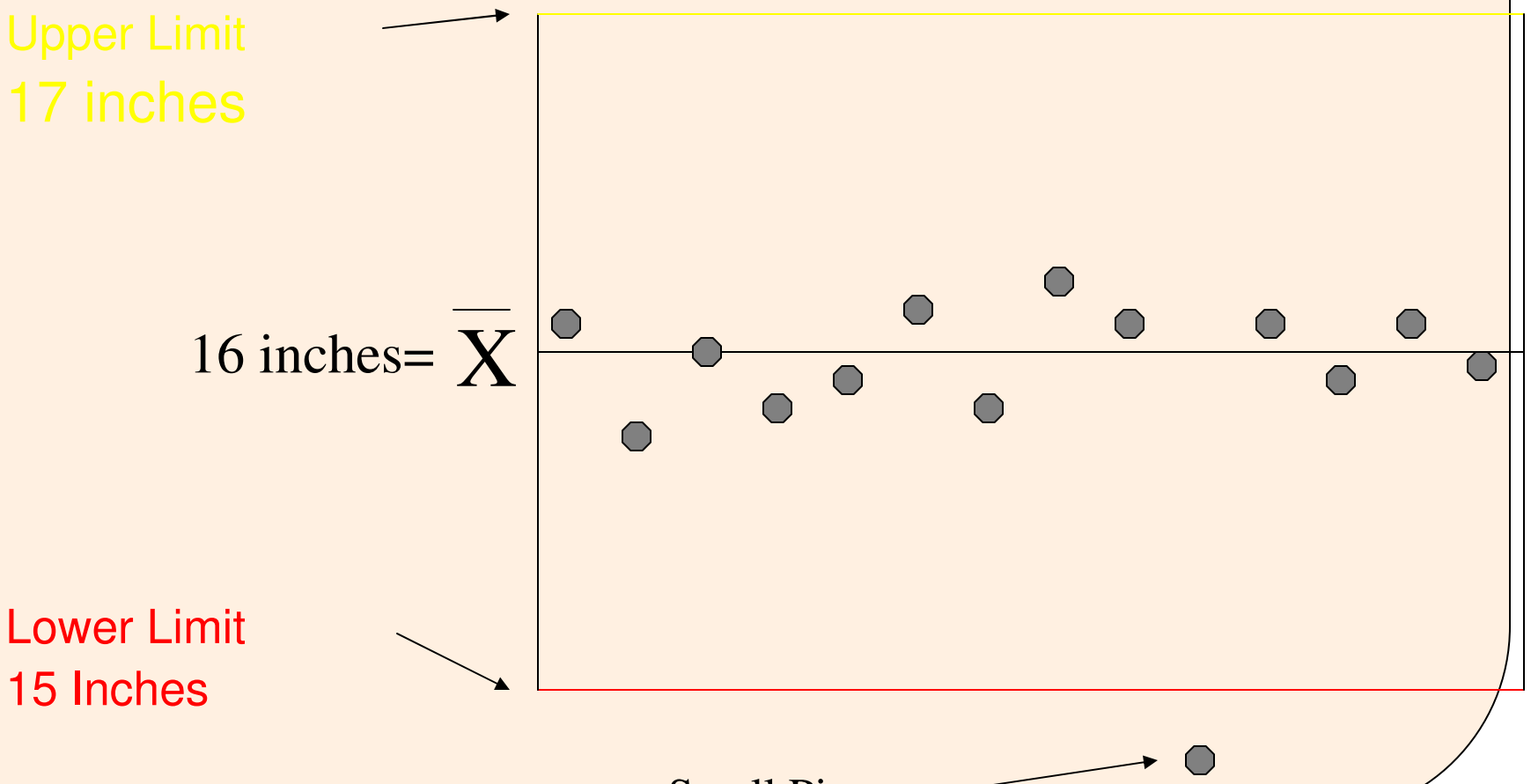


If X is increased, y may decrease.

Control charts

- Plot of a metric with control limits defined
  - Upper control limit: If value of metric exceeds this, take action
  - Lower control limit: If value goes below this, take action
  - (maybe) Warning levels: If value outside this, check if all is well
- Control limits may be derived statistically or less formally (based on “reasonable” values / other impacts)
  - Formal statistical process control has formulae for deriving limits: often 3 sigma deviation from desired outcome
- Useful to flag “outlier” values e.g. components with very high defect rates, projects that have parameters outside “normal levels” etc.
  - Formal statistical process control not used much in software

Pizza example Control Charts



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Summary

- The quality tools together form a suite:
  - Histograms, run charts, control charts can identify problems
  - Fishbone is used to brainstorm possible causes
  - Scatterplots can be used to analyze whether relationships exist
  - Pareto analysis identifies which causes are most worth addressing
  - Checklists, templates, process definition and workflow automation can eliminate problems

Exercise

- Start with the problem “Meetings that run too long and don’t produce much”
- Do a fishbone analysis
- Figure out how you would gather data about relative contribution of different causes
- Do a pareto analysis of causes from anecdotal data (not generally recommended!)
- Identify ways to implement improvements in meeting effectiveness
  - Hopefully, use them in future!

Assignment 2

- Due Thu Sep 24
- Identify any one activity you do regularly that could do with "defect elimination"
  - E.g. Transferring files from one computer to another, maintaining a website, organizing activities for your club, packing to go on a trip / hike…
- Identify some measurements that would tell you how you are doing
- Figure out some simple techniques that will "reduce process variation" i.e. eliminate defects
- If possible, put it in practice
- Write up ½ - 1 page about it and post it as assignment 2
- Identify one partner in class (not necessarily in your team) and exchange feedback