کارگاه آموزشی ابزارهای حل مسأله:

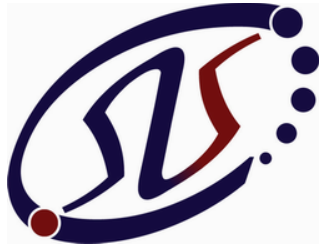
در **بهمن ماه سال جاری** دوره آموزشی **ابزارهای حل مسأله** برای اعضای محترم کمیته مستندسازی متشکل از ۹ نفر از اعضای هیات علمی دانشگاه به عنوان مسوولین کارگروه‌های مختلف و معاون طرح و برنامه دانشگاه، در طی چندین جلسه برگزار گردید و مطالب زیر مورد بحث و بررسی قرار گرفتند:

ابزارهای حل مساله

- Tree Diagram
- AND
- Brainstorming
- Cause Effect
- Checksheet
- Control Chart
- Flowchart
- Forced Field
- Histogram
- Matrix
- Nominal Group
- Scatter Diagram
- Afinity
- Pareto
- PDPC
- Prioritization
- Problem Solving
- Proc. Capability
- Radar Chart
- Relationships
- Run Chart

مطالب ارائه شده در این کارگاه آموزشی

به نام خدا



ابزارهای حل مساله

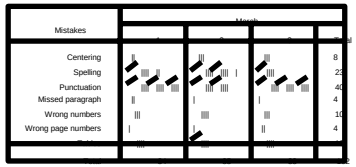
Problem Solving Tools

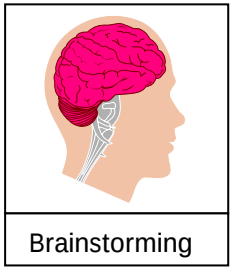
شرکت نیکوسگال دانشگاه فردوسی مشهد

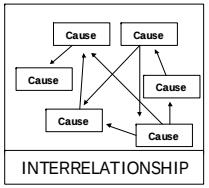
سید مجید امامیه

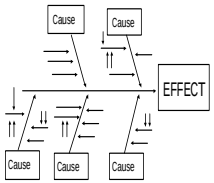
بهمن ۸۵

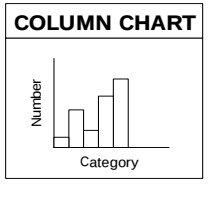
Problem Solving Tools

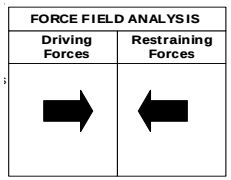


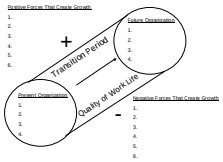


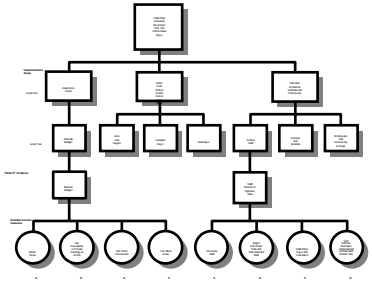


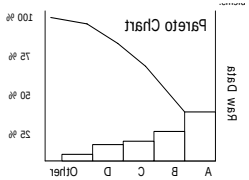


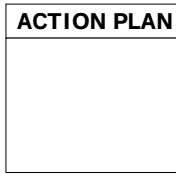


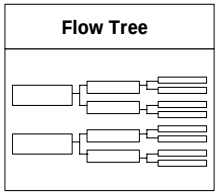


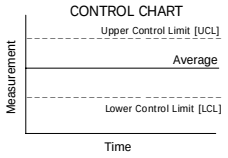


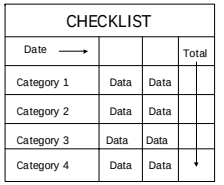


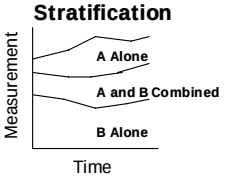


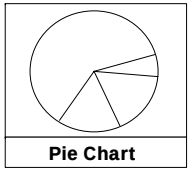


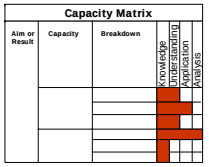


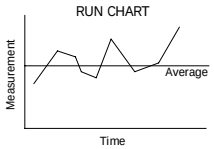


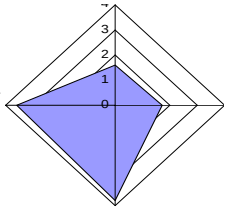


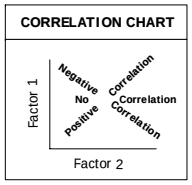


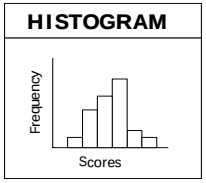


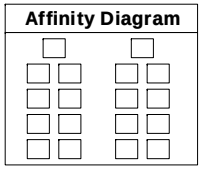


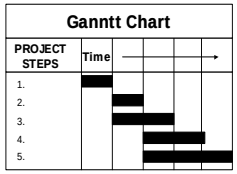


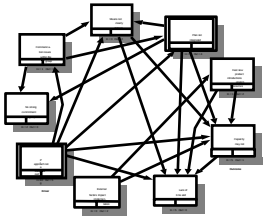


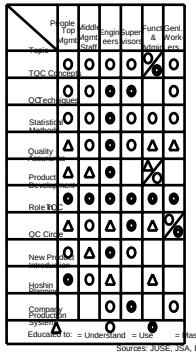


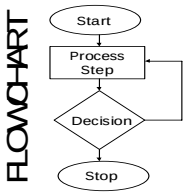


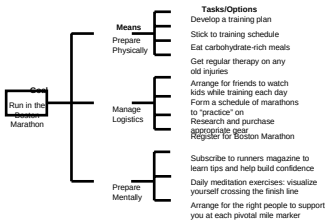


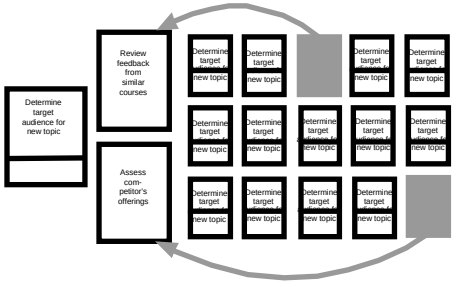


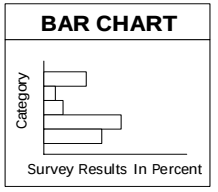












Process Tool Overview

- Tree Diagram
- AND
- Brainstorming
- Cause Effect
- Checksheet
- Control Chart
- Flowchart

- Forced Field
- Histogram
- Matrix
- Nominal Group
- Scatter Diagram
- Afinity

- Pareto
- PDPC
- Prioritization
- Problem Solving
- Proc. Capability
- Radar Chart
- Relationships
- Run Chart

Data Points

Choose the Right Tool

Number Data (Count or attribute)	Tool to Use
• Show frequency of events	• Check Sheet • Pareto • Control Chart
• Show process performance over time	• Run Chart
• Show capability of process to meet customer requirements	• Process Capability

Number Data (Measure or variable)	Tool to Use
• Show relationships among multiple data sets over time	•Radar Chart •Run Chart
• Show centering and variation of a process	• Histogram
• Show correlations between two or more data sets	• Scatter
• Show process performance over time	• Run Chart • Control Chart
• Show capability of process to meet customer requirements	• Process Capability

Word Data	Tool to Use
• Show process flow	AND • Gantt • Flowchart
• Generate ideas • Narrow Ideas	• Brainstorming • NGT/Multivoting
• Sort ideas	• Affinity • Cause & Effect • Force Field
• Show relationships	• Cause & Effect • Interrelationship
• Show greater level of detail	Cause & Effect • Tree Diagram
• Show correlations	Cause & Effect • Force Field • Interrelationship • Prioritization • Radar Chart
• Develop consensus	•Matrix Diagram • Prioritization
• Plan contingencies	• PDPC

Back

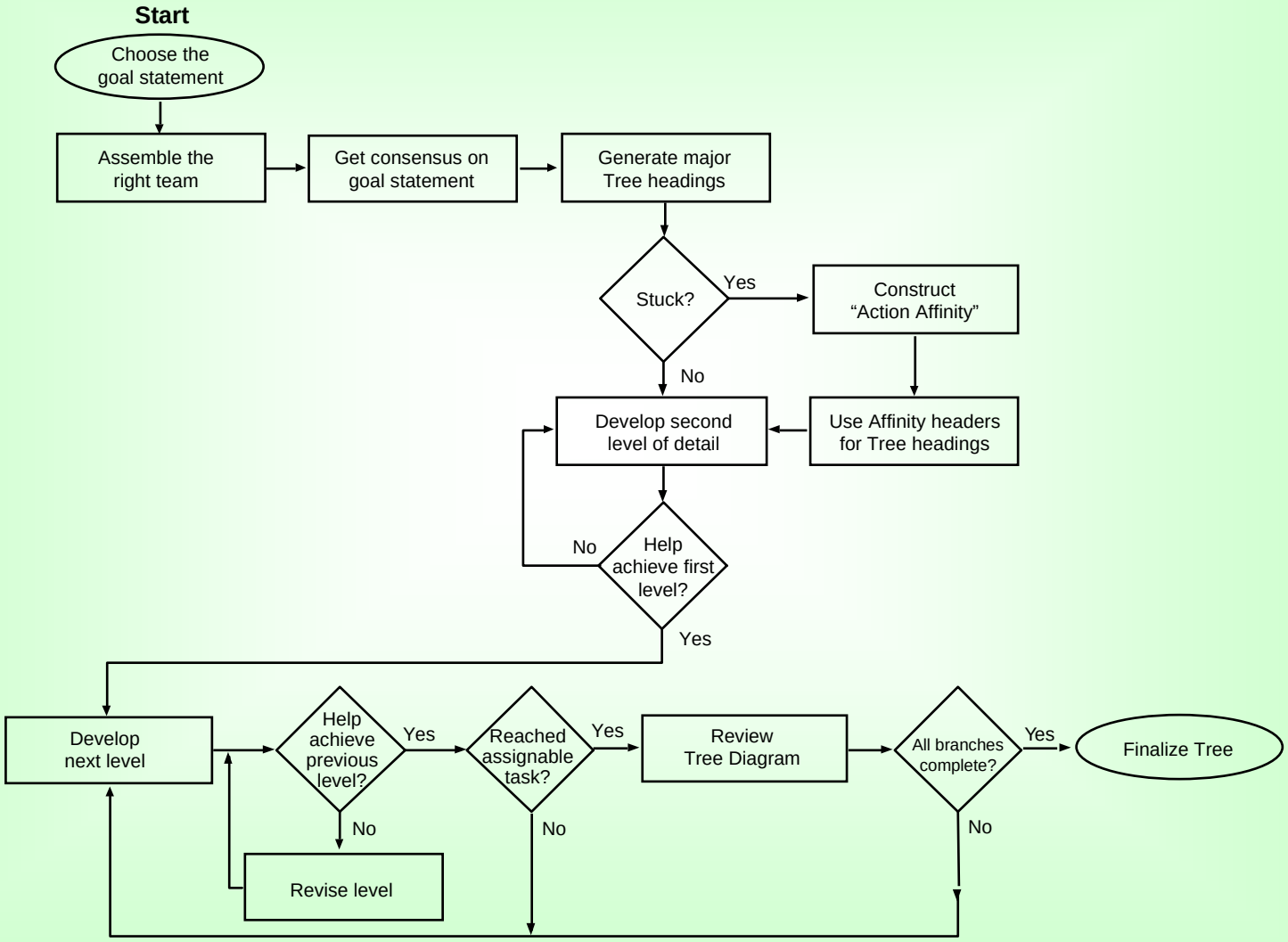
Constructing the Tree Diagram

- Step 1 Choose the Goal
- Step 2 Assemble the Right Team
- Step 3 Generate Major Headings
- Step 4 Break into Detail
- Step 5 Review Completed Tree

Tree Diagram Essentials

- Key Success Behaviors
  - Welcome complexity by revealing its structure
  - Know that getting “stuck” is just a temporary condition
  - Know when to stop “branching” the Tree

Steps at a Glance: Tree



Step-by-Step Construction

- **Step 1** Choose the Goal

Goal: Increase workplace suggestions

Step-by-Step Construction

- **Step 3** Generate Major Headings

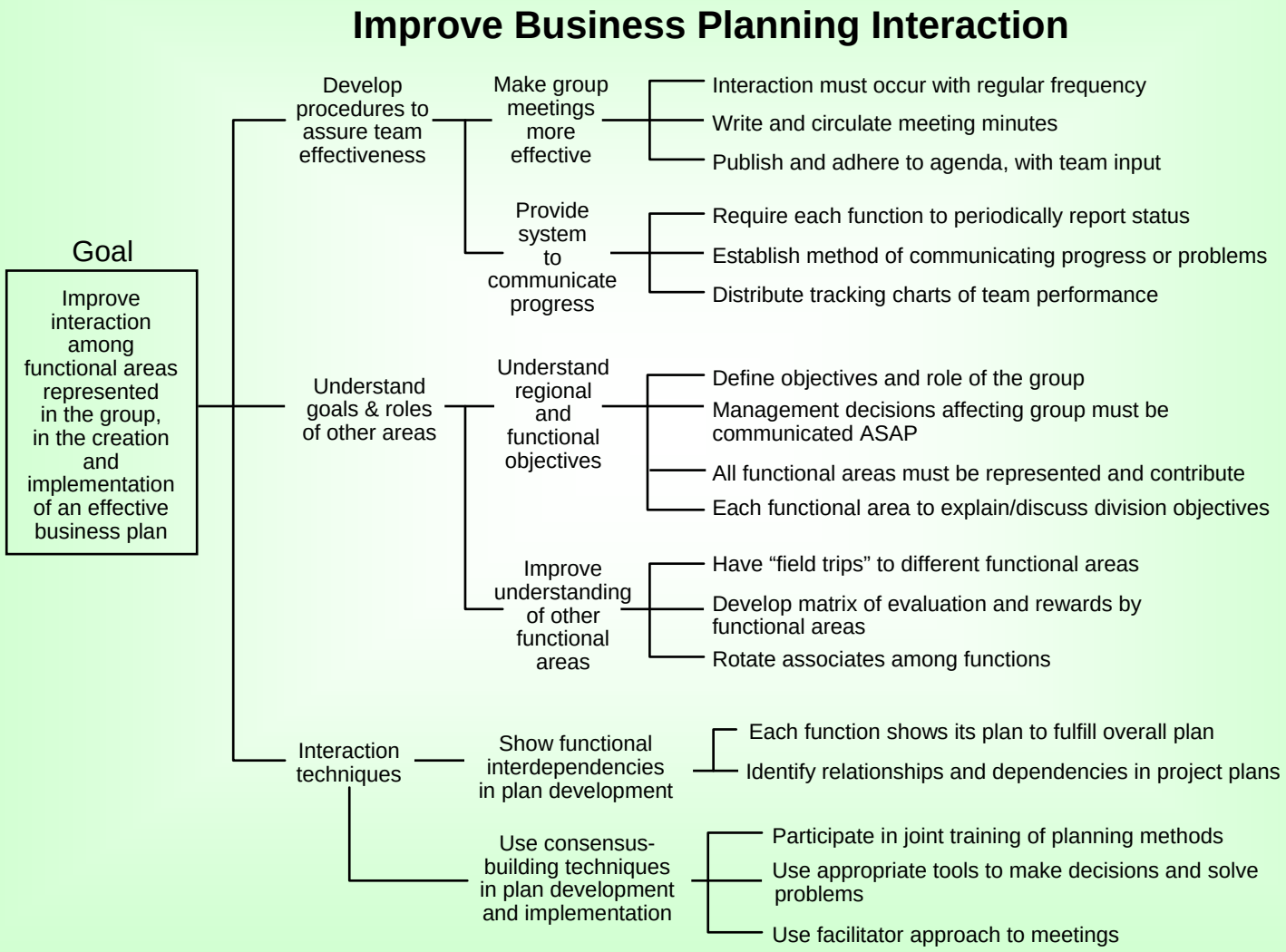
Goal	Means
Increase workplace suggestions	Create a workable process
	Create capability
	Measure results
	Provide recognition

Step-by-Step Construction

- **Step 3** Generate Major Headings

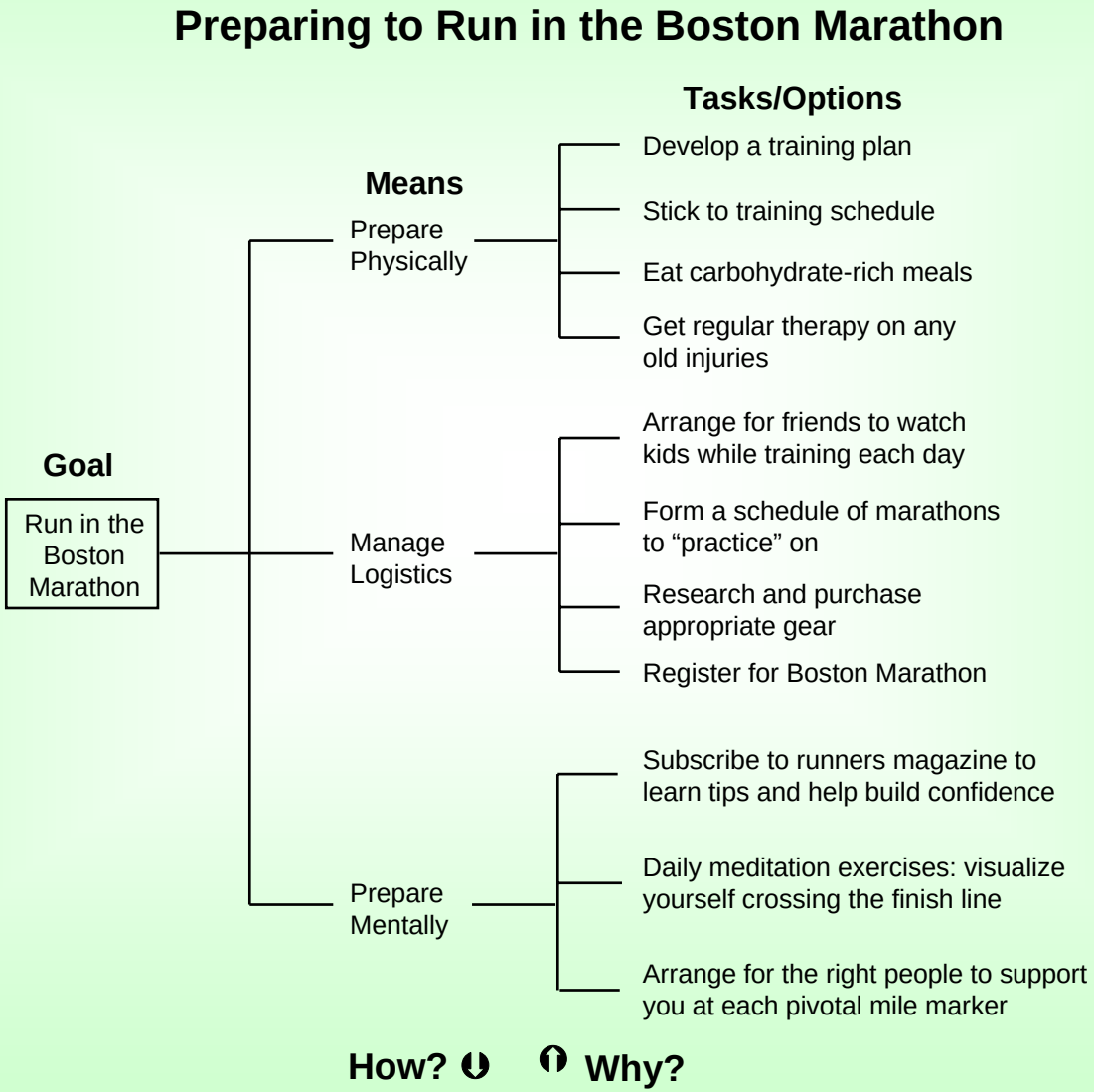
Goal	Means
Increase workplace suggestions	Create a workable process
	Create capability
	Measure results
	Provide recognition

Tree Example



Information provided courtesy of Goodyear

Tree Example



Back

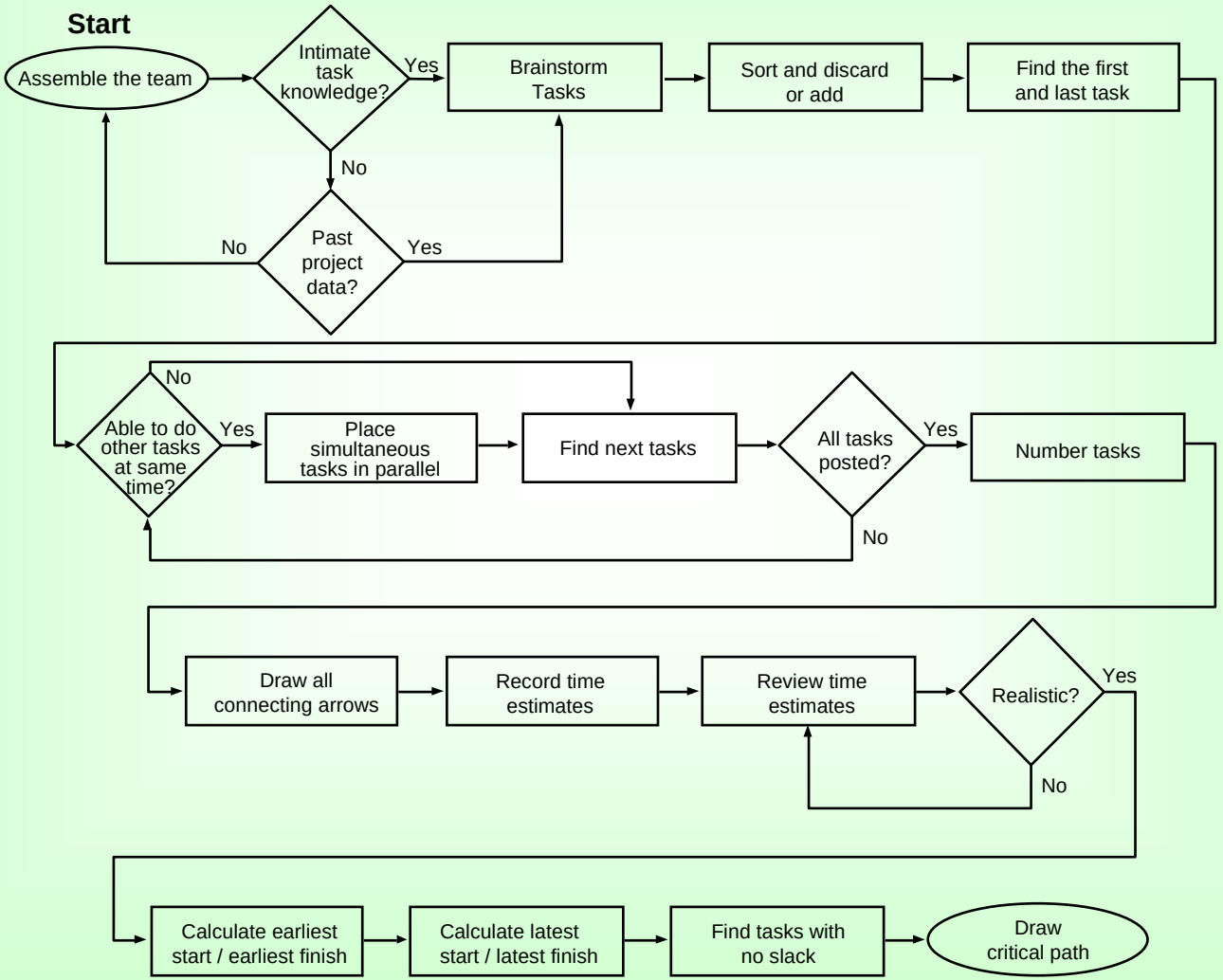
Constructing the AND

- Step 1 Assemble the Team
- Step 2 Brainstorm All Tasks
- Step 3 Find the First Task
- Step 4 Find Simultaneous Tasks
- Step 5 Find the Next Tasks
- Step 6 Detail the Chart
- Step 7 Find the Critical Path

AND Essentials

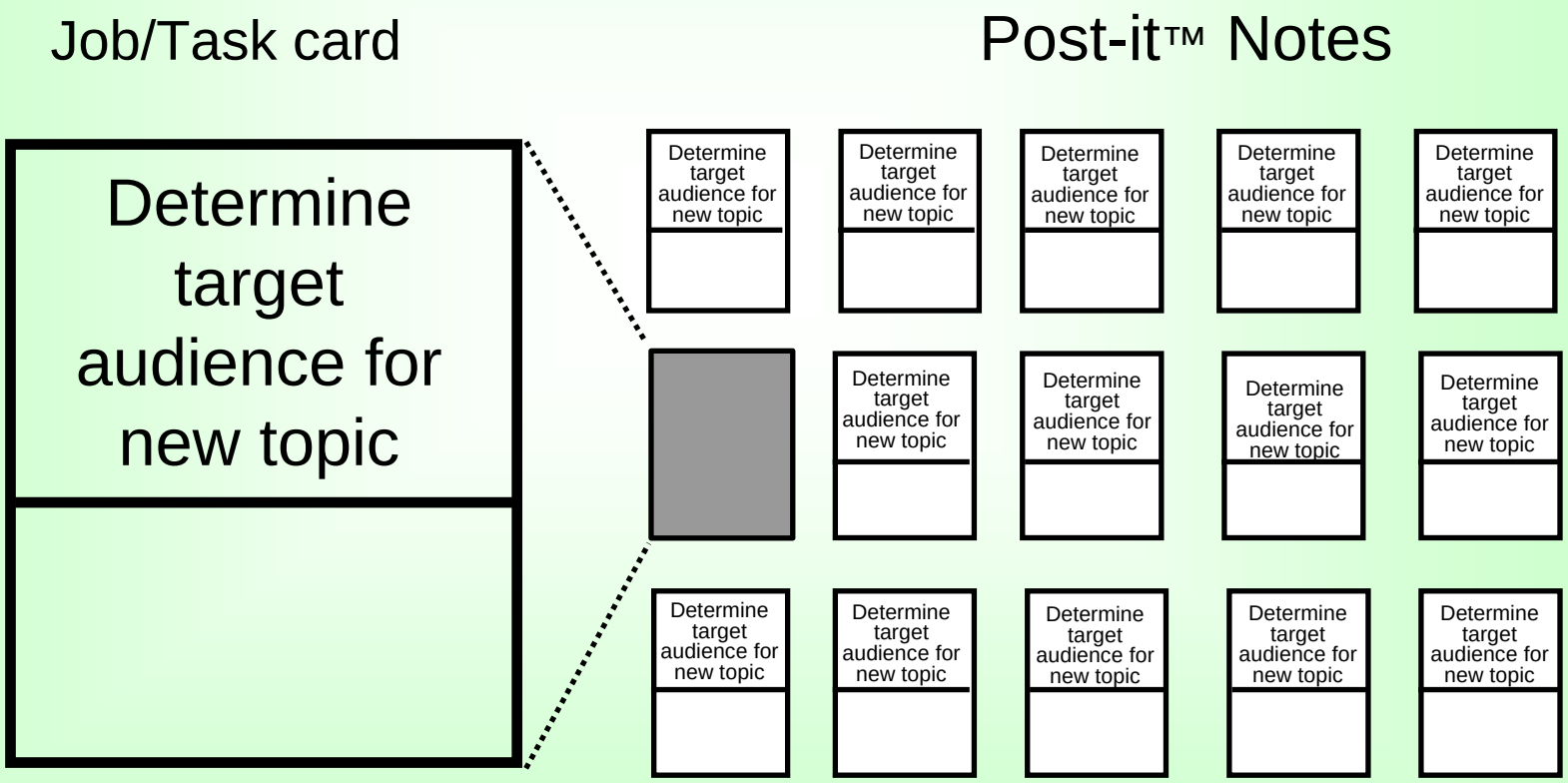
- Key Success Behaviors
  - Include the “doers” in the planning, especially in estimating task durations
  - Focus on NECESSARY, and not simply LOGICAL, connections between tasks
  - Always build the AND from the ground up; don’t work backward from the desired project completion schedule

Steps at a Glance: AND



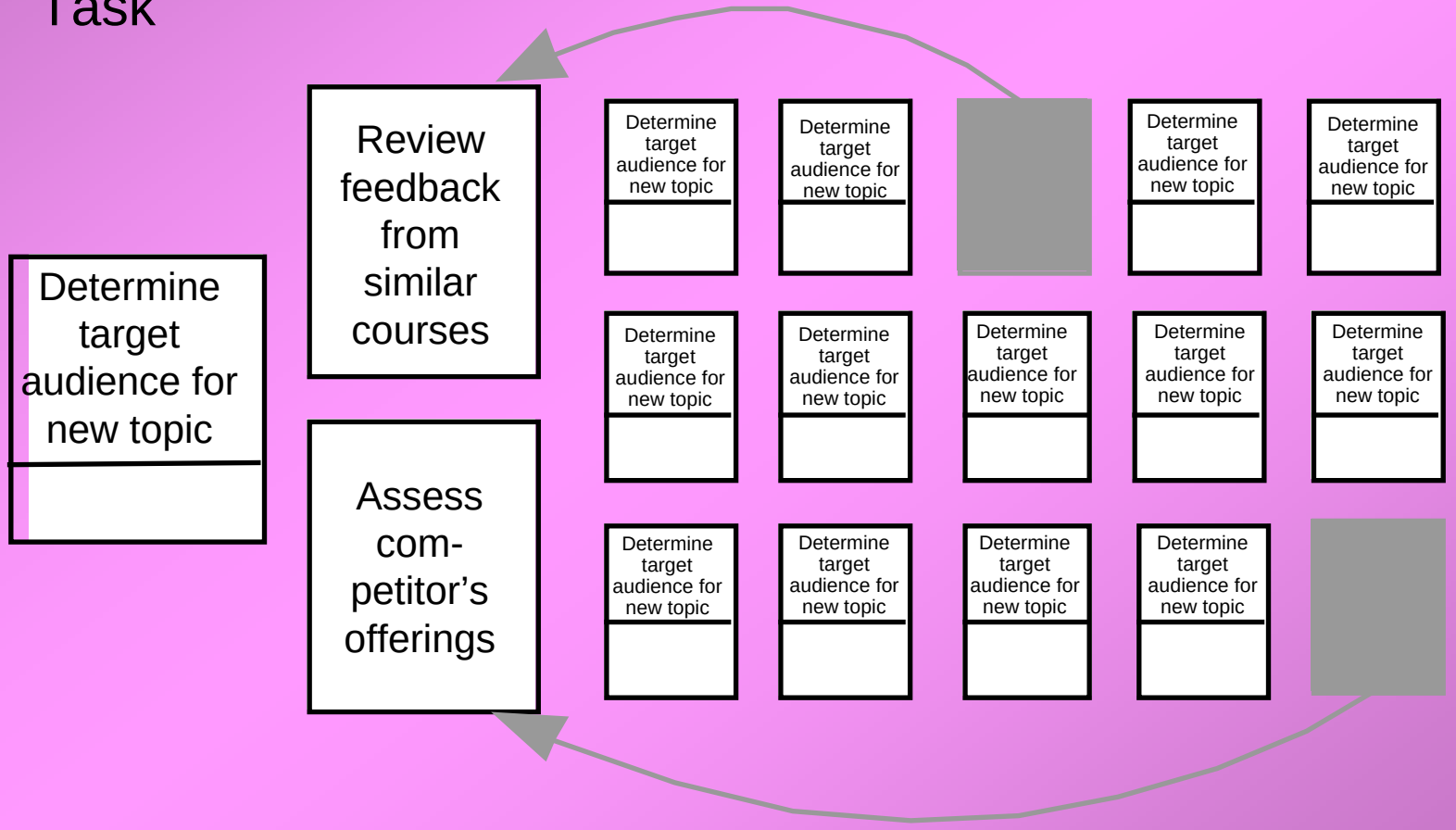
Step-by-Step Construction

- **Step 3** Find the First Task



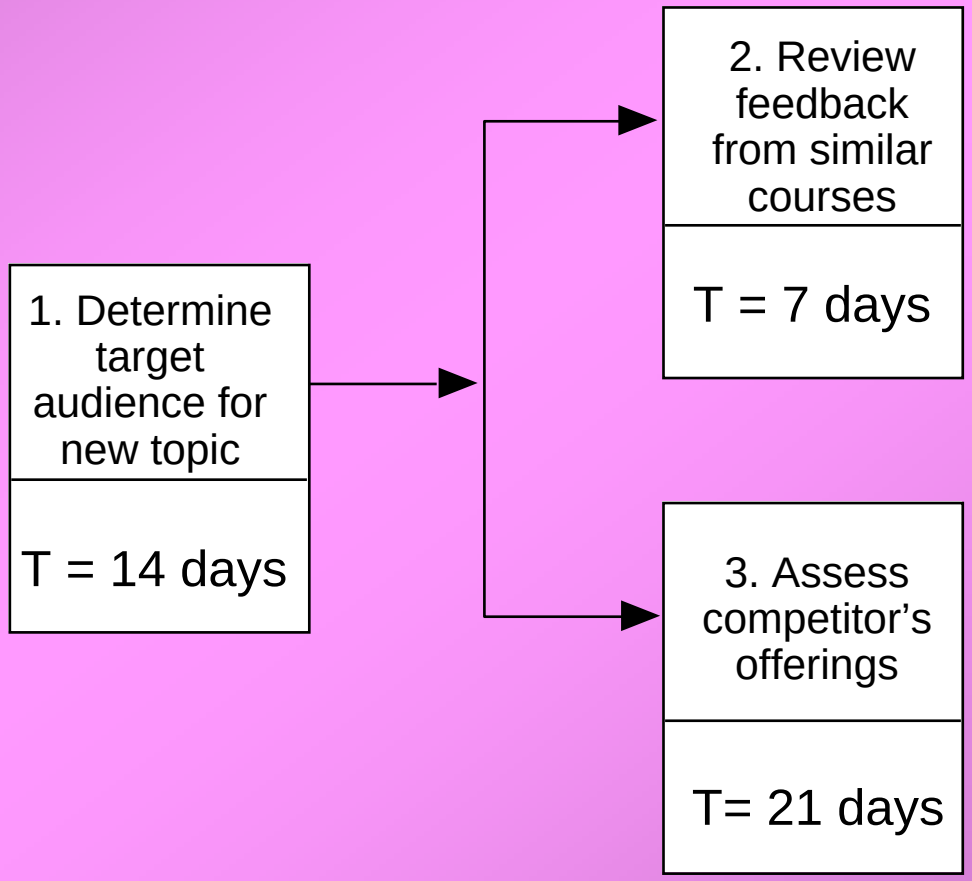
Step-by-Step Construction

- **Step 5** Find the Next Task



Step-by-Step Construction

- **Step 6** Detail the Chart



Step-by-Step Construction

- **Step 7** Find the Critical Path

Finding the critical path by calculating the slack

Earliest Start (ES)	Earliest Finish (EF)
Latest Start (LS)	Latest Finish (LF)

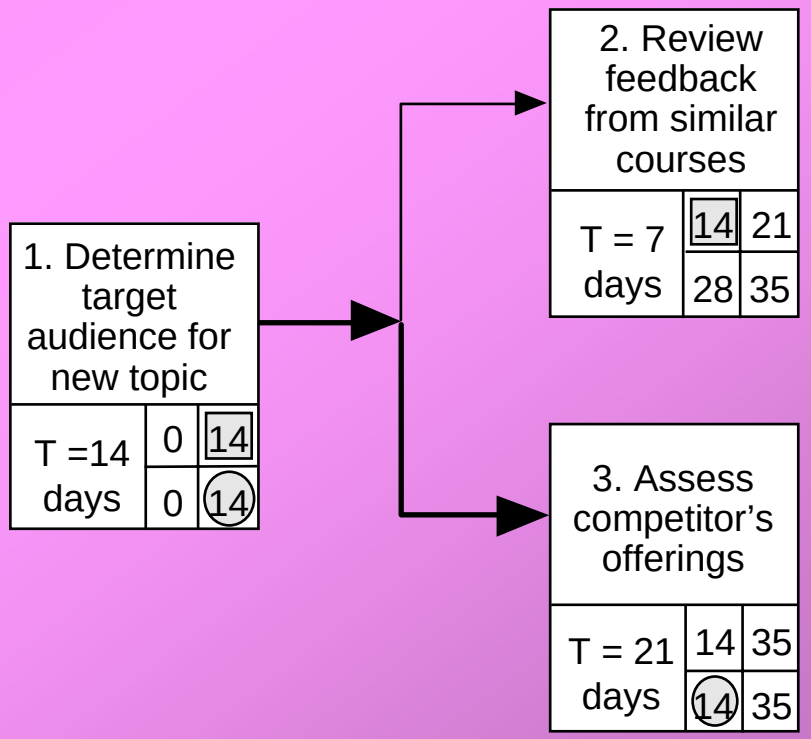
ES = The *largest* EF of any *previous* connected task

EF = ES + the time to complete the task

LS = LF - the time to complete the task

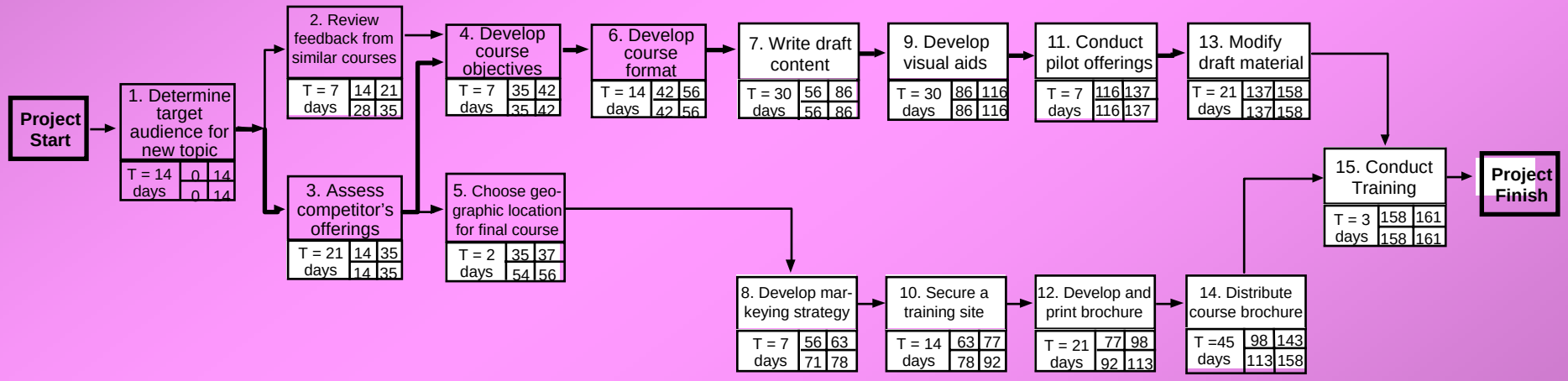
LF = The *smallest* LS of any connected *following* task

When ES = LS AND EF = LF , that task is on the critical path, and therefore there is no schedule flexibility in this task.



Step-by-Step Construction

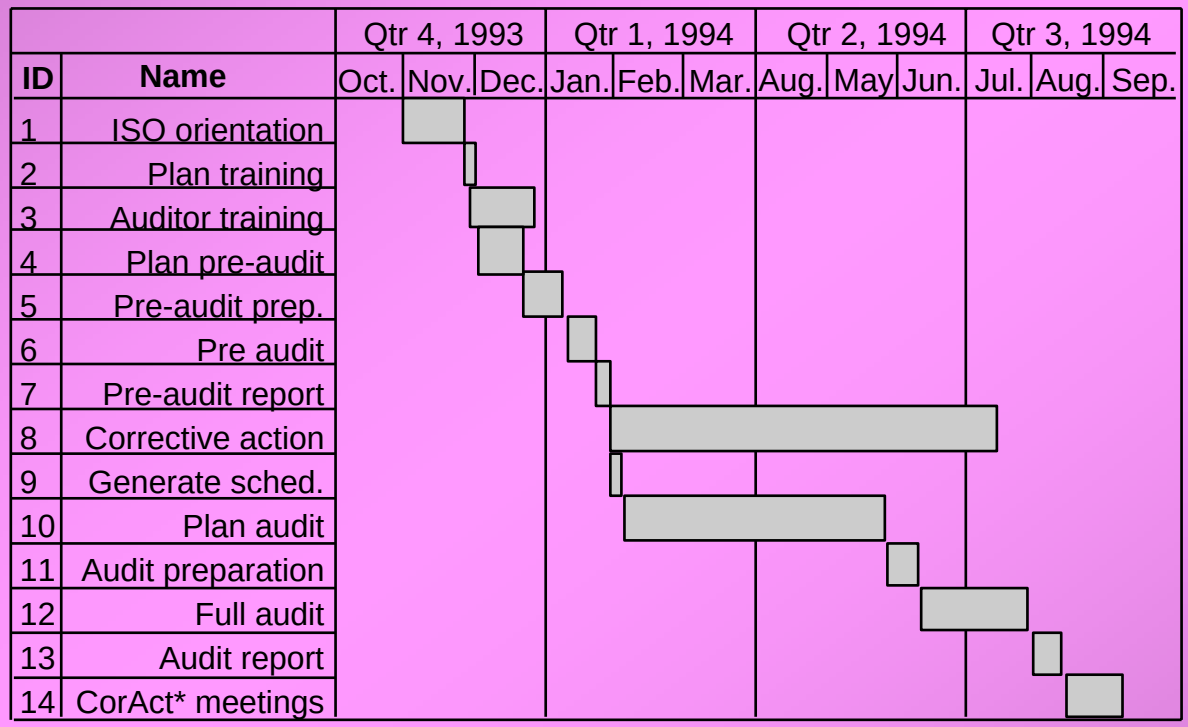
- **Step 7** Find the Critical Path (final AND)



Project duration: 161 days

Gantt Chart Example (AND Variation)

ISO 9000 Audit Schedule



ID	Name
1	ISO orientation
2	Plan training
3	Auditor training
4	Plan pre-audit
5	Pre-audit prep.
6	Pre audit
7	Pre-audit report
8	Corrective action
9	Generate sched.
10	Plan audit
11	Audit preparation
12	Full audit
13	Audit report
14	CorAct* meetings

* CorAct = Corrective action

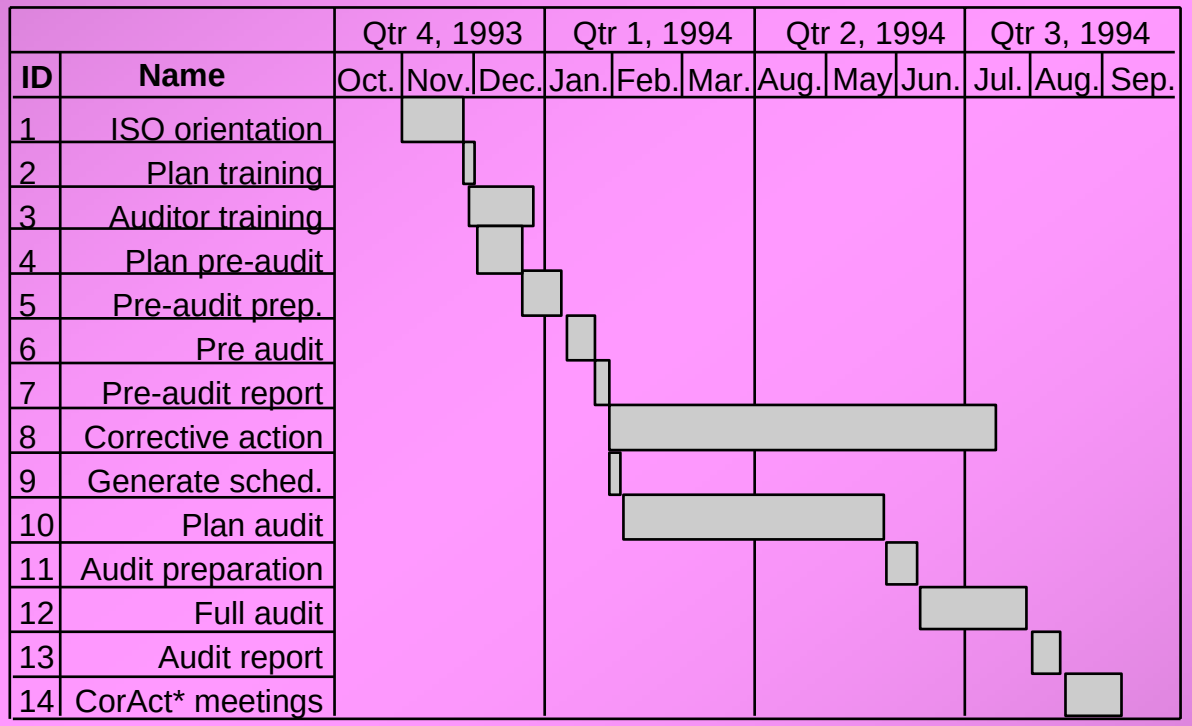
Key Dates

1/3	Release documentation request for pre-audit
1/21	All documentation for pre-audit collected
1/28	Hold pre-audit orientation meeting
2/25	Release full audit schedule
6/13	Commence full audit
7/29	Finish full audit
8/12	Hold full audit orientation meeting

Information provided courtesy of BGP

Gantt Chart Example (AND Variation)

ISO 9000 Audit Schedule



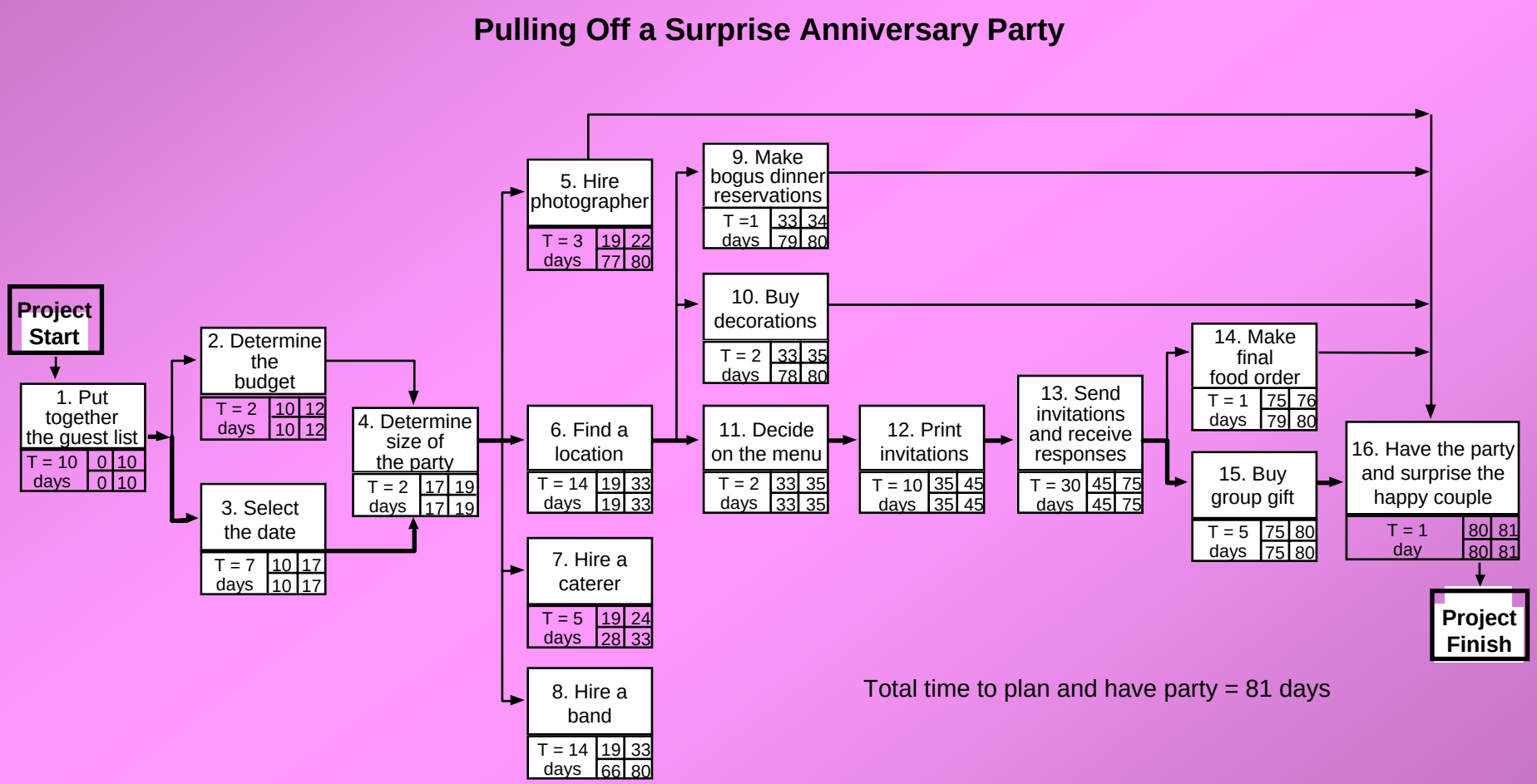
Key Dates

* CorAct = Corrective action

1/3	Release documentation request for pre-audit	2/25	Release full audit schedule
1/21	All documentation for pre-audit collected	6/13	Commence full audit
1/28	Hold pre-audit orientation meeting	7/29	Finish full audit
		8/12	Hold full audit orientation meeting

Information provided courtesy of BGP

Activity Network Diagram Example



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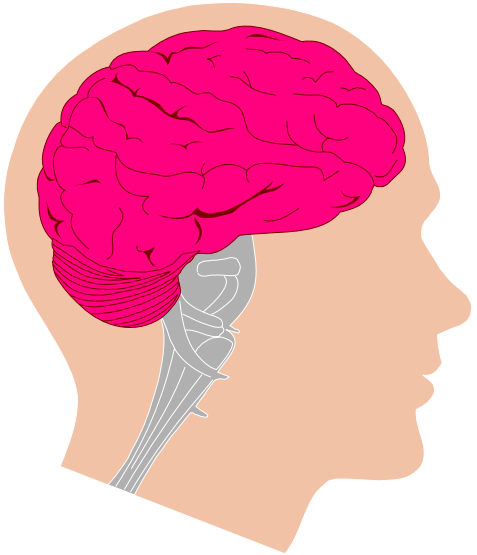
Brainstorming

Brainstorming is a procedure that allows a group to express problem areas, ideas, solutions, or needs. It allows each participant to state their opinion in a non-threatening environment. Brainstorming helps a group create many ideas in as short a time as possible. Brainstorming can be used in two ways: **structured** or **unstructured**.

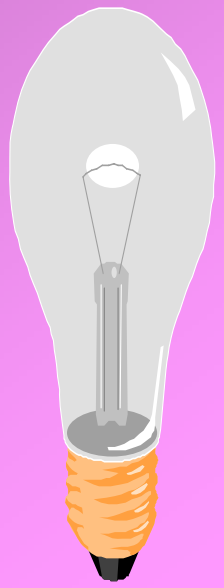


Brainstorming

Brain Storming

Brainstorming is simply listing all ideas put forth by a group in response to a given problem or question.

To conduct a successful brainstorm:



- Make sure everyone understands and is satisfied with the central question before you open up for ideas.
- You may want to give everyone a few seconds to jot down a few ideas before getting started.
- Begin by going around the table or room, giving everyone a chance to voice their ideas or pass. After a few rounds, open the floor.
- More ideas are better. Encourage radical ideas and piggybacking.
- Suspend judgment of all ideas.
- Record exactly what is said. Clarify only after everyone is out of ideas.
- Don't stop until ideas become sparse. Allow for late-coming ideas.
- Eliminate duplicates and ideas that aren't relevant to the topic.

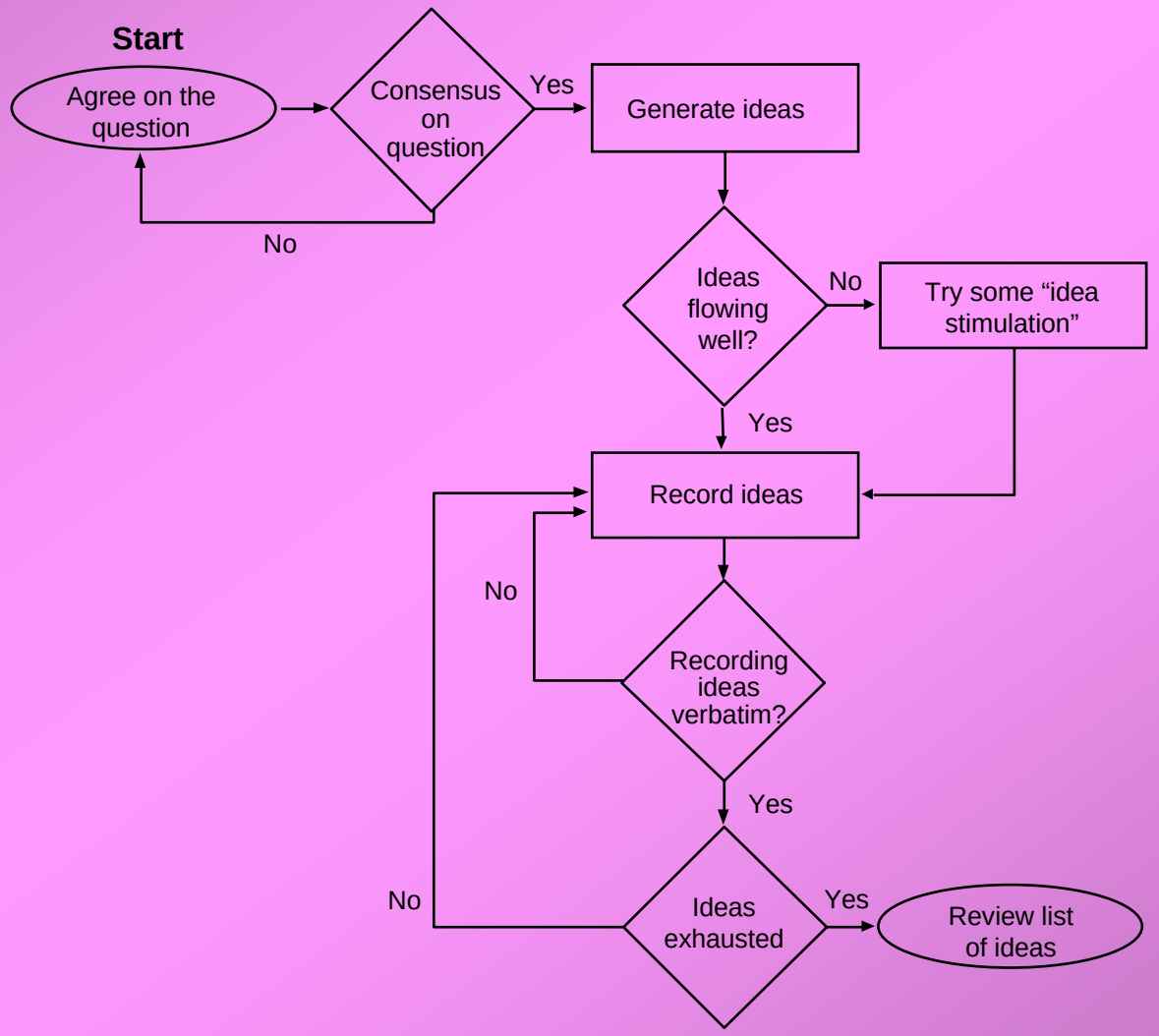
Steps of Brainstorming

- Step 1 Agree on the Question
- Step 2 Generate Ideas
- Step 3 Record Ideas
- Step 4 Check: Ideas Exhausted?
- Step 5 Review List of Ideas

Brainstorming Essentials

- Key Success Behaviors
  - Never criticize ideas
  - Use the ideas of others as building blocks for your own
  - Record ideas as spoken
  - Listen

Steps at a Glance: Brainstorming



Back

Cause/Effect Fishbone

Constructing the Cause & Effect

- Step 1 Create a Problem Statement
- Step 2 Generate the Causes
- Step 3 Construct the Diagram

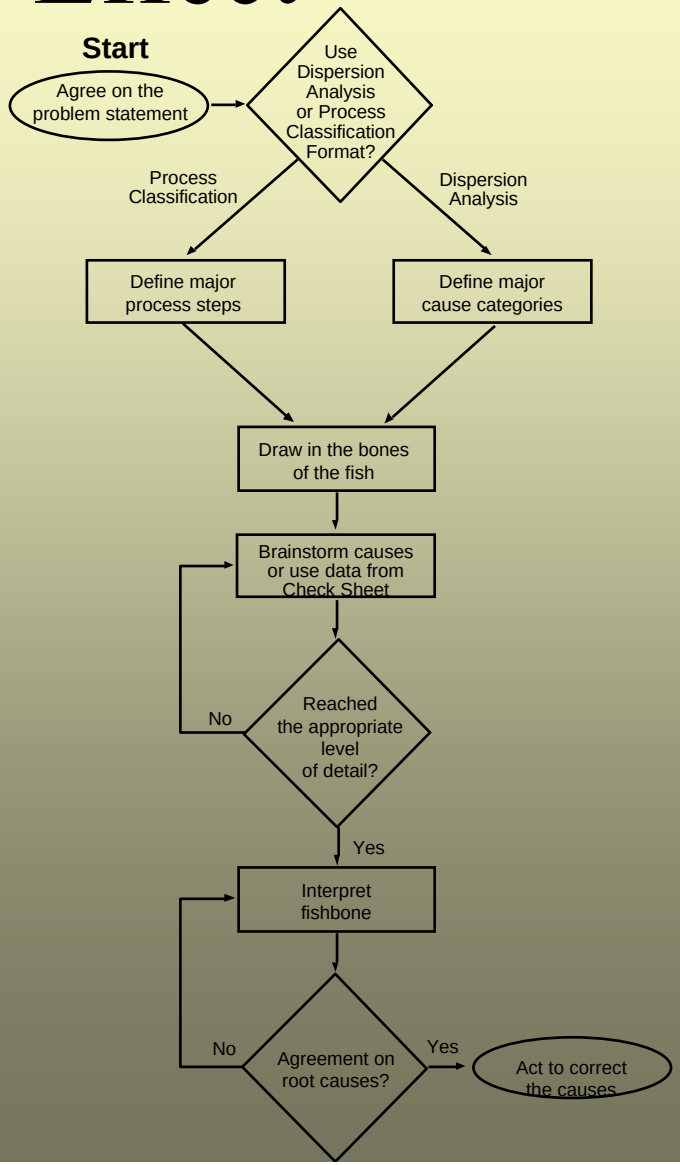
Cause & Effect Essentials

- Key Success Behaviors
  - Clearly state the problem
  - Ask “Why?” several times
  - Look for recent changes as likely causes

Suggestions for using fishbone diagrams:

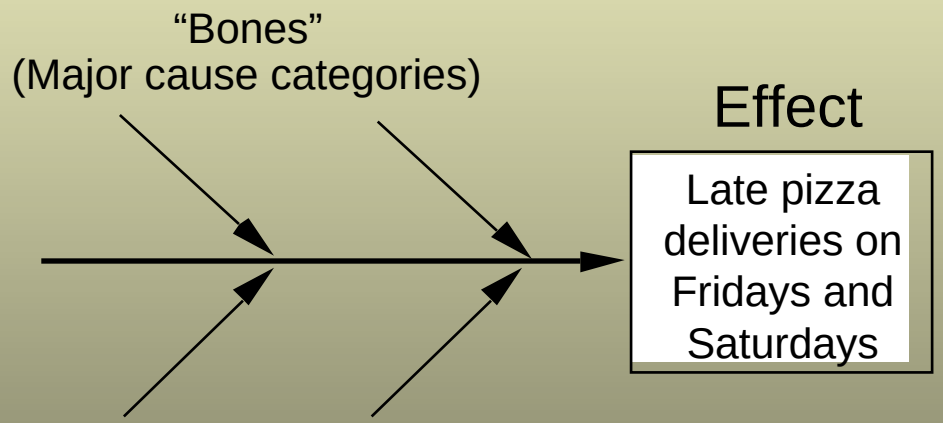
- There should be no judgment about ideas when people say them. The point is to create as many causes as possible.
- Everyone will have an opinion about what causes a problem. Organizing these ideas improves the chance that good ideas can be tested.
- Label the main bones of the fishbone in ways that are best for your problem or event.
- You can use the fishbone diagram not only to get to the root of a problem, but to help with planning.

Steps at a Glance: Cause & Effect



Step-by-Step Construction

– Step 3a Construct the Diagram:
Write Problem Statement
Causes



Step-by-Step Construction

– Step 3b Construct the Diagram:
Draw Major Cause Categories

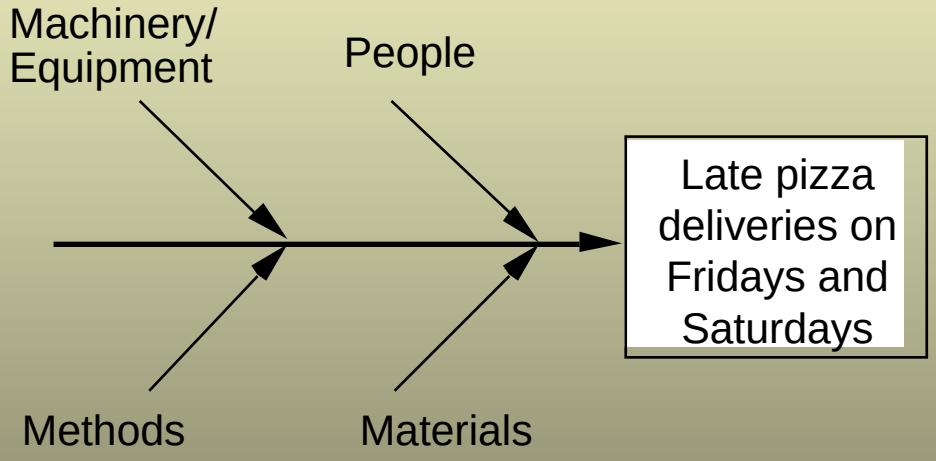
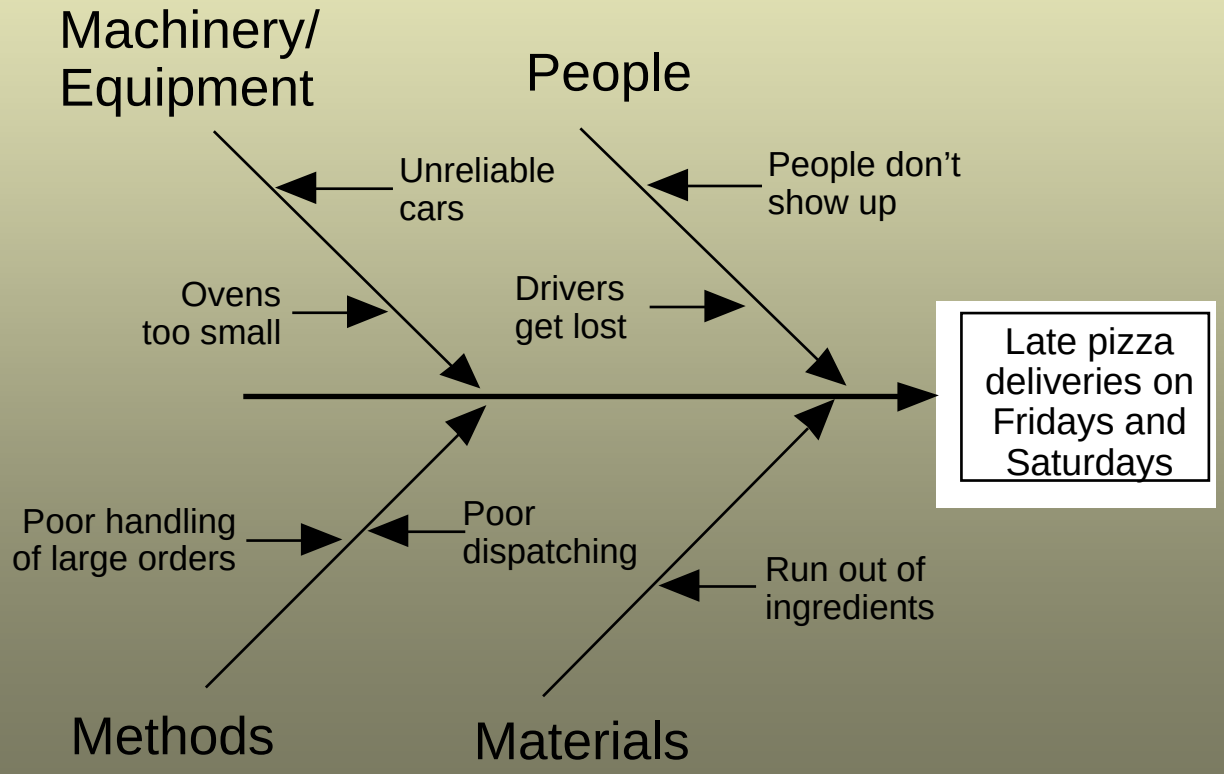


Illustration Note: In a Process Classification Type format, replace the major “bone” categories with: “Order Taking,” “Preparation,” “Cooking,” and “Delivery.”

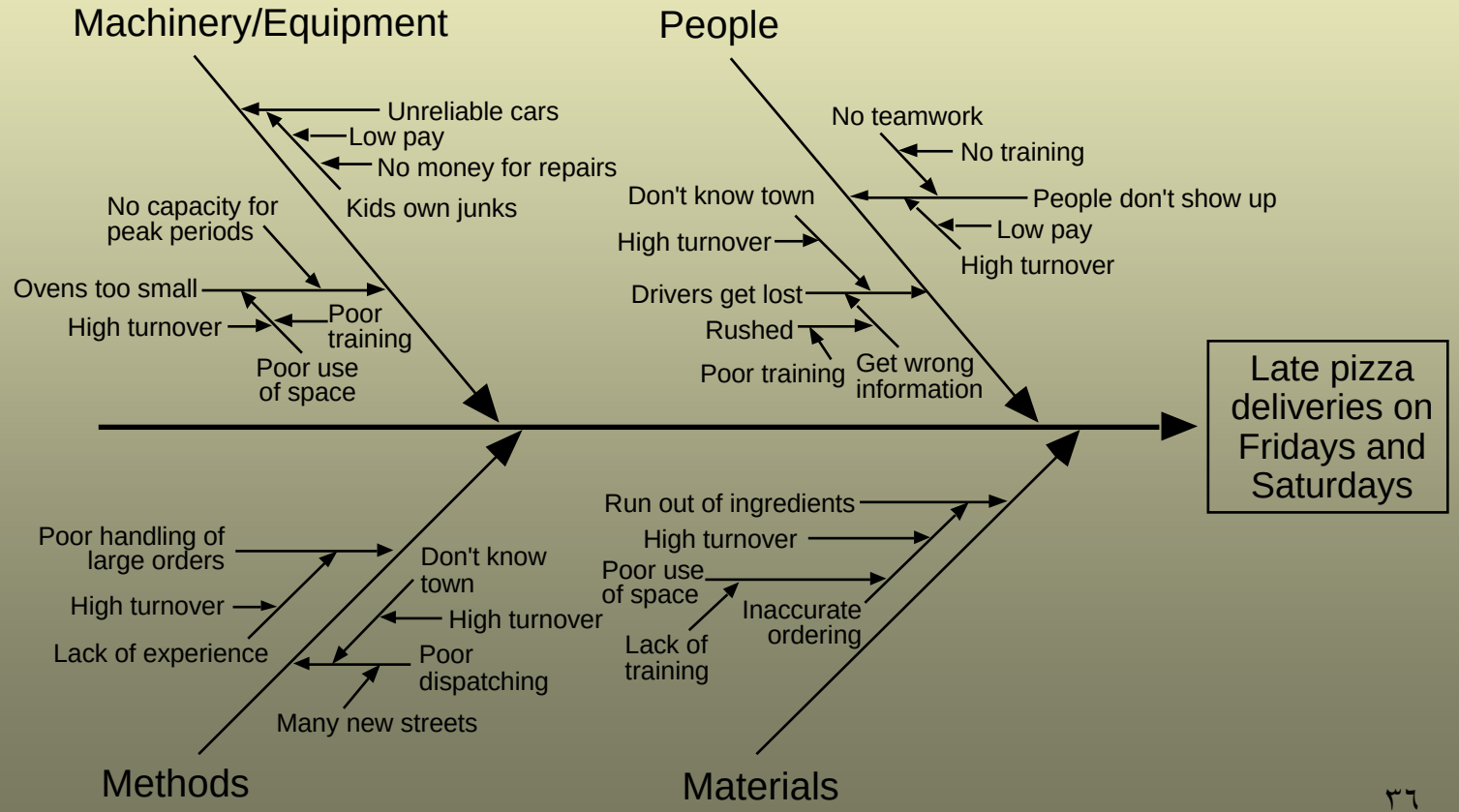
Step-by-Step Construction

– Step 3c Construct the Diagram:
Place Causes in Correct Category

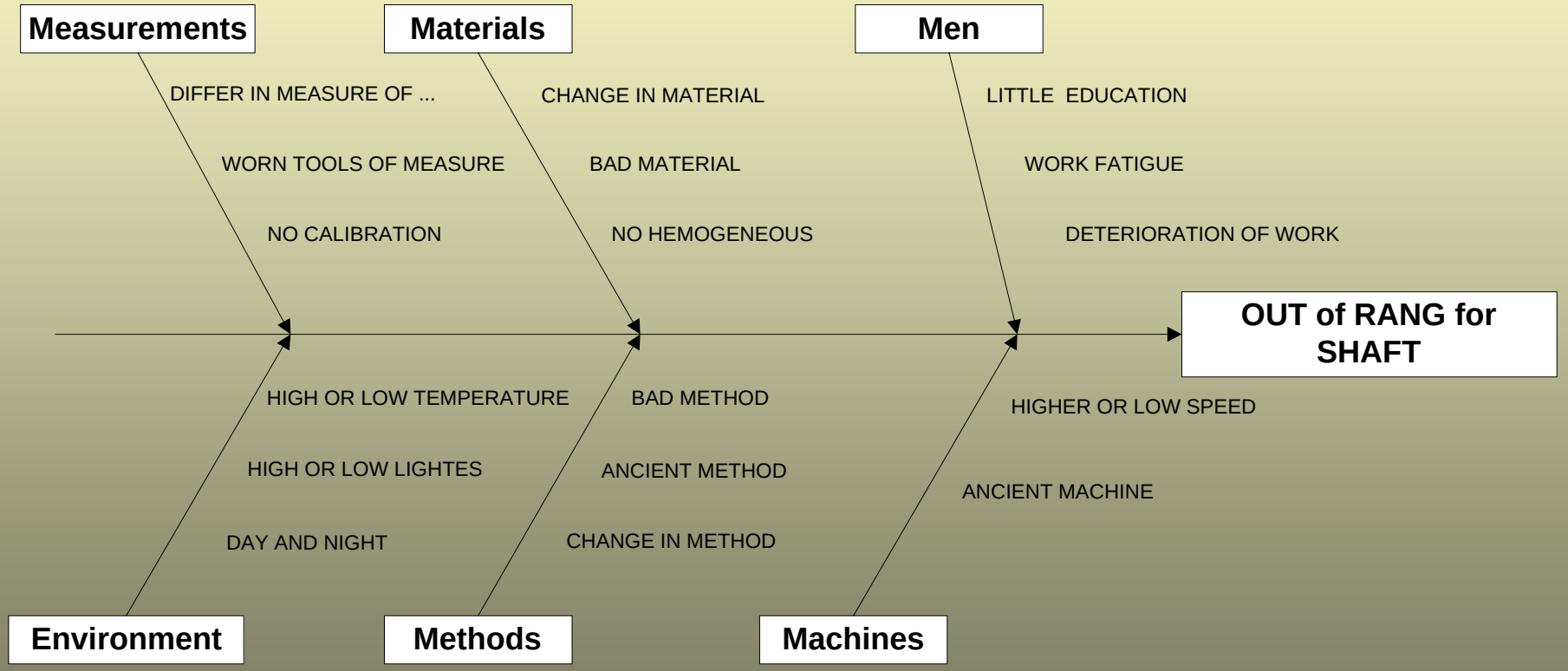


Step-by-Step Construction

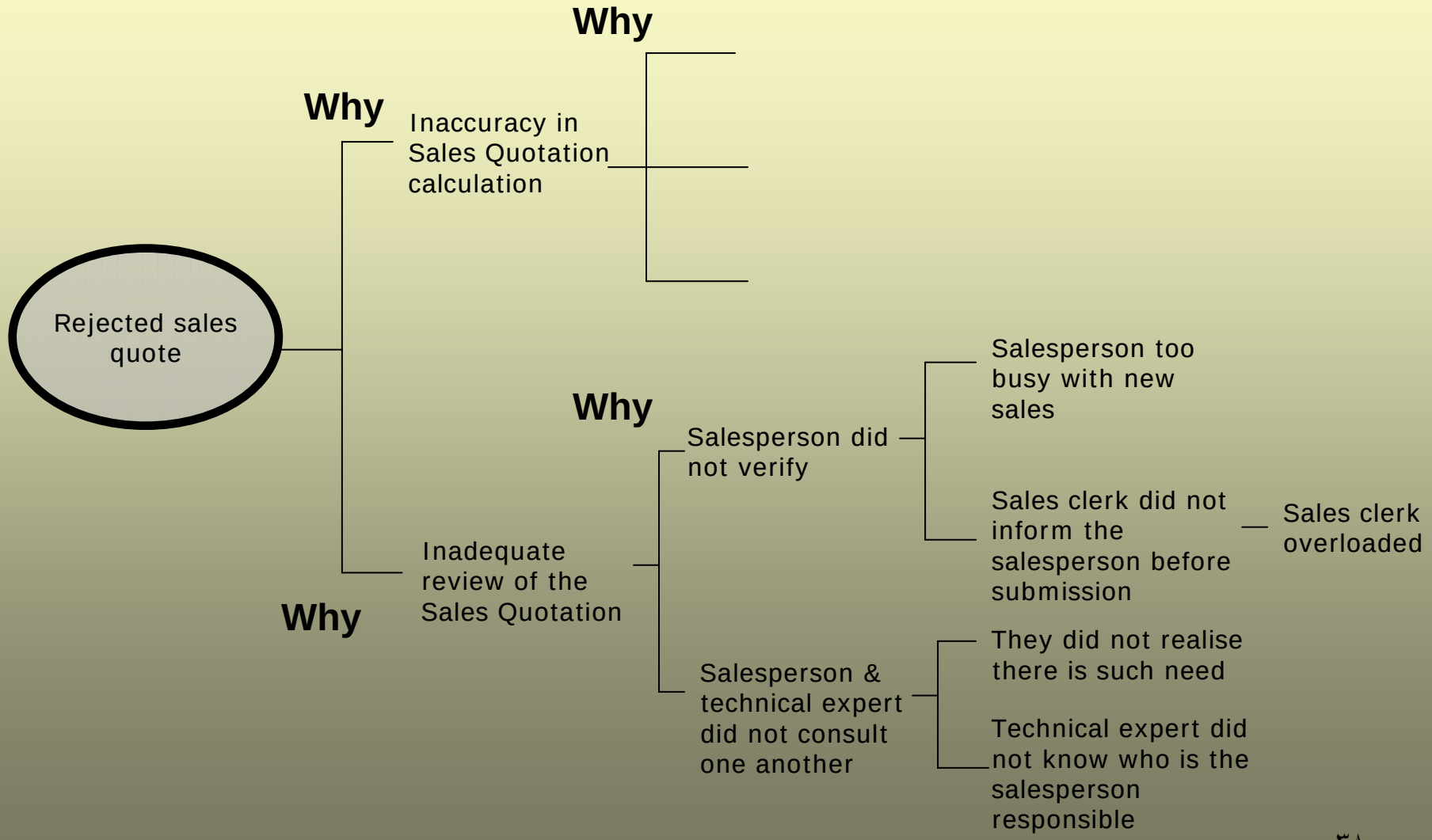
– Step 3d Construct the Diagram:
Question “Why?” for Each Cause



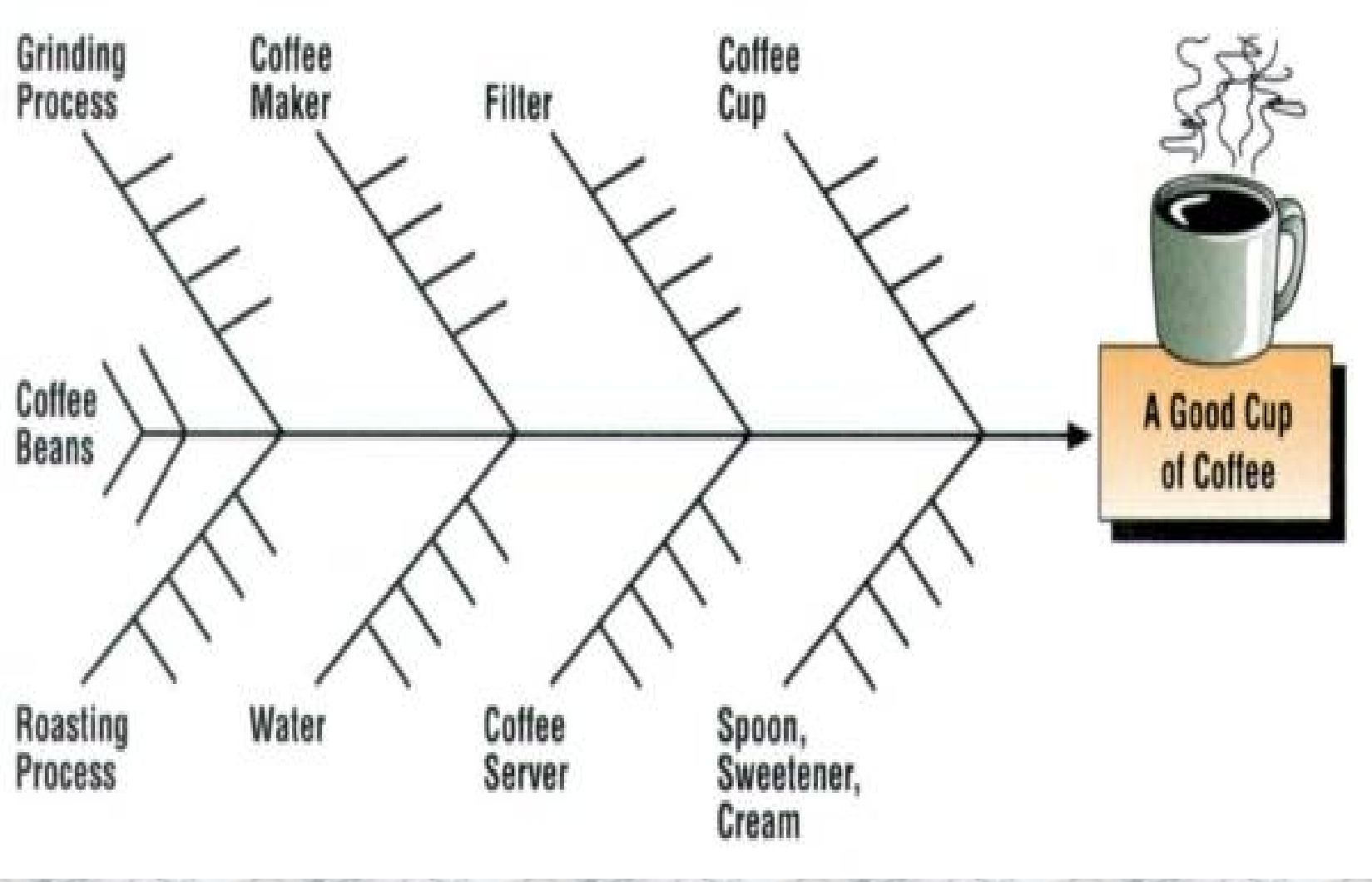
5 M


Measurements
Materials
Men
DIFFER IN MEASURE OF ...
WORN TOOLS OF MEASURE
NO CALIBRATION
CHANGE IN MATERIAL
BAD MATERIAL
NO HEMOGENEOUS
LITTLE EDUCATION
WORK FATIGUE
DETERIORATION OF WORK
OUT of RANG for SHAFT
HIGH OR LOW TEMPERATURE
HIGH OR LOW LIGHTES
DAY AND NIGHT
BAD METHOD
ANCIENT METHOD
CHANGE IN METHOD
HIGHER OR LOW SPEED
ANCIENT MACHINE
Environment
Methods
Machines

Example: WHY-WHY Diagram

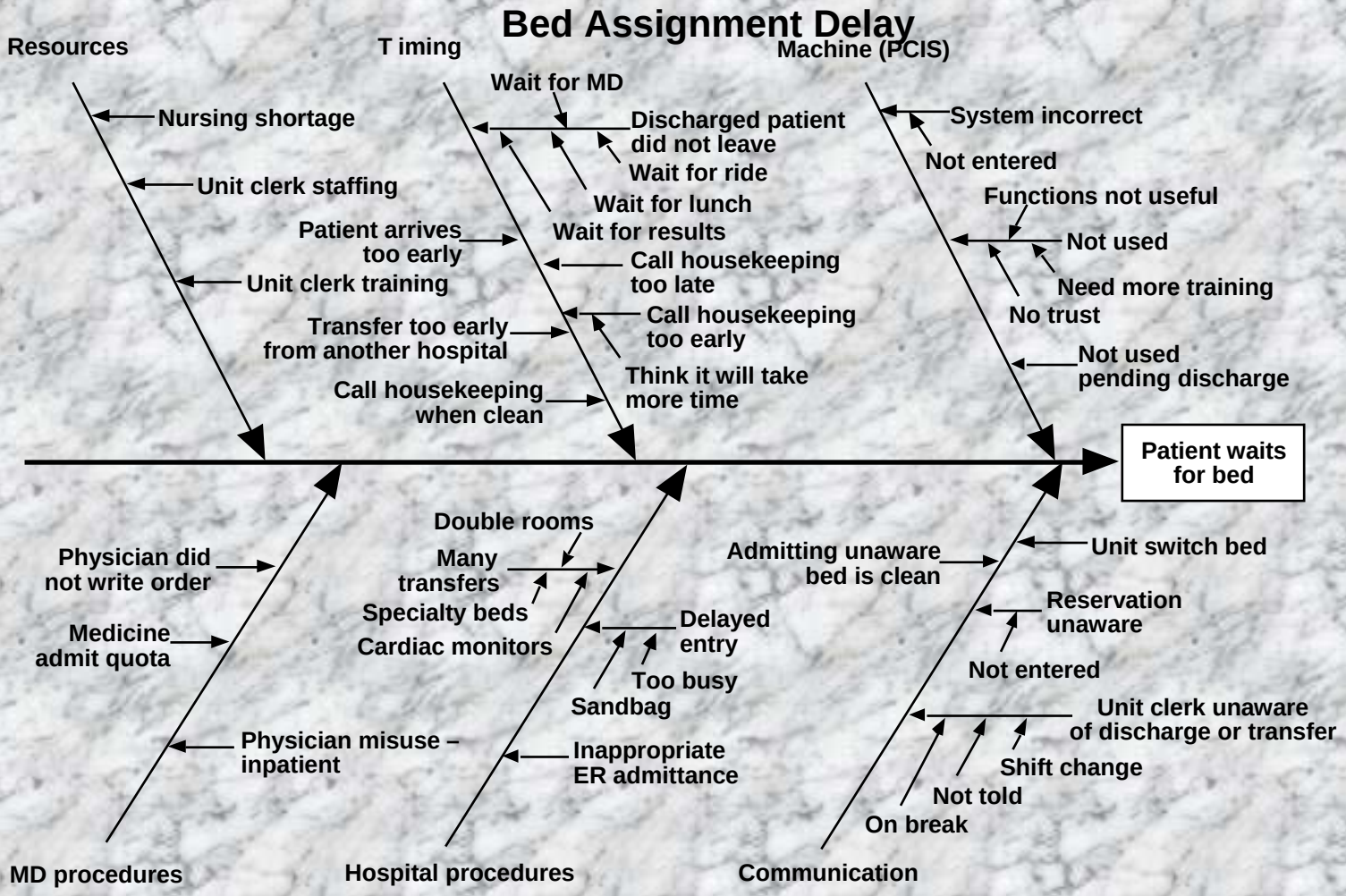


Cause and Effect Diagram



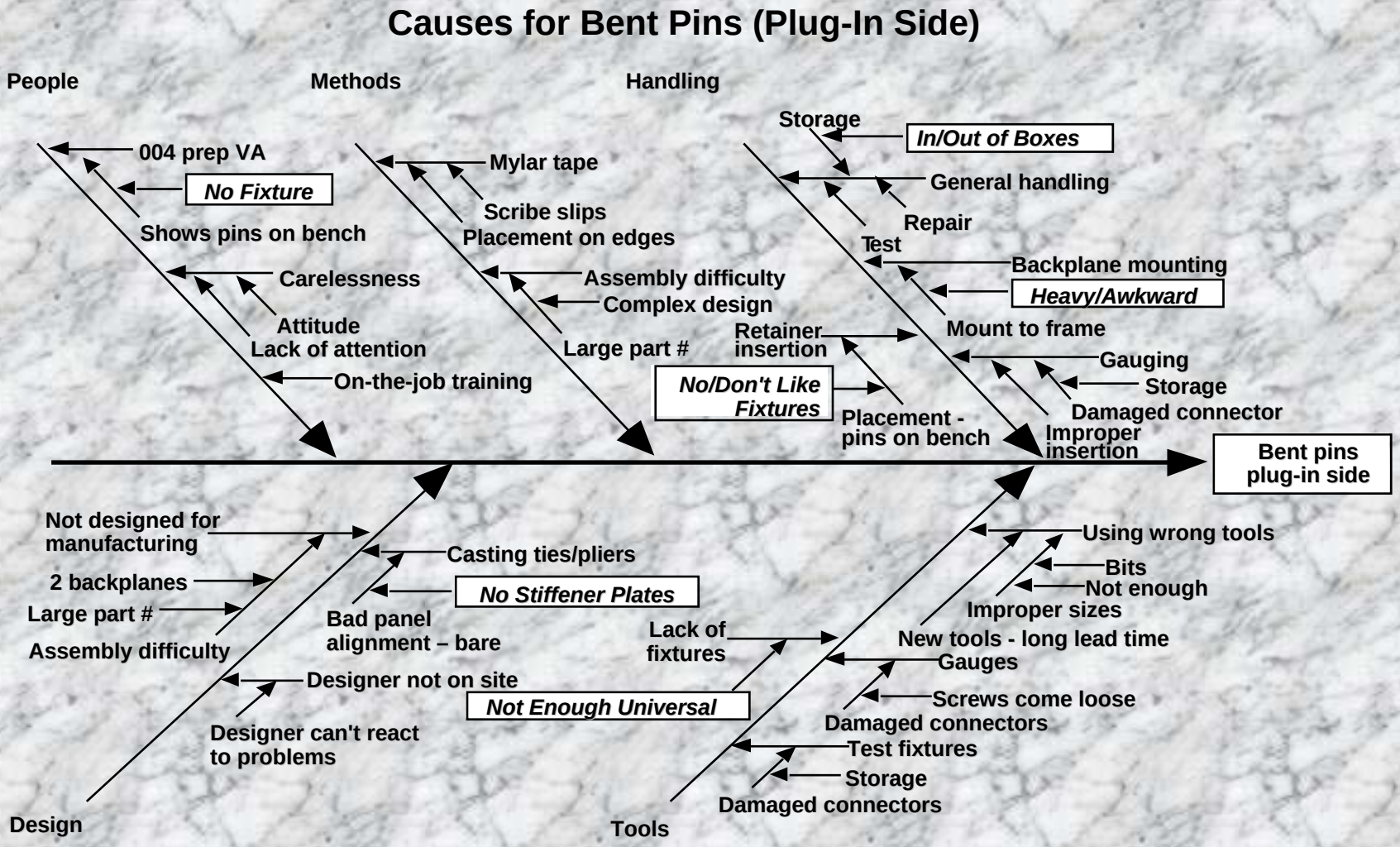
Fill in the details for what makes a good cup of coffee

Cause & Effect Example



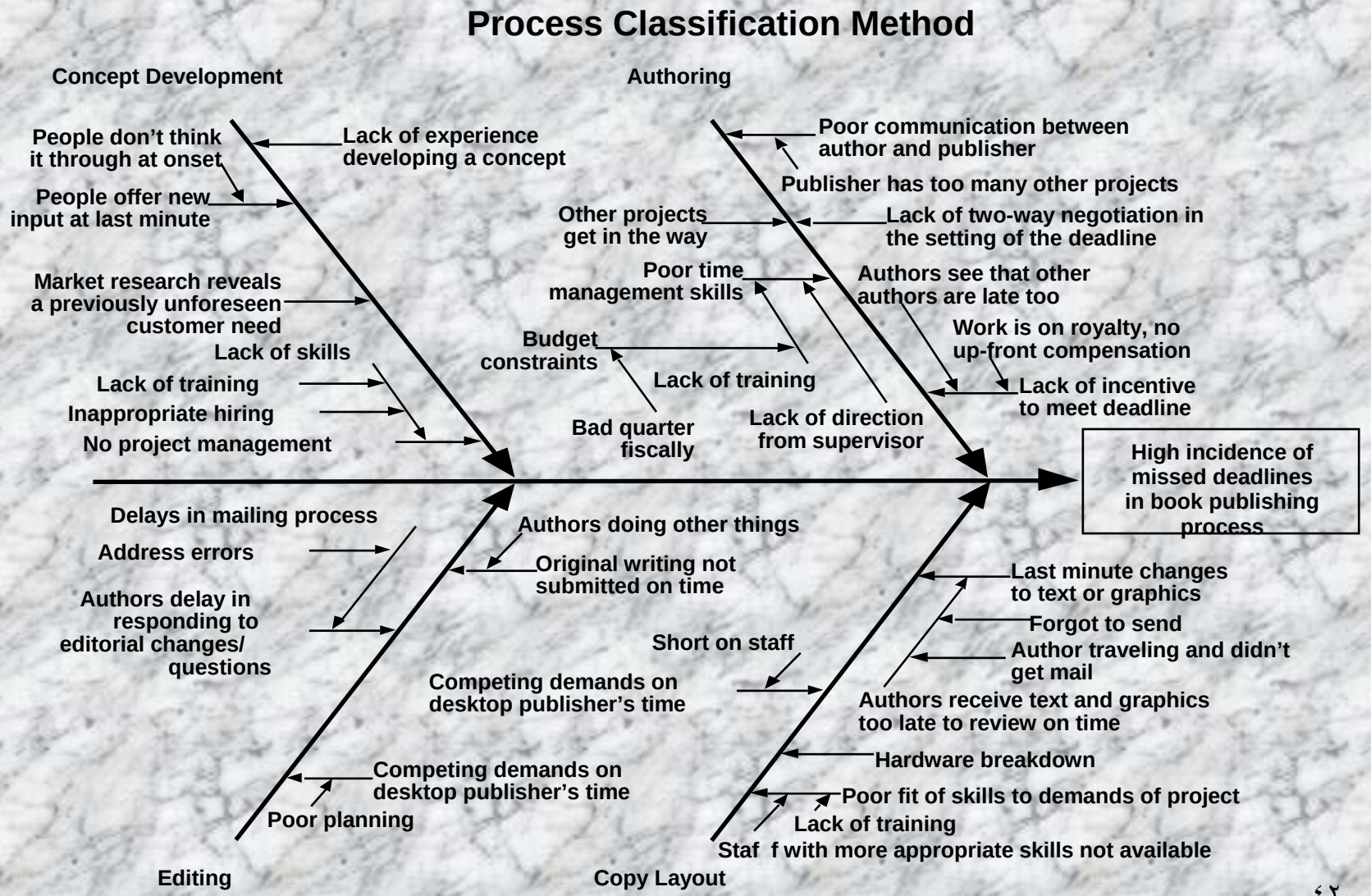
Information provided courtesy of
Rush-Presbyterian-St. Luke's Medical Center

Cause & Effect Example

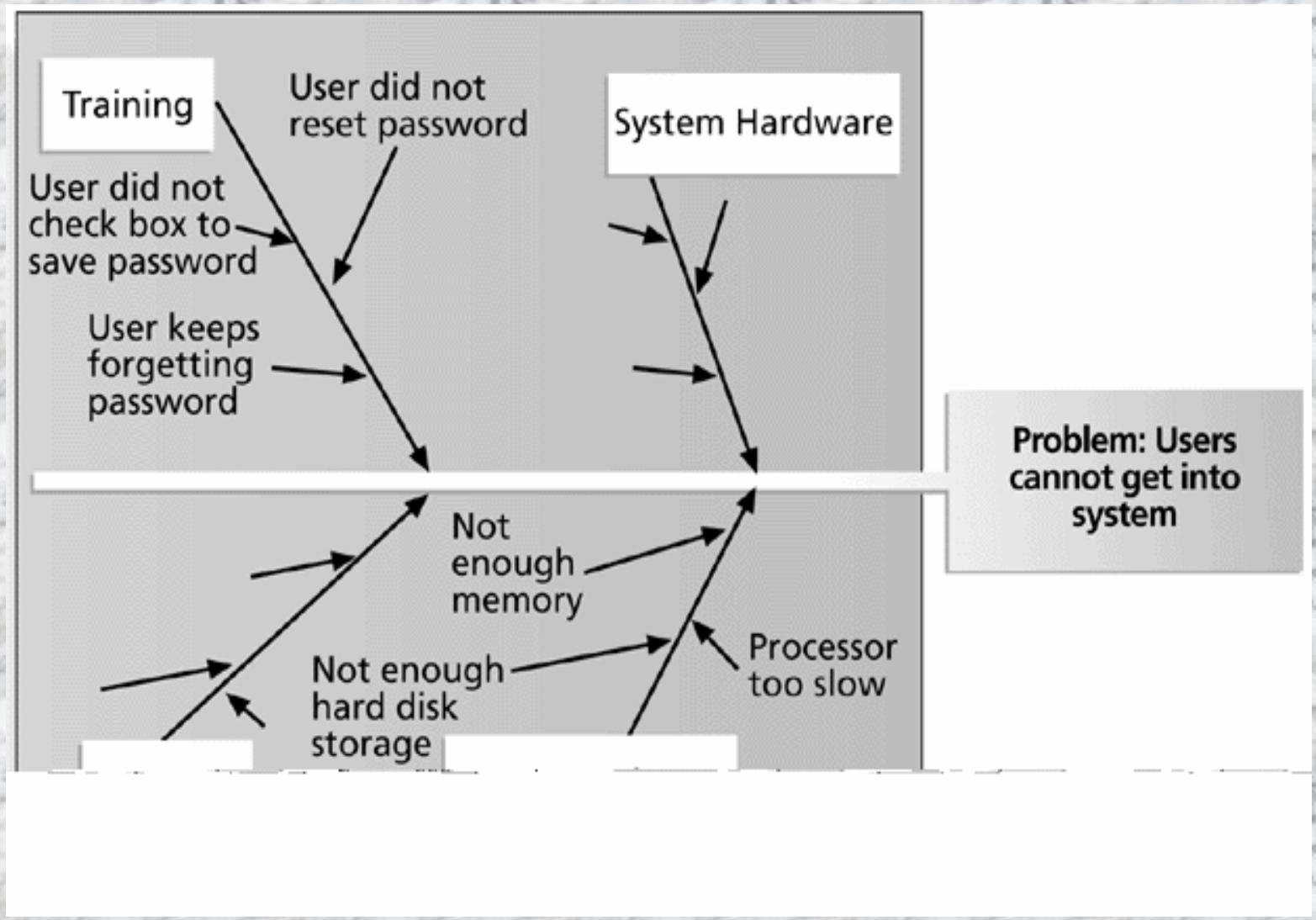


Information provided courtesy of AT&T

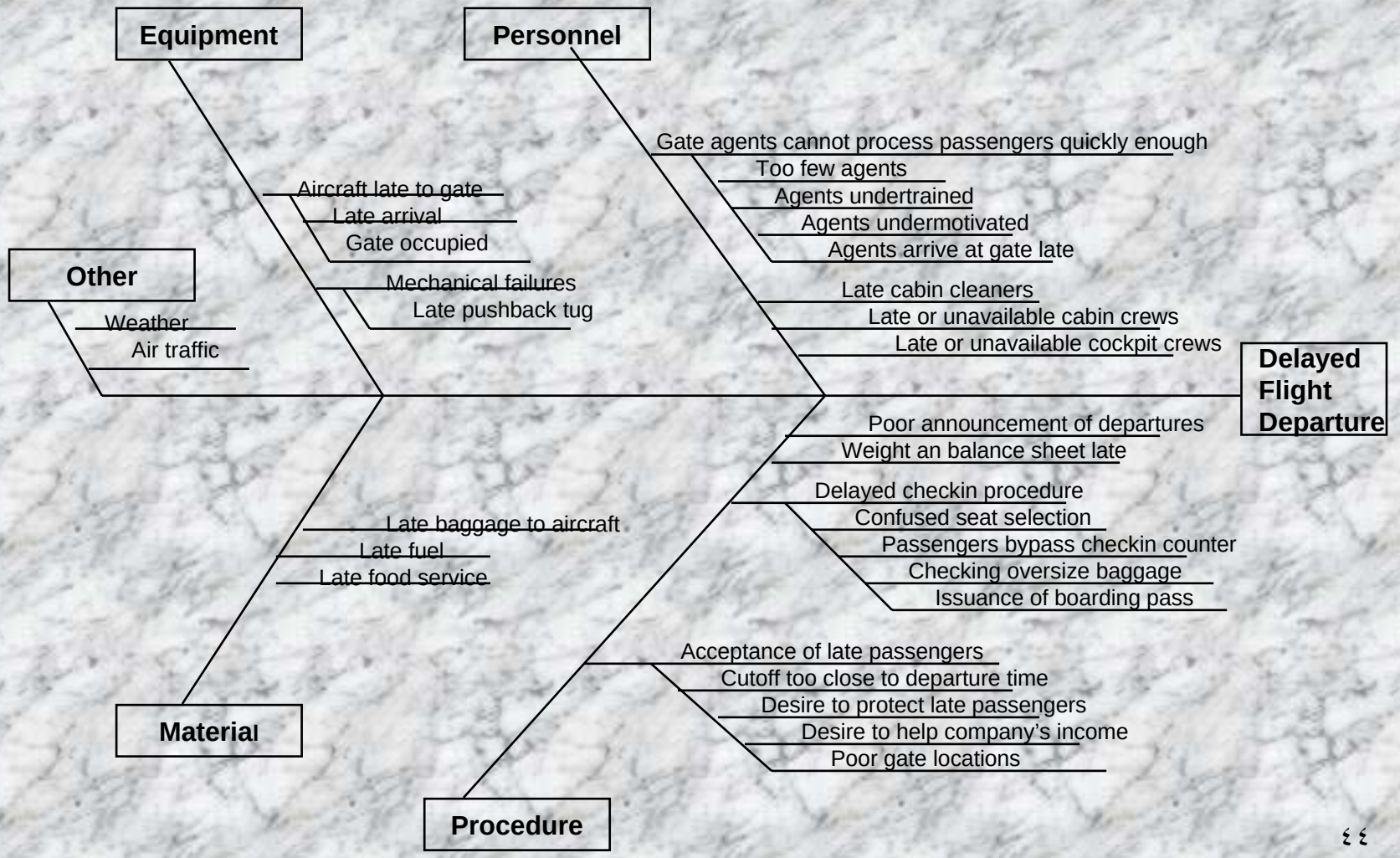
Cause & Effect Example



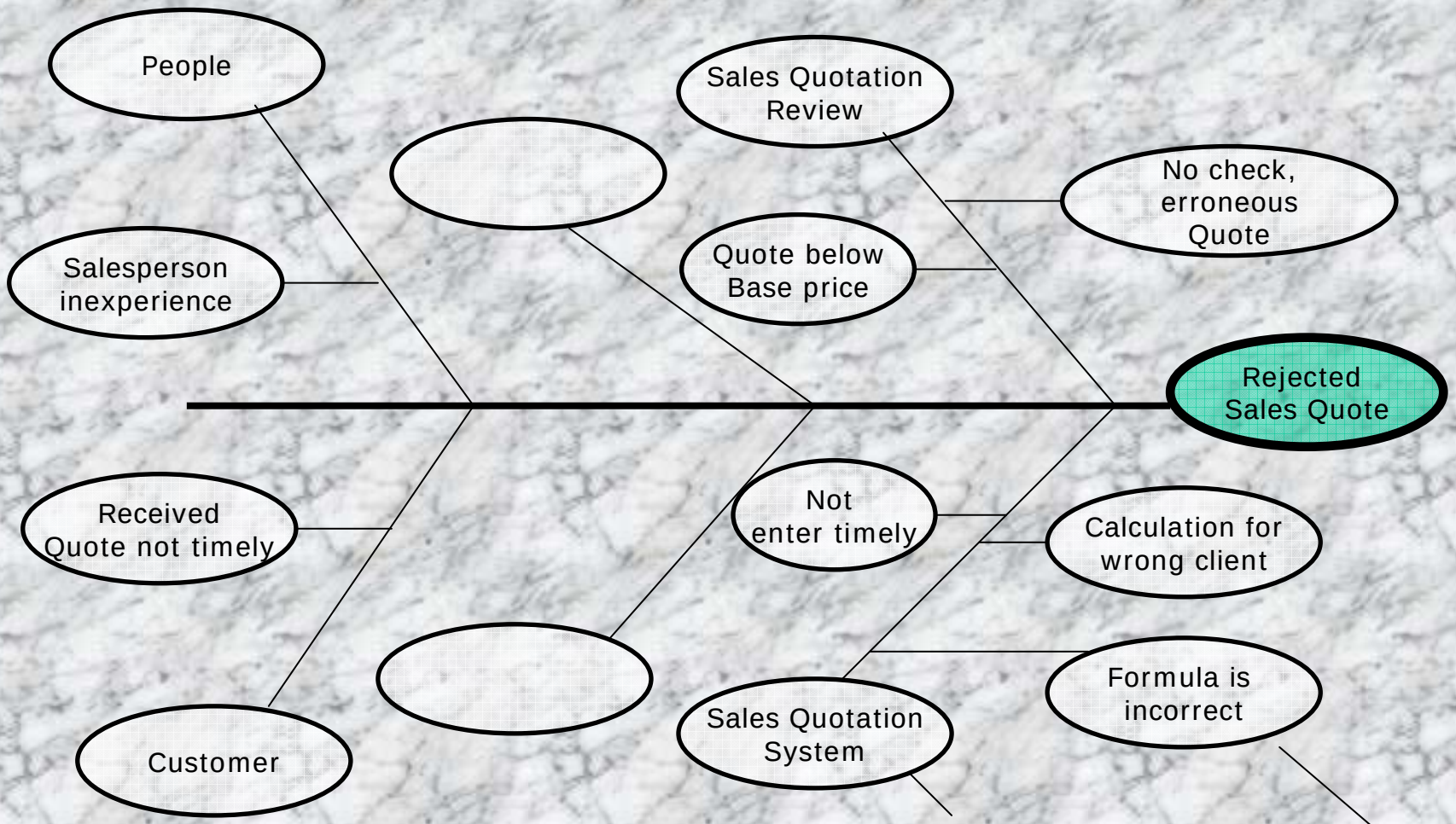
Cause & Effect Example



Cause & Effect Example



Cause & Effect Example



Back

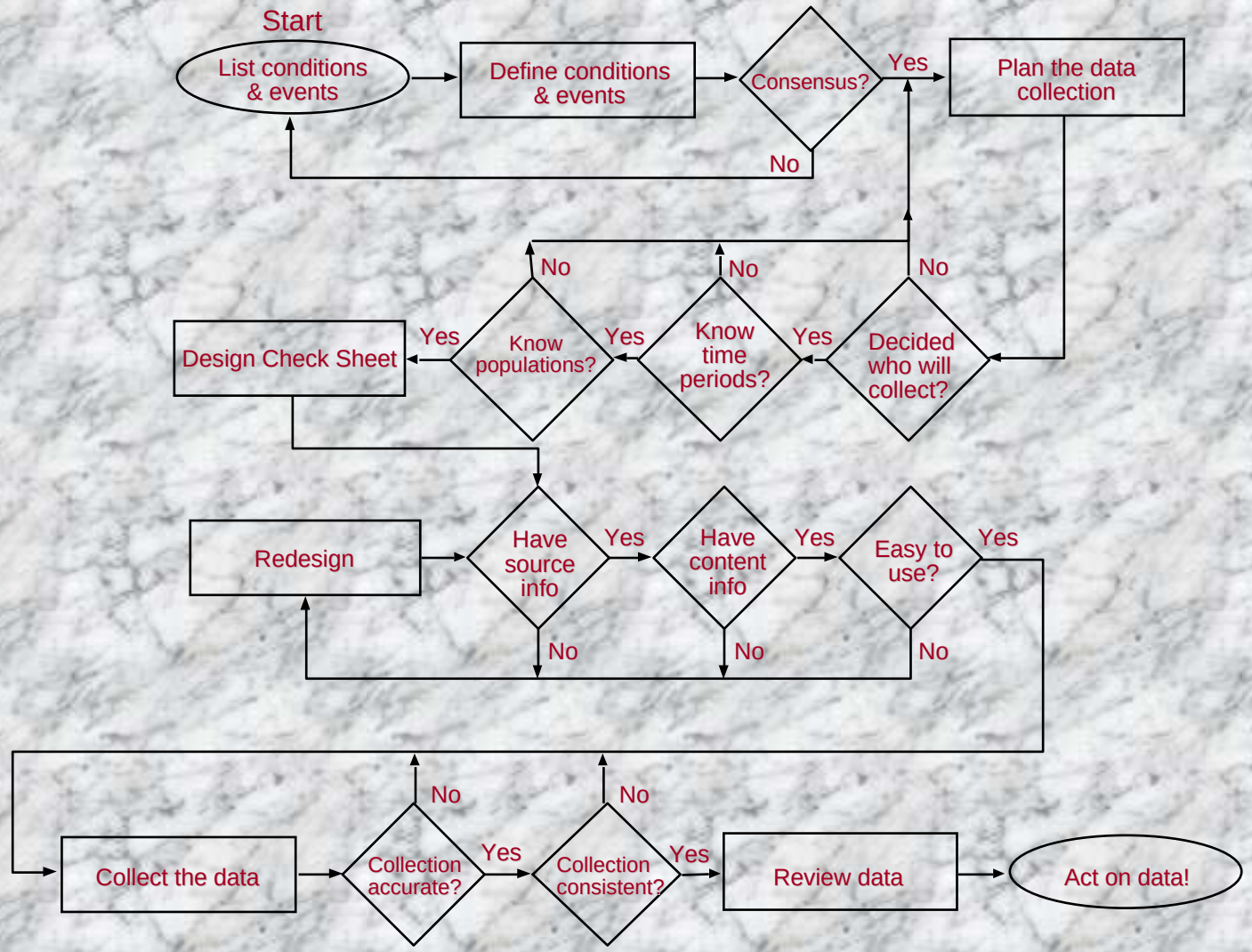
Constructing the Check Sheet

- Step 1 Agree on Definitions
- Step 2 Plan the Data Collection
- Step 3 Design the Check Sheet
- Step 4 Collect the Data

Check Sheet Essentials

- Key Success Behaviors
  - Reassure data collectors that “negative” data will not result in blame or poor performance reviews
  - Train the data collectors
  - Remember “ease of use” when designing the form

Steps at a Glance: Check Sheet



Step-by-Step Construction

– Step 3 Design the Form

Source Information (a-e)

- a Name of project
- b Location of data collection
- c Name of person recording data, if it applies
- d Date(s)
- e Other important identifiers

Content Information (f-j)

- f Column with defect/event name
- g Columns with collection days/dates
- h Totals for each column
- i Totals for each row
- j Grand total for both columns and rows

a Project: Admission Delays				c Name: (if applicable)			e Shift: All	
b Location: Emergency Room				d Dates: 3/10 to 3/16				
f **Reason:**	g **Date**							i **Total**
	3/10	**3/11**	**3/12**	**3/13**	**3/14**	**3/15**	**3/16**	
Lab delays	9	4	6	6	3	12	12	52
No beds available	2	7	2	4	5	8	3	31
Incomplete patient information	7	3	1	2	2	4	5	24
h **Total**	33	28	36	30	25	47	38	j 237

Check Sheet Example

Keyboard Errors in Class Assignment

Mistakes	March			
	1	2	3	Total
Centering	||	|||	|||	8
Spelling	𝍸 ||	𝍸 𝍸 |	𝍸	23
Punctuation	𝍸 𝍸 𝍸	𝍸 𝍸	𝍸 𝍸 𝍸	40
Missed paragraph	||	|	|	4
Wrong numbers	|||	||||	|||	10
Wrong page numbers	|	|	||	4
Tables	||||	𝍸	||||	13
Total	34	35	33	102

Information provided courtesy of Millcreek Township School District, Millcreek Township, Pennsylvania

Check Sheet Example

Carmen's World Famous Whoopie Pies

Project: *Types of defects in finished pies*	**Data collected by:** *Carl*				**Dates:** *June 20-26*			
	Location: *Heavenly, Maine plant*				**Lot size:** *200*			
Defect	**June 20**	**June 21**	**June 22**	**June 23**	**June 24**	**June 25**	**June 26**	**Total**
Too much cream	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	24
Too little cream	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	9
Too crumbly	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	21
Too big	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	13
Too small	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	14
Not sweet enough	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	9
Not chocolaty enough	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	1
Has a bite in it	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	𝍸	6

Back

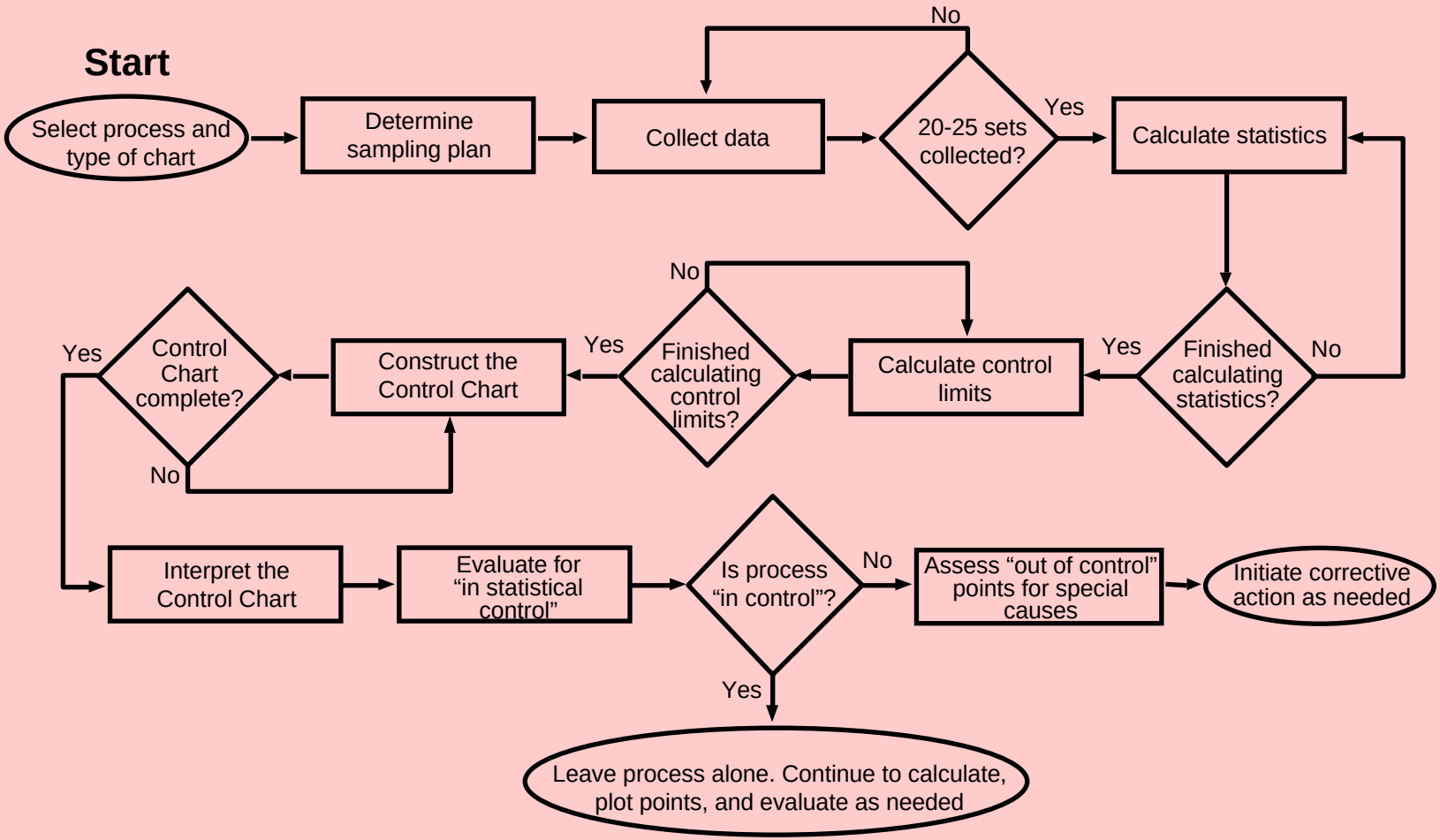
Constructing the Control Chart

- Step 1 Select the Process
- Step 2 Determine Sampling Plan
- Step 3 Initiate Data Collection
- Step 4 Calculate Statistics
- Step 5 Calculate Control Limits
- Step 6 Construct the Chart
- Step 7 Interpret the Chart

Control Chart Essentials

- Key Success Behaviors
  - Don’t “Control Chart” everything—be selective
  - Provide careful preparation and support
  - When in doubt, consult with an expert

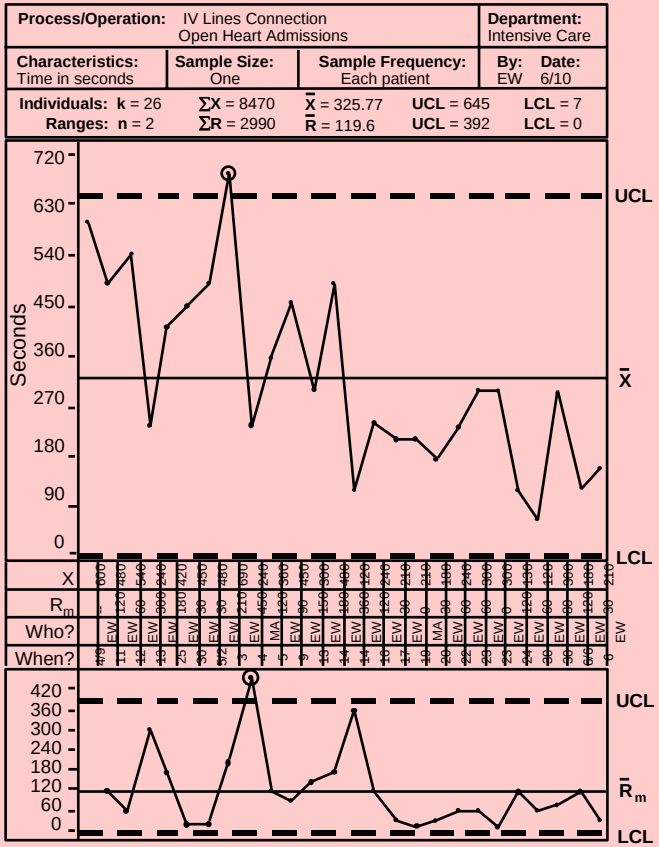
Steps at at Glance: Control Chart



Control Chart Example

- **Individuals & Moving Range**

IV Lines Connection Time

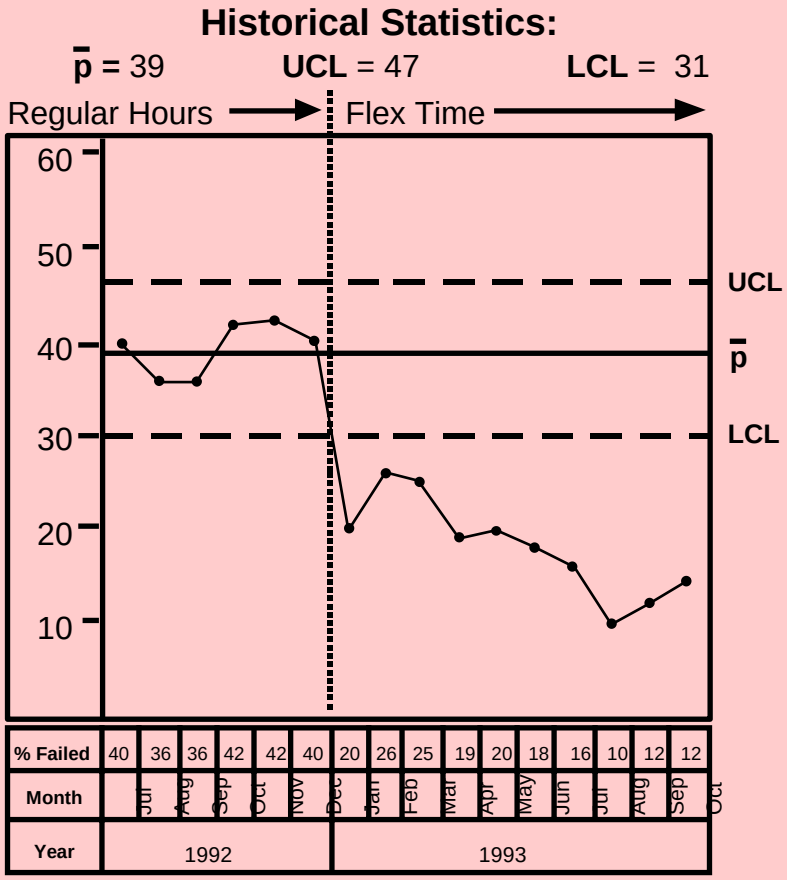


Information provided courtesy of
Parkview Episcopal Medical Center

Control Chart Example

- **$\bar{p}$ Chart**

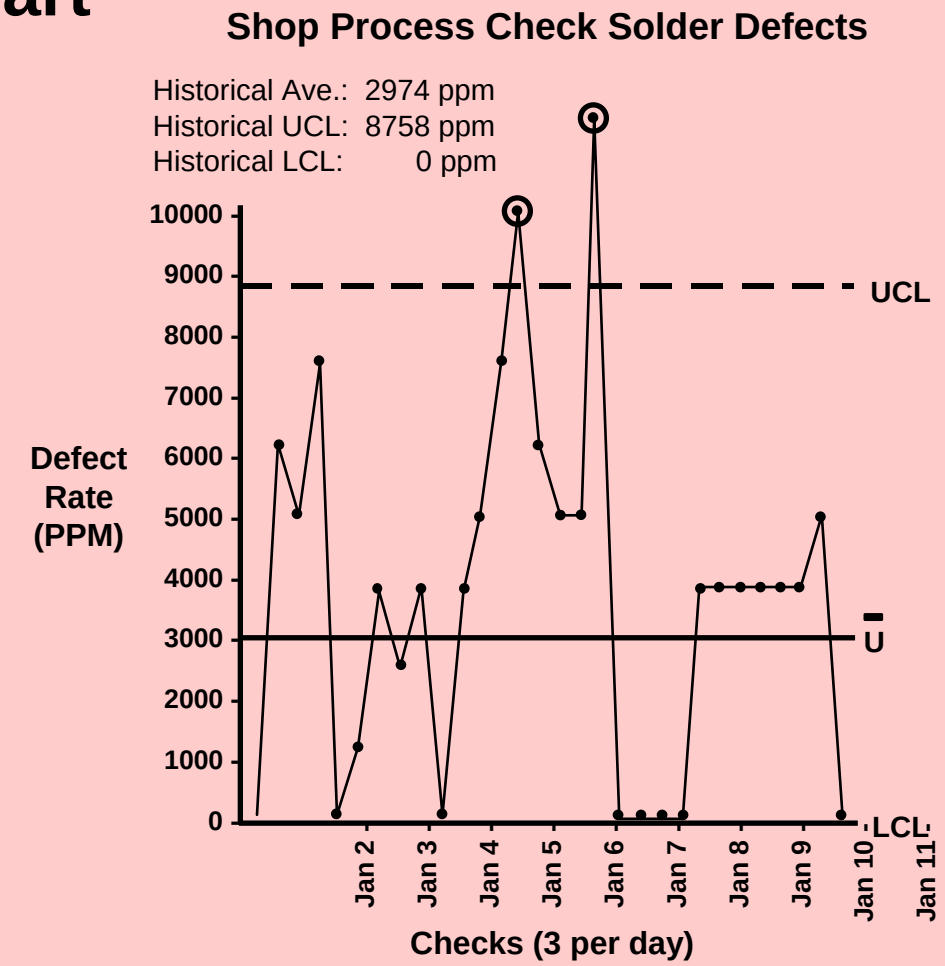
General Dentistry: Percent of Patients Who Failed to Keep Appointments



Information provided courtesy of U.S. Navy, Naval Dental Center, San Diego

Control Chart Example

- **u Chart**



Information provided courtesy of AT&T

Control Chart Example

- **Average & Range**

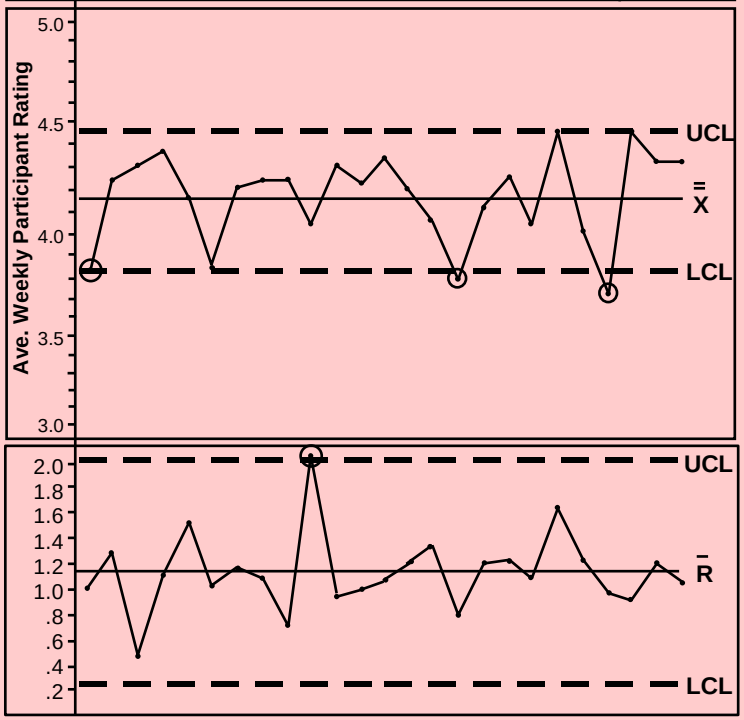
$\bar{X}$ & R Chart

Overall Course Evaluations

n = 10 evaluations randomly sampled each week

1-Not at all 2-Not very 3-Moderately 4-Very 5-Extremely

Wk #	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	
$\bar{X}$		3.76	4.21	4.29	4.36	4.13	3.77	4.17	4.21	4.22	4.00	4.30	4.20	4.32	4.18	4.02	3.71	4.08	4.23	3.98	4.46	3.96	3.63	4.48	4.30	4.29
R		1.01	1.27	0.48	1.32	1.52	1.03	1.15	1.07	0.70	2.05	0.95	0.99	1.06	1.21	1.33	0.78	1.21	1.23	1.08	1.64	1.20	0.98	0.91	1.10	1.03
																										Ave.
																									1.14	4.13



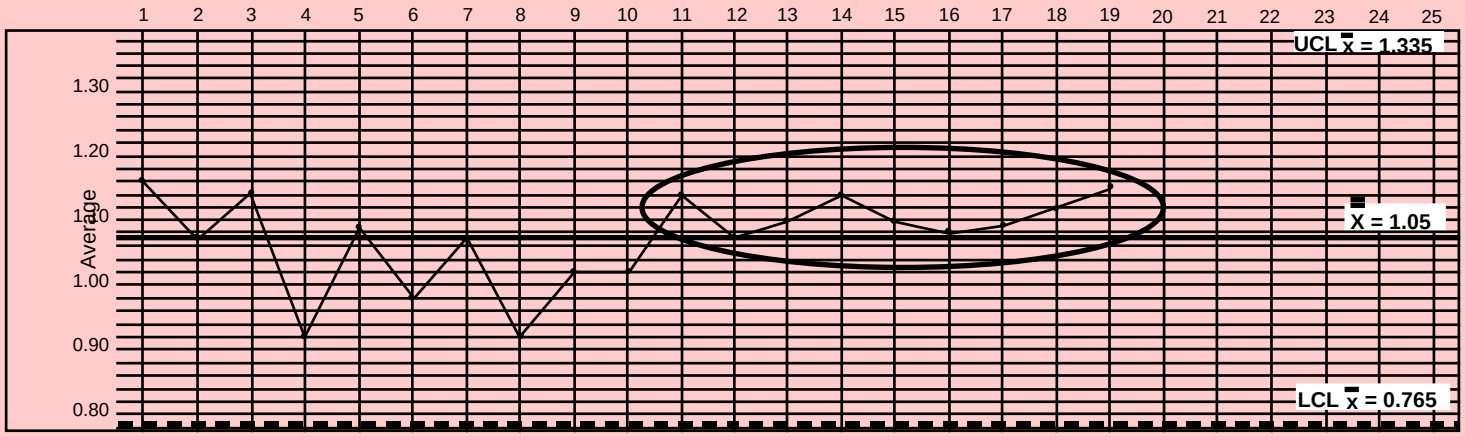
Information provided courtesy of Hamilton Standard

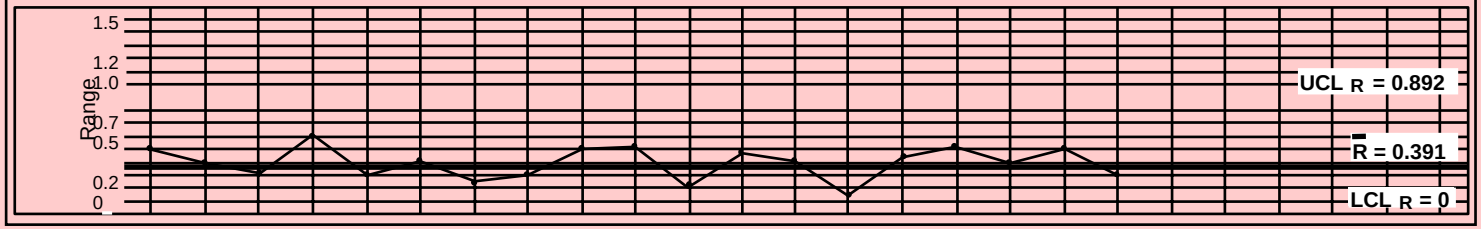
Control Chart Example

- **Average & Range**

Project Name (Product)	In-house Copy Quality Test	Operation (Process)	Improve copy quality by monitoring Black Density	Specification Limits	Black Density not less than 1.0

		4/20	4/21	4/22	4/23	4/24	4/28	4/29	4/30	5/1	5/4	5/5	5/6	5/7	5/8	5/11	5/12	5/13	5/14	5/15
Date																				
Sample Measurements	1	1.88	1.25	1.14	0.74	0.90	1.21	0.95	0.77	1.19	1.06	1.04	0.94	1.34	1.02	0.87	1.12	1.32	0.90	1.29
	2	1.36	1.06	1.29	1.26	1.18	0.82	1.19	1.04	1.15	1.33	1.12	1.13	0.95	1.14	1.09	1.32	0.96	1.38	0.99
	3	1.01	0.83	0.96	0.62	1.17	0.89	1.01	0.95	0.67	0.82	1.12	1.28	1.02	1.18	1.30	1.04	1.07	0.86	1.01
	4	1.33	1.05	1.10	0.96	1.03	0.92	–	0.83	0.98	0.80	1.21	0.85	1.00	1.13	1.04	0.78	0.93	1.27	1.22
	5																			
Sum		4.58	4.19	4.49	3.58	4.28	3.84	3.15	3.59	3.99	4.01	4.49	4.20	4.31	4.47	4.30	4.26	4.28	4.41	4.51
Average, $\bar{X}$		1.14	1.05	1.12	0.90	1.07	0.96	1.05	0.90	1.00	1.00	1.12	1.05	1.08	1.12	1.08	1.06	1.07	1.10	1.13
Range, R		0.48	0.42	0.33	0.64	0.28	0.39	0.24	0.27	0.52	0.53	0.17	0.43	0.39	0.16	0.43	0.54	0.39	0.52	0.30
Notes																				





Back

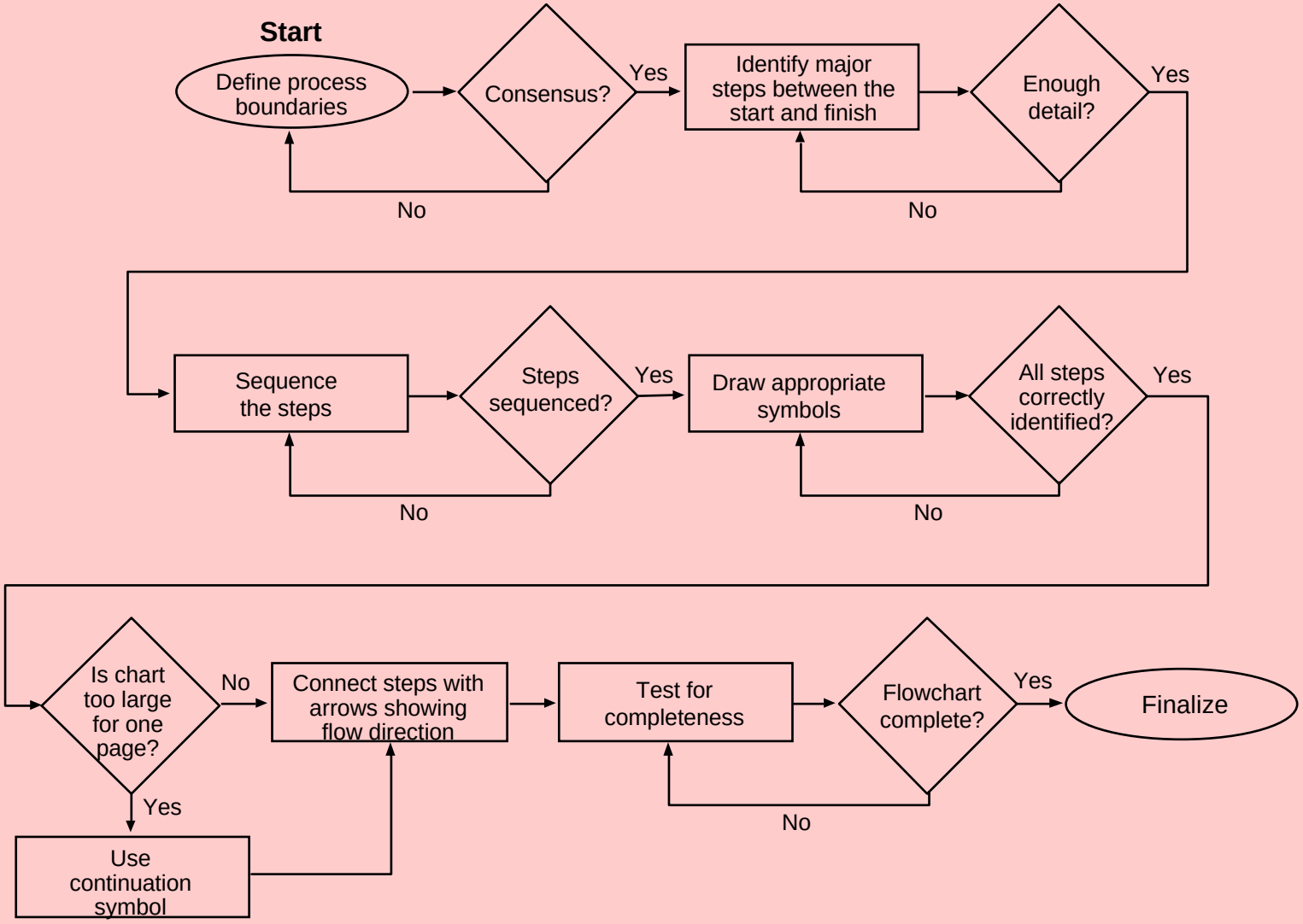
Constructing the Flowchart

- Step 1 Determine the Boundaries
- Step 2 List the Steps
- Step 3 Sequence the Steps
- Step 4 Draw Appropriate Symbols
- Step 5 Test for Completeness
- Step 6 Finalize the Flowchart

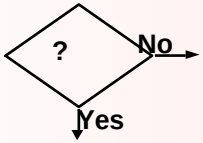
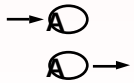
Flowchart Essentials

- Key Success Behaviors
  - Stay focused on what the team is trying to achieve
  - Be open to each person's suggestions for changes
  - Persevere—hard work will be rewarded later

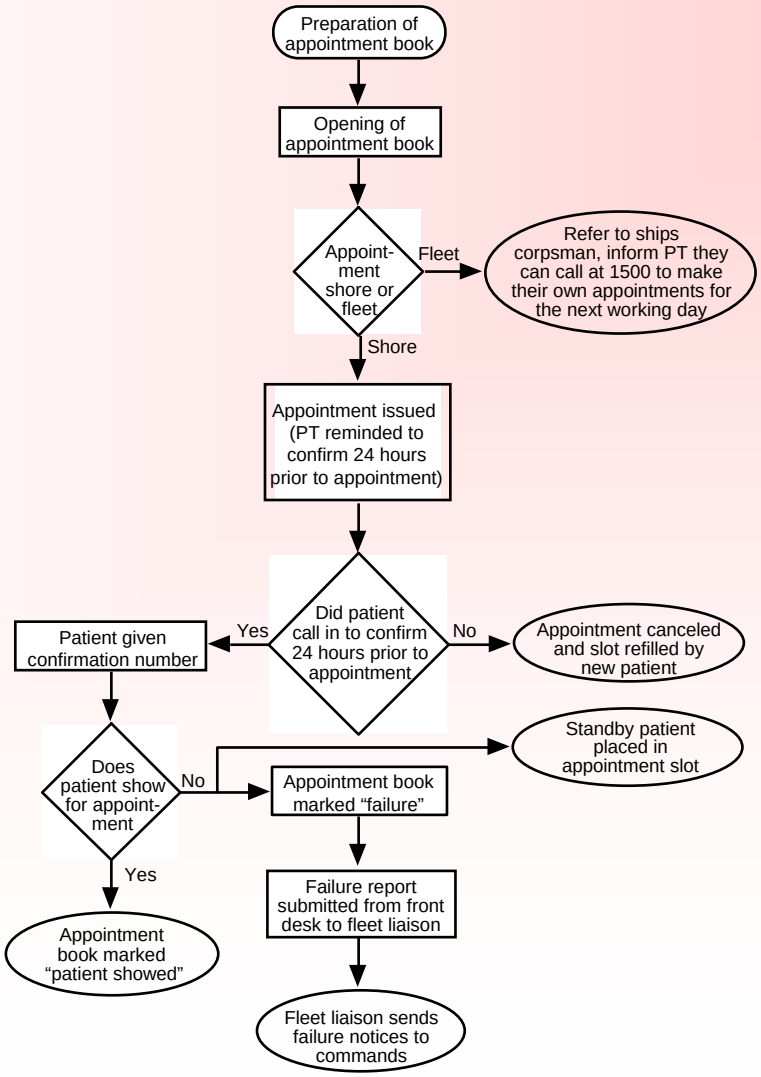
Steps at a Glance: Flowchart



Flowchart Symbols

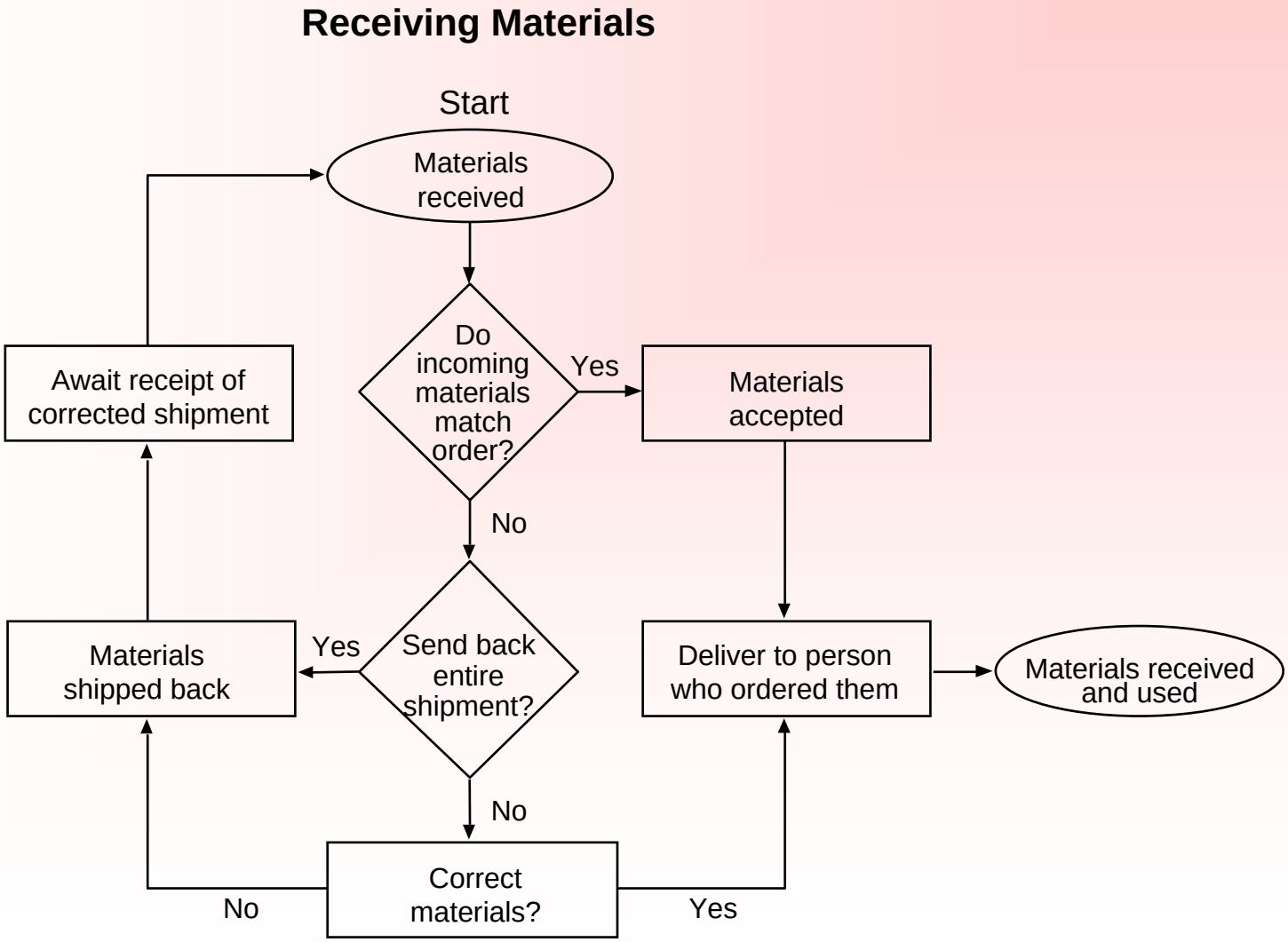
Symbol	Represents	Detail/Example
	Start/End Input/Output	Request for proposal, request for new hire, raw material
	Task, action, execution point	Hold a meeting, make a phone call, open a box
	Decision point	Yes/no Accept/reject Pass/fail Criteria met/not met
	Document	A report or form is filled out, job request, meeting minutes
	Shadow signifies additional flowchart for this task	A major task has subtasks not needed for this study or subtasks not included due to limited space
	Delay	Waiting for service, report sitting on a desk
	Continuation	Go to another page, go to another part of the chart
	Arrow	Shows direction or flow of the process steps

Flowchart Example



Information provided courtesy of U. S. Navy, Naval Dental Center, San Diego

Flowchart Example



Back

Constructing the Force Field

- Step 1 Brainstorm the Forces
- Step 2 Prioritize the Forces

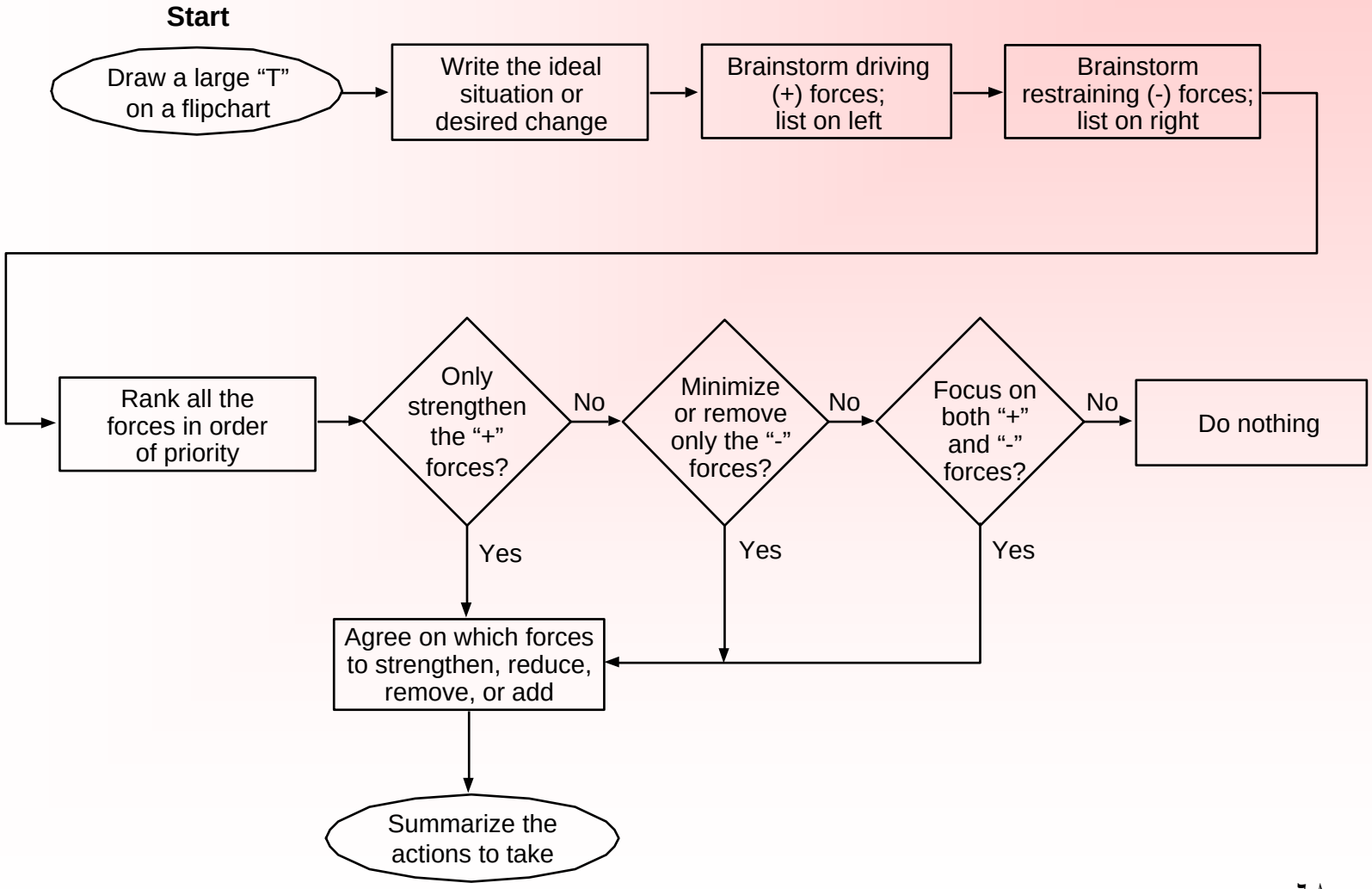
Purpose of force Field

A force field analysis helps teams find out what is driving, slowing, or preventing change. The tool helps a team to work together, to find a starting point from which to take action, and to show both sides of the change issue.

Force Field Essentials

- Key Success Behaviors
  - Clearly define both the current situation and the desired situation
  - Clearly state the importance of filling the gap between the two situations
  - Keep focused on the purpose at all times
  - Look closely at all of the forces at work in implementing the change
  - Be keenly aware of your own biases and try not to “sell” others

Steps at a Glance: Force Field Analysis



Force Field Analysis Example

Conduct A Weekly Training Program For Teachers To Learn State Test Objectives Integration

Driving Forces (+)

- The Superintendent is very supportive
- (3) Will improve state test scores
- (1) Teachers are involved in decision making to impact instruction
- Teachers meet weekly already
- (2) Principal is supportive
- Teachers are willing to try

Restraining Forces (-)

- Teachers are reluctant to have data collectors in classroom
- Time to gather data
- (2) Heightened stress
- Teachers have a set way of delivering lessons
- (1) Limited time to implement change
- Teaching to the test is not always good teaching

Actions:

1.) Let teachers know that their input is important, and that this is not a tool to evaluate their performance

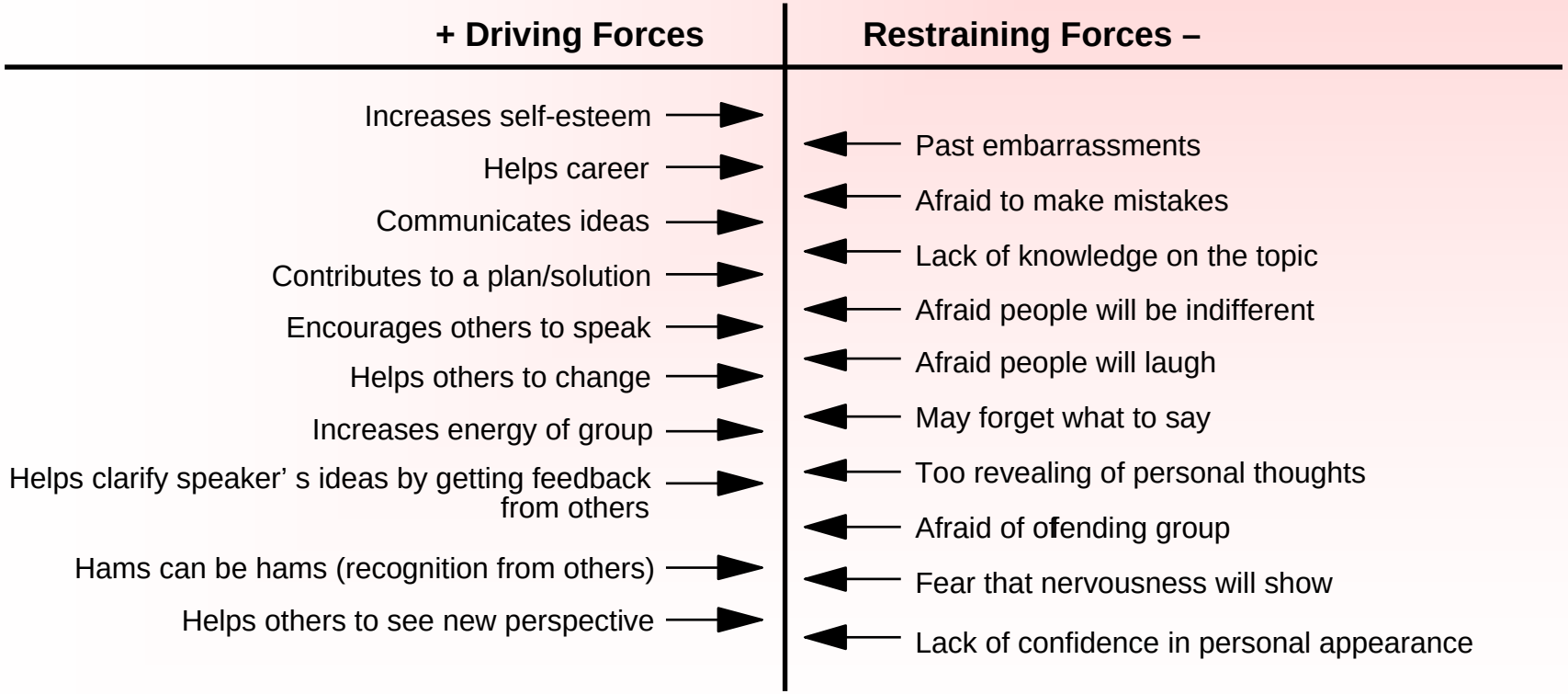
2.) The principal will give a pep talk to teachers

3.) The trainer will show teachers how to take their regular lesson plans and add state test objectives.

Force Field Analysis Example

Fear of Public Speaking

Ideal state: To speak confidently, clearly, and concisely in any situation.



Force Field Analysis Example

Desired Change: Quit Smoking

+ Driving Forces		Restraining Forces –	
Clothes & breath smell like smoke	(3)	It’s too hard to quit	(10)
Costs money	(8)	Many of your friends smoke	(4)
Getting hackers cough	(6)	Spouse smokes	(9)
Don’t want your kids to start smoking	(10)	It’s enjoyable	(6)
Know it can adversely affect your health	(9)	Work is too stressful right now to quit	(8)
Can’t smoke at work	(5)	Doesn’t affect physical activity level	(5)
Support group available in community	(7)	Don’t want to gain any weight by quitting	(3)
		You can quit anytime, but you/re not ready yet	(2)

Back

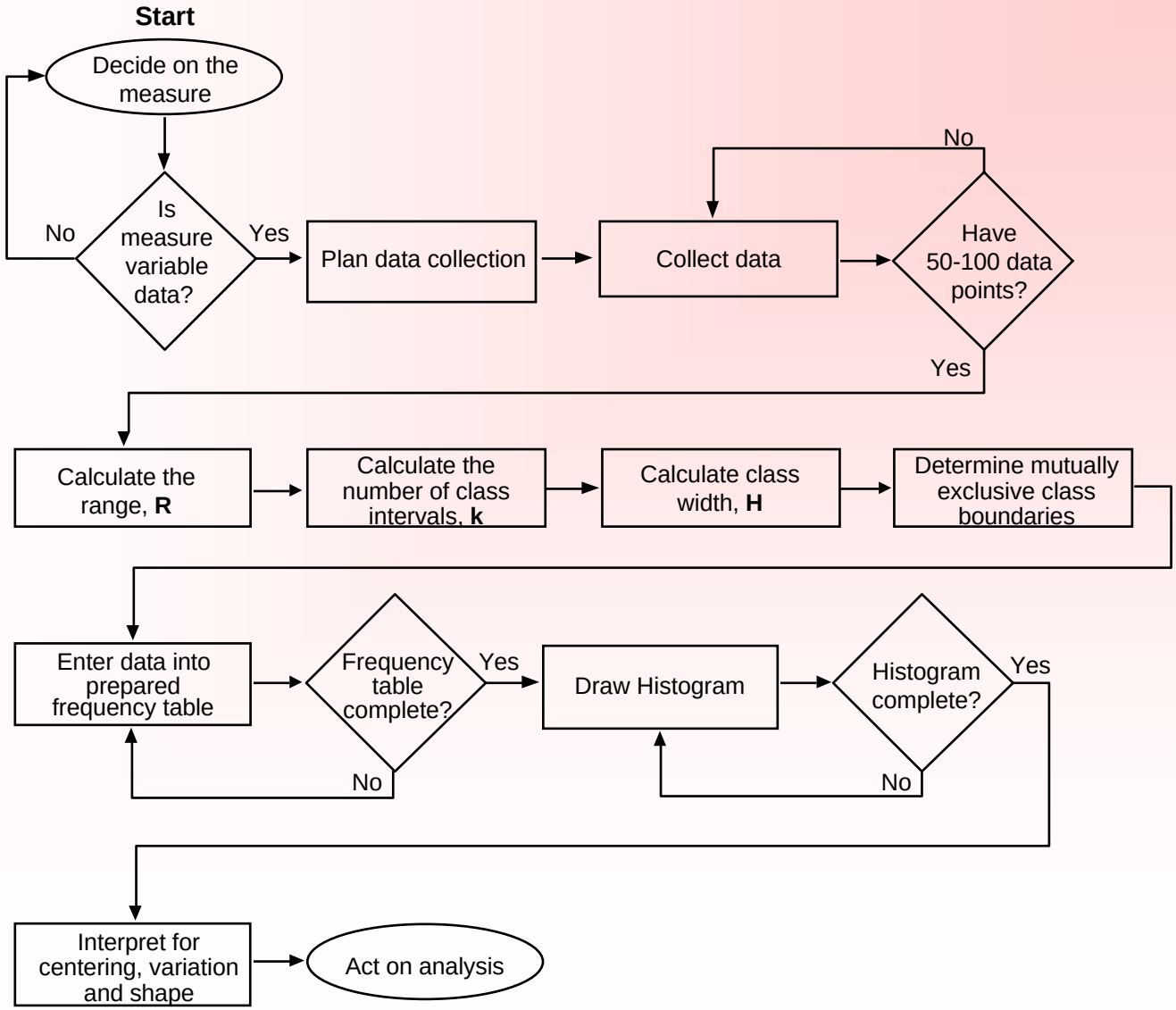
Constructing the Histogram

- Step 1 Decide on the Measure
- Step 2 Gather Data
- Step 3 Prepare a Frequency Table
- Step 4 Draw a Histogram
- Step 5 Interpret the Histogram

Histogram Essentials

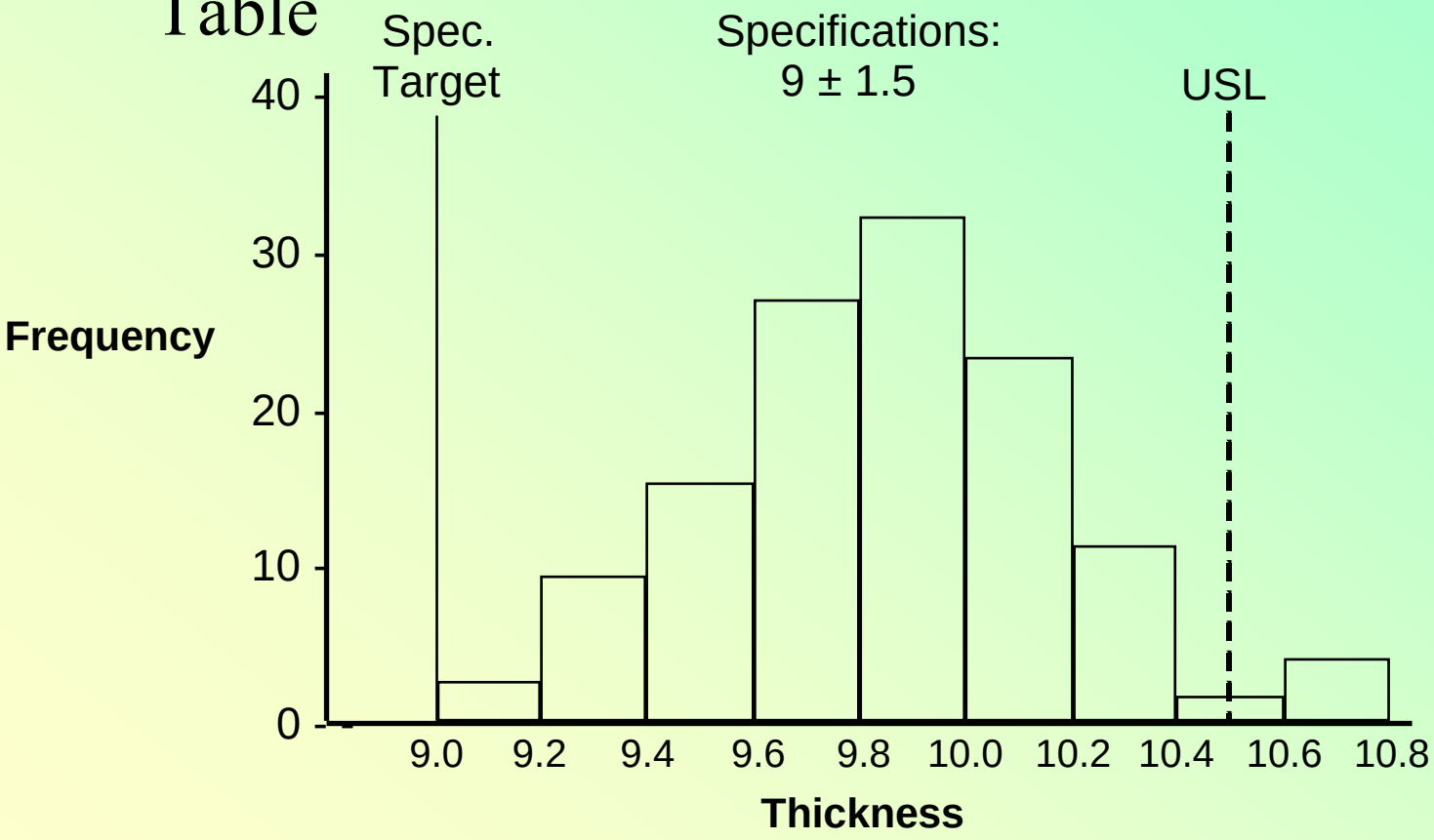
- Key Success Behaviors
  - Remind the team that when they are gathering data, it's okay for each value to be different
  - Don't collect less data than required to "save time"
  - Encourage each other through the hard parts; the purpose of the Histogram is to acquire information, not statistical stamina
  - Optional: use computer software to generate a Histogram

Steps at a Glance: Histogram



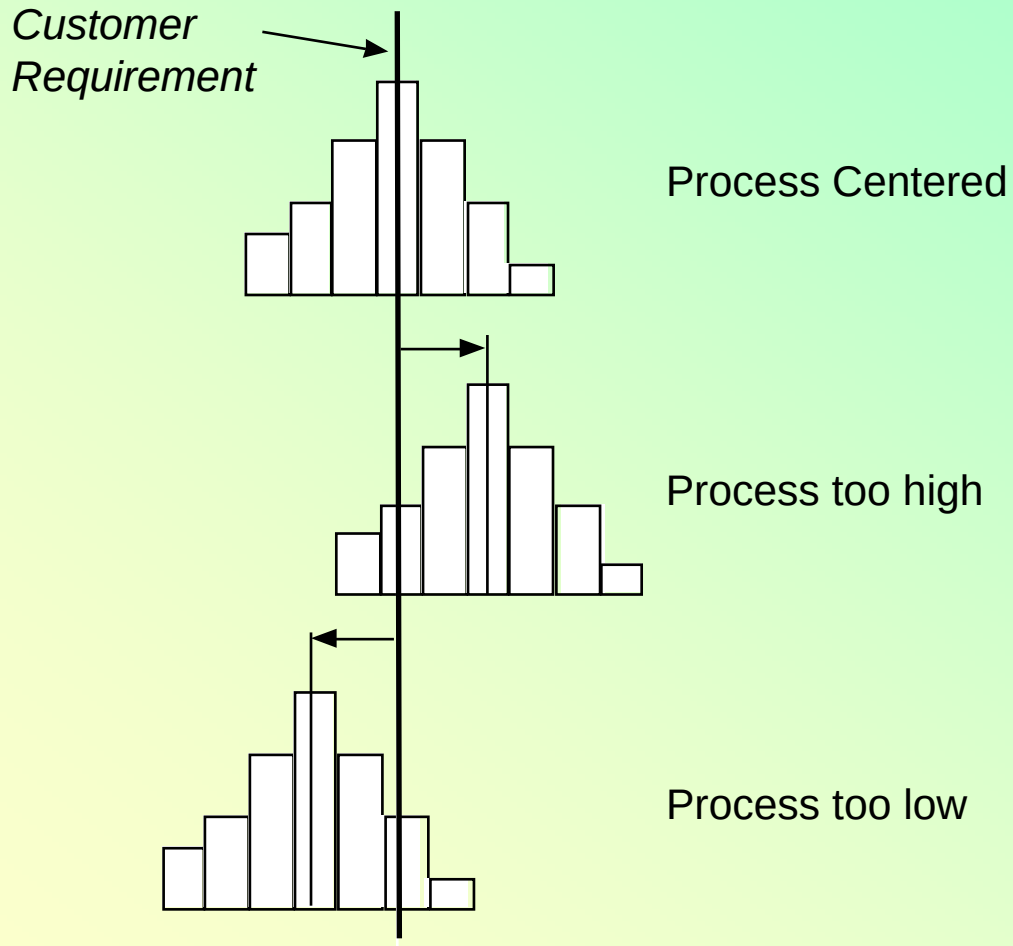
Step-by-Step Construction

– Step 4 Draw Histogram - Using Frequency Table



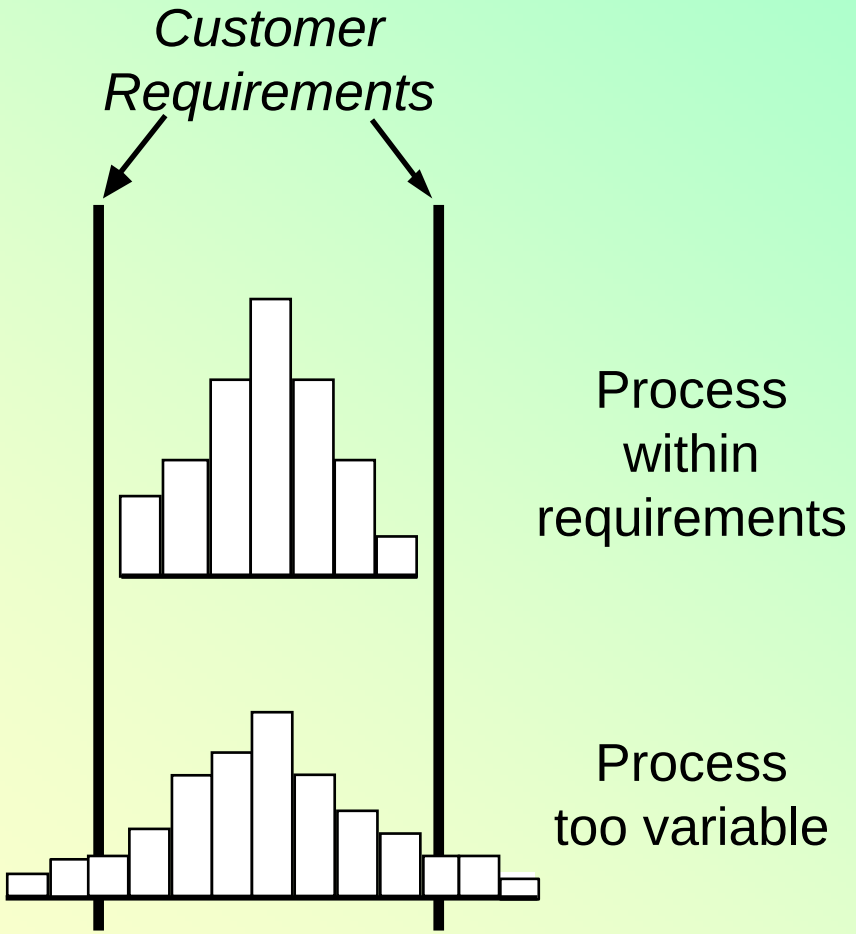
Step-by-Step Construction

– Step 5 Interpret Histogram (Centering)



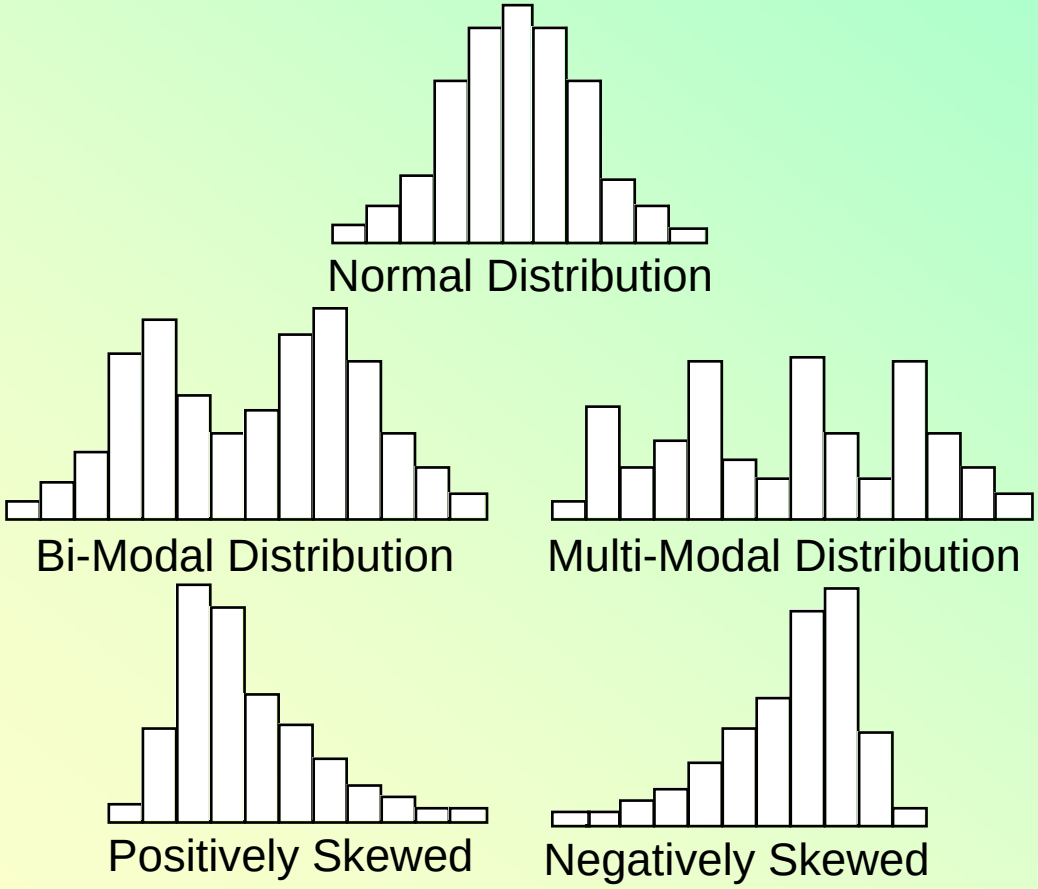
Step-by-Step Construction

– Step 5 Interpret Histogram (Variation)



Step-by-Step Construction

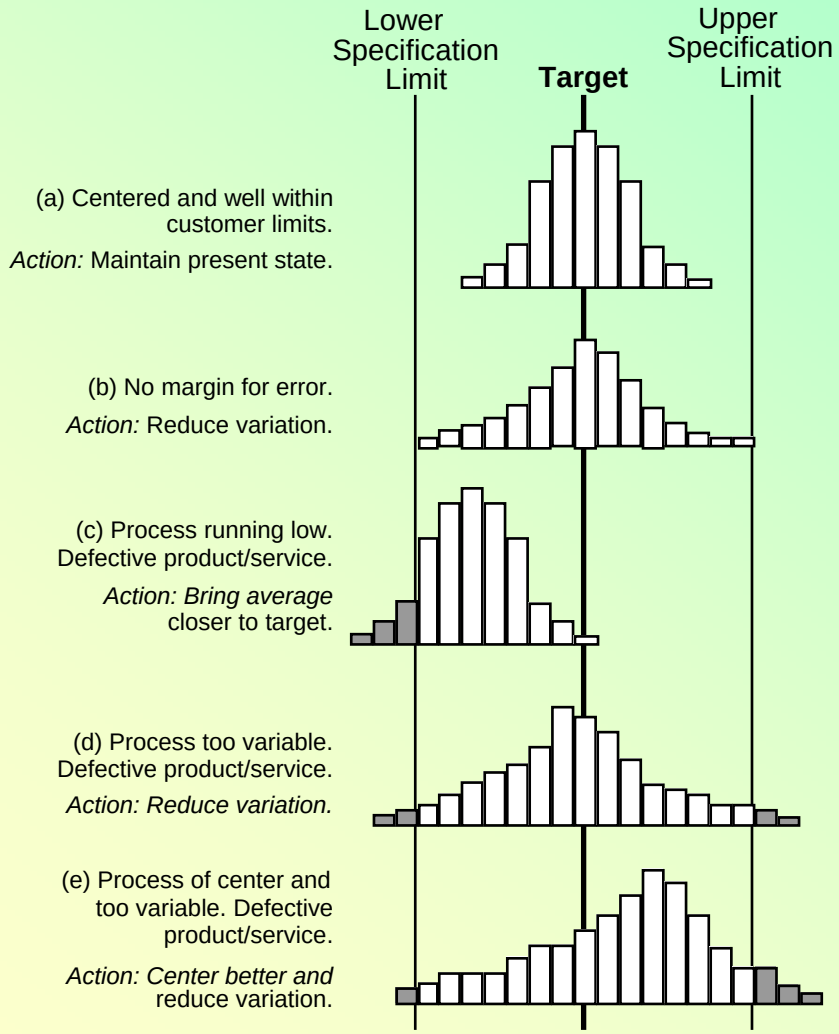
– Step 5 Interpret Histogram (Shape)



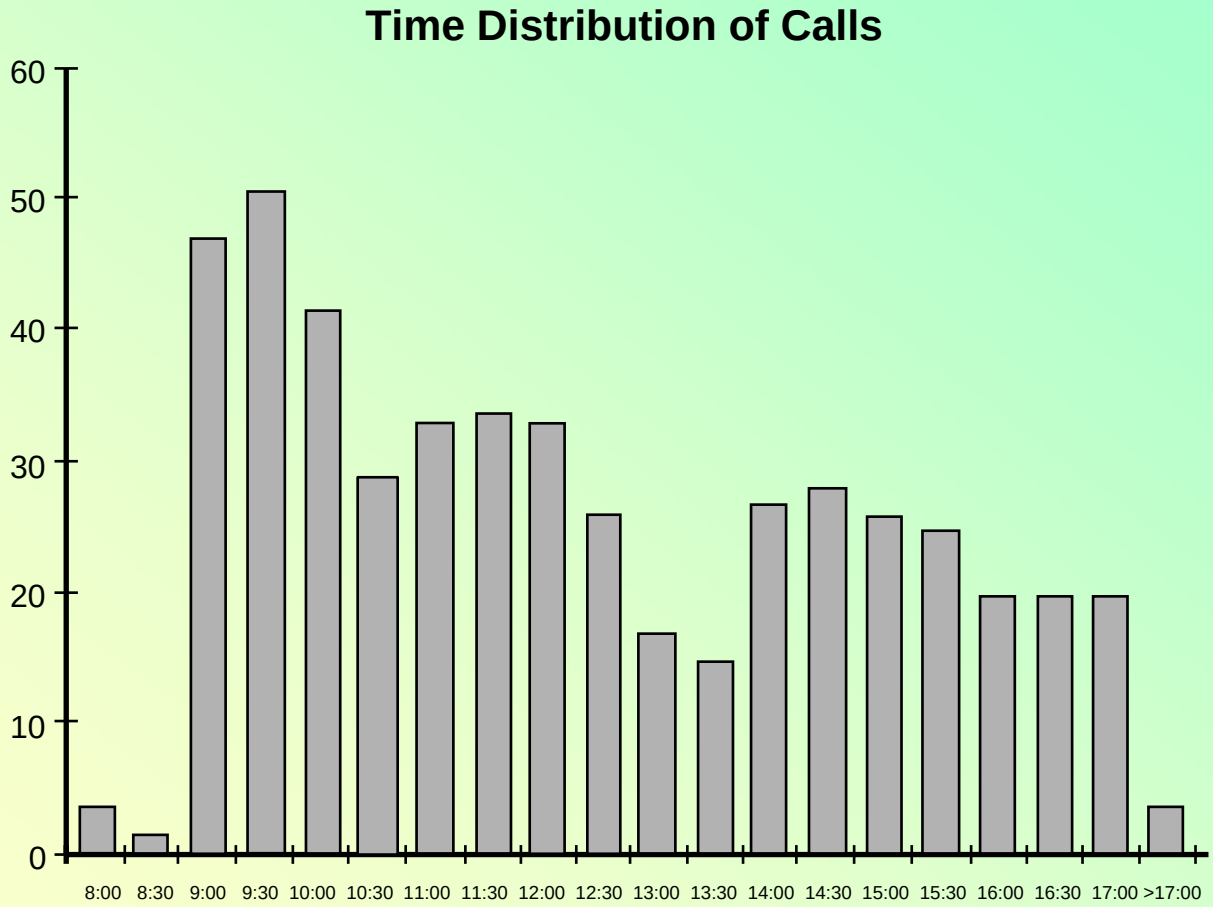
Step-by-Step Construction

- **Step 5 Interpret Histogram**

Centering and Spread Compared to Customer Target and Limits



Histogram Example

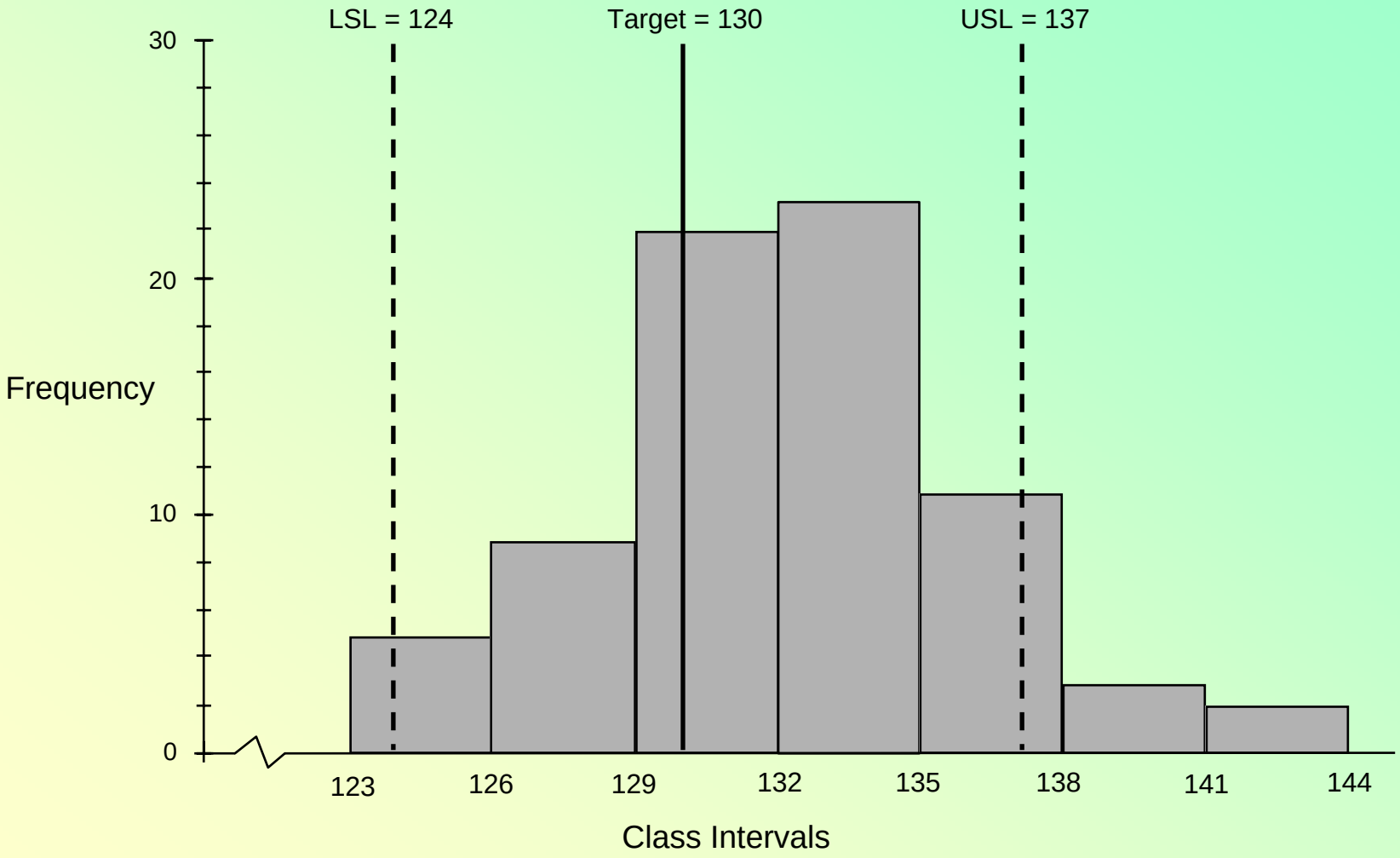


HOTrep data May 22 to August 4

Information provided courtesy of SmithKline Beecham

Histogram Example

Generic Example



Back

Matrix Diagram

The matrix diagram method

> clarifies problematic spots through multidimensional thinking. ... The matrix diagram method identifies corresponding elements involved in a problem situation or event. These elements are arranged in rows and columns on a chart that shows the presence or absence of relationships among collected pairs of elements. ... Effective problem solving is facilitated at the intersection points, also refered to as the idea conception points. ... Matrix diagrams are classified on the basis of their pattern into five groups: (1) the L-type matrix, (2) the T-type matrix, (3) the Y-type matrix, (4) the X-type matrix, and (5) the C-type matrix.

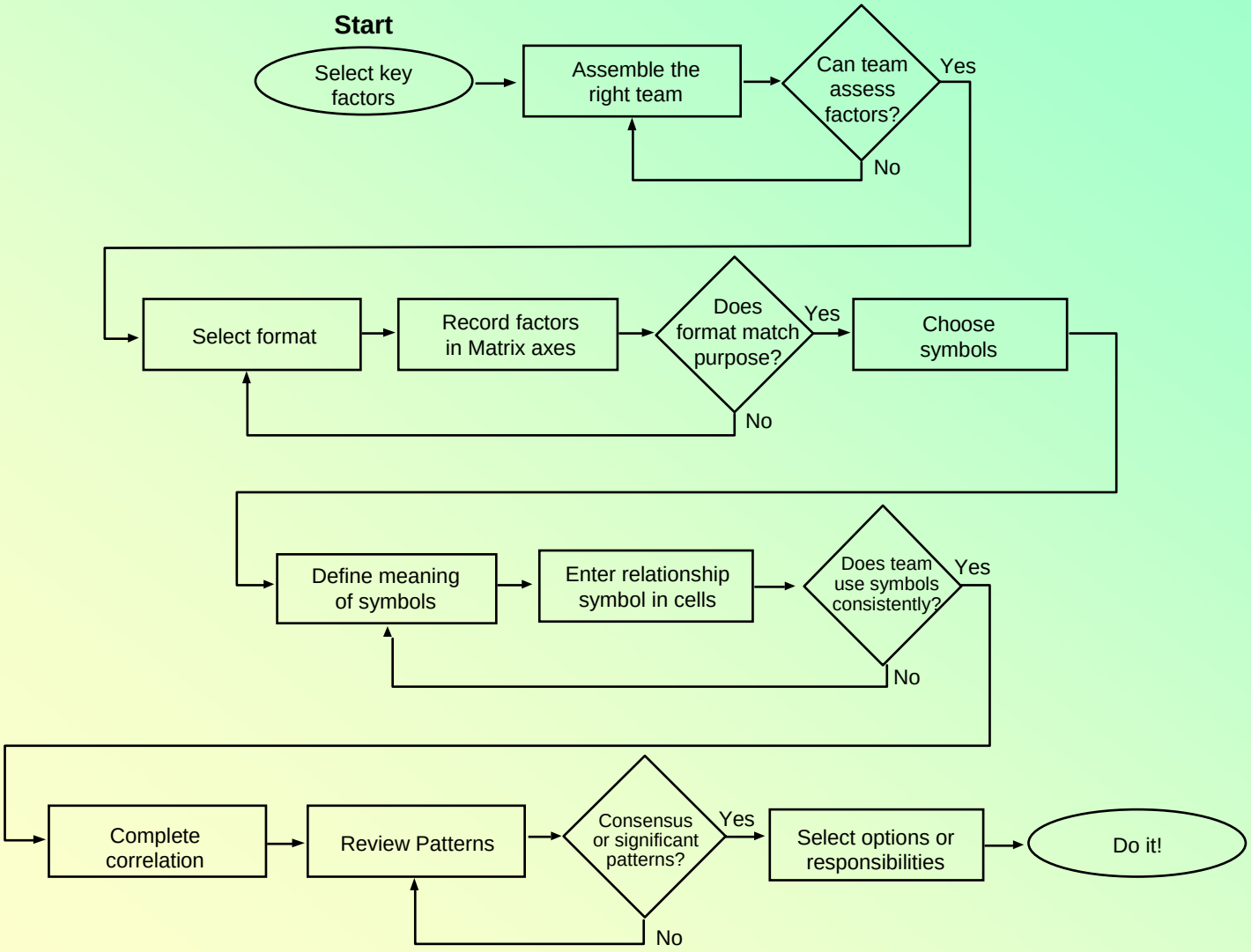
Constructing the Matrix Diagram

- **Step 1 Select the Key Factors**
- **Step 2 Assemble the Right Team**
- **Step 3 Select the Format**
- **Step 4 Define the Symbols**
- **Step 5 Complete the Matrix**

Matrix Diagram Essentials

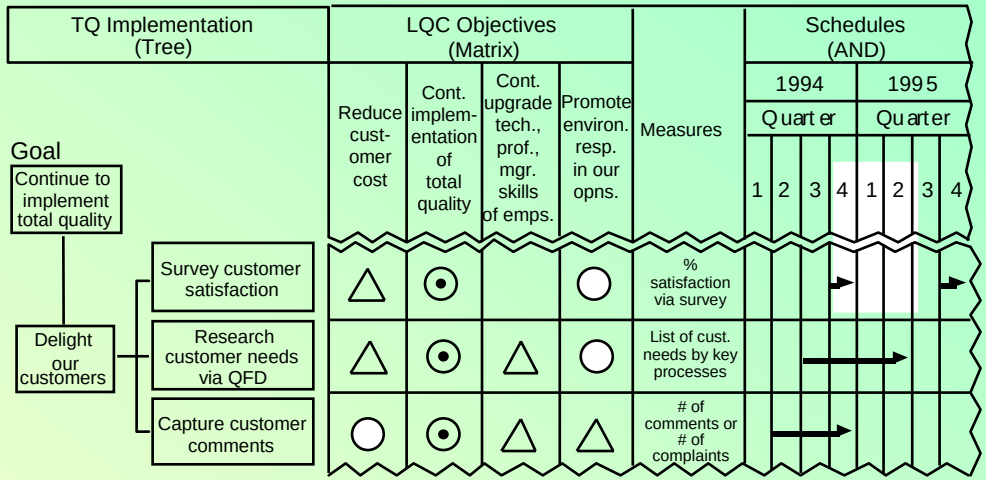
- Key Success Behaviors
  - Use symbols consistently
  - Look at each cell independently and make a decision; don't try to force patterns to emerge in the matrix
  - Resolve conflicts with data
  - Look for emerging patterns

Steps at a Glance: Matrix

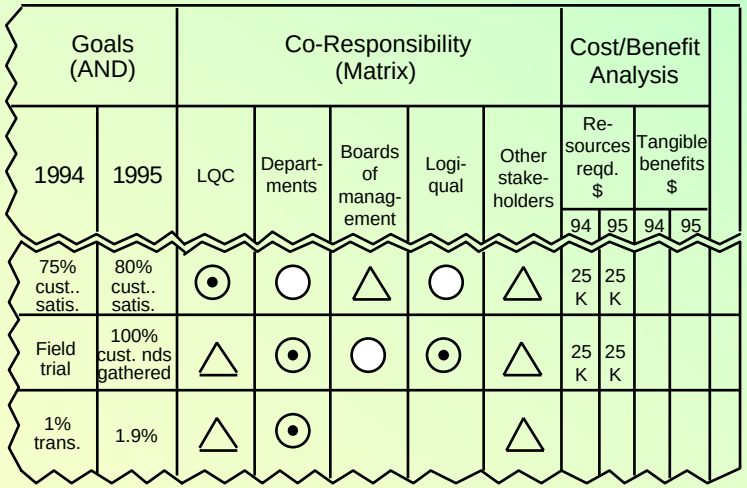


Matrix Example

Logistics Annual Plan



⊙ = 9 Strong influence/relationship
○ = 3 Some influence/relationship
△ = 1 Weak influence/relationship
Blank = No influence/relationship



⊙ = 9 Prime responsibility
○ = 3 Secondary responsibility
△ = 1 Kept informed

Information provided courtesy of Bell Canada

Matrix Example

Summary of TQC Education and Training in Japan
Content Distribution by Levels/Functions

Topic \ People	Top Mgmt.	Middle Mgmt. Staff	Engin-eers	Super-visors	Funct. & Admin.	Genl. Work-ers
TQC Concepts	○	○	○	○	○/◎	○
QC Techniques	○	○	◎	◎		○
Statistical Methods	○	○	◎	○	○	○
Quality Assurance	△	○	◎	○	△	△
Product Development	△	△	◎		△/○	
Role in TQC	◎	◎	◎	◎	◎	◎
QC Circle	△	○	△	◎	△	○/◎
New Product Introduction	○	△	◎	○		
Hoshin Planning	◎	○	△		△	
Company Production System			○	◎		○

Educated to: △ = Understand ○ = Use ◎ = Master

Sources: JUSE, JSA, Deming Prize Companies

Printed in 1989 GOAL/QPC Research Committee Research Report, "Total Quality Control Education in Japan," page 9.

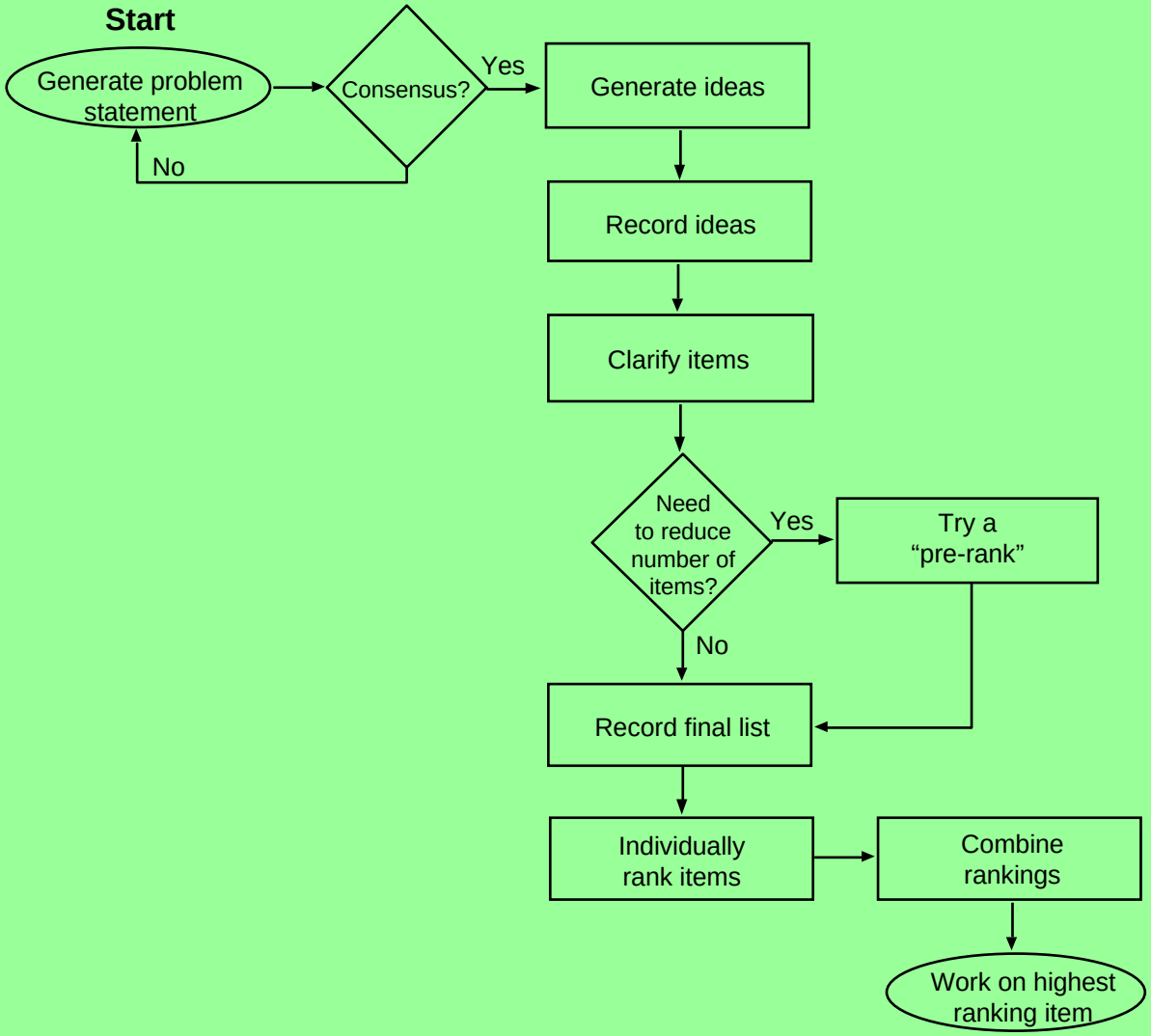
Using Nominal Group Technique

- Step 1 Generate Items
- Step 2 Record Items
- Step 3 Clarify Items
- Step 4 Record the Final List
- Step 5 Rank Items Individually
- Step 6 Combine Rankings

Nominal Group Technique Essentials

- Key Success Behaviors
  - Focus on the purpose of the activity when ranking
  - Respect the values of other team members in the ranking process
  - Try to understand the logic behind each other's opinions

Steps at a Glance: NGT



Step by Step: Using NGT

- **Step 4 Record the Final List**

Example: Why does the department have inconsistent output?

A Lack of Training
B No documented process
C Unclear quality standards
D Lack of cooperation with other departments
E High turnover

Step by Step: Using NGT

– Step 5 Rank Items Individually

Example: Larry's sheet of paper looks like this:

A	**4**
B	**5**
C	**3**
D	**1**
E	**2**

Step by Step: Using NGT

– Step 6 Combine Rankings

	Larry	Nina	Norm	Paige	Si		Total
A	4	5	2	2	1	=	14
B	5	4	5	3	5	=	22
C	3	1	3	4	4	=	15
D	1	2	1	5	2	=	11
E	2	3	4	1	3	=	13

"No documented process," B, would be the highest priority. The team would work on this first and then move through the rest of the list as needed.

NGT Example

What are ways to increase literacy among all employees in the organization?

Item	Maya	José	Sidney	Rebecca	Pete	Total
Provide confidential on-site literacy training	3	3	1	2	3	12
Start a confidential network to connect students with tutors	4	1	3	4	4	**16**
Offer the resources for potential students to organize monthly reading parties	1	2	2	1	1	7
Give a small bonus for reading milestones achieved	2	4	4	3	2	**15**

Back

Constructing the Scatter Diagram

- Step 1 Collect Paired Data
- Step 2 Draw the Axes
- Step 3 Plot the Data
- Step 4 Interpret the Data

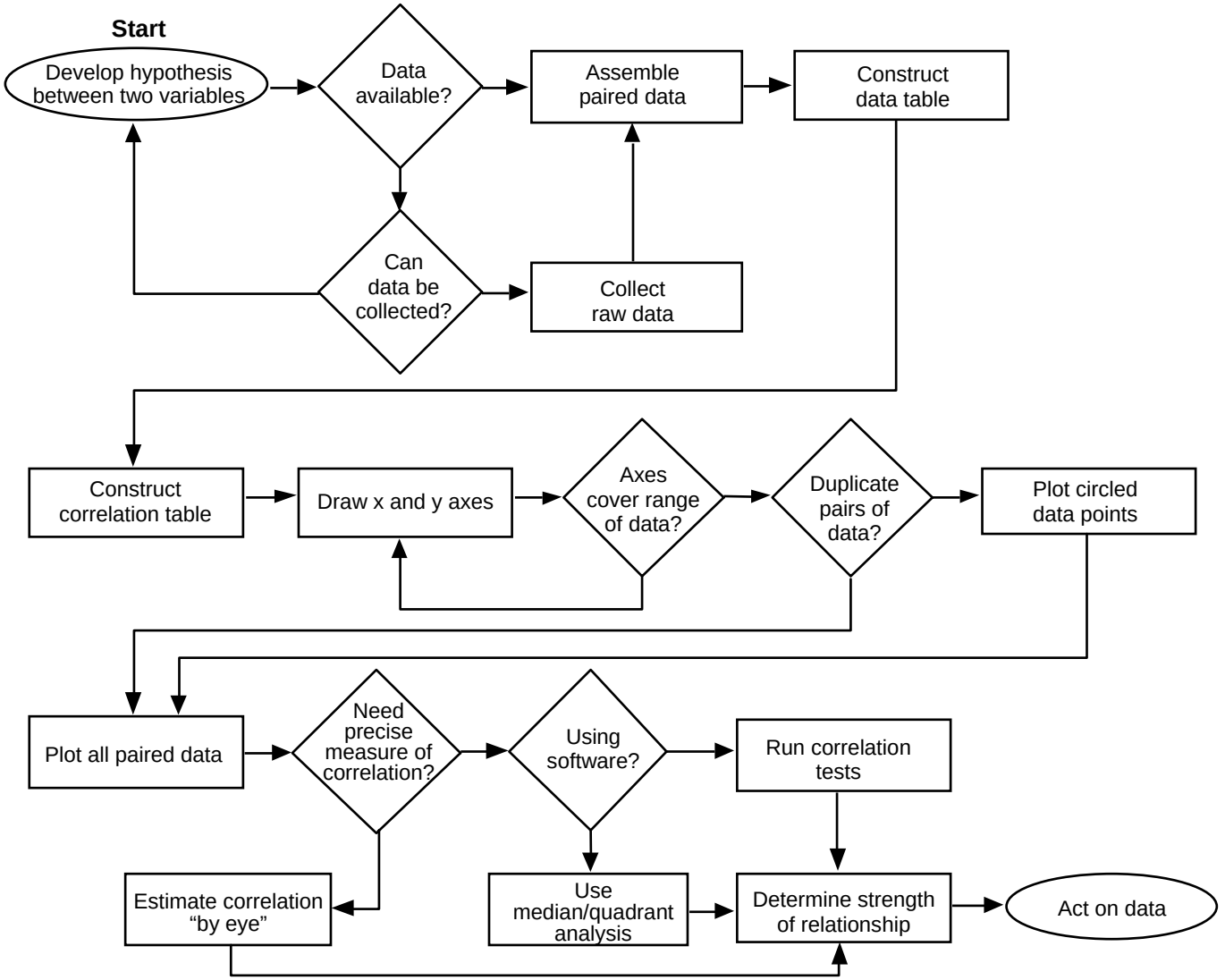
Scatter Diagrams

- The scatter diagram is used to examine the relationships between variables.
- Scatter diagrams are used to investigate the possible relationship between two variables that both relate to the same "event." A straight line of best fit (using the least squares method) is often included.
- The shape of the scatter diagram often indicates what type of relationship may exist.

Scatter Diagram Essentials

- Key Success Behaviors
  - Use the tool only when credible data exist
  - Test first for the most likely relationships
  - Don’t reject unexpected correlations
  - Speak in terms of relationship strength, NOT cause and effect

Steps at a Glance: Scatter



Step-by-Step Construction

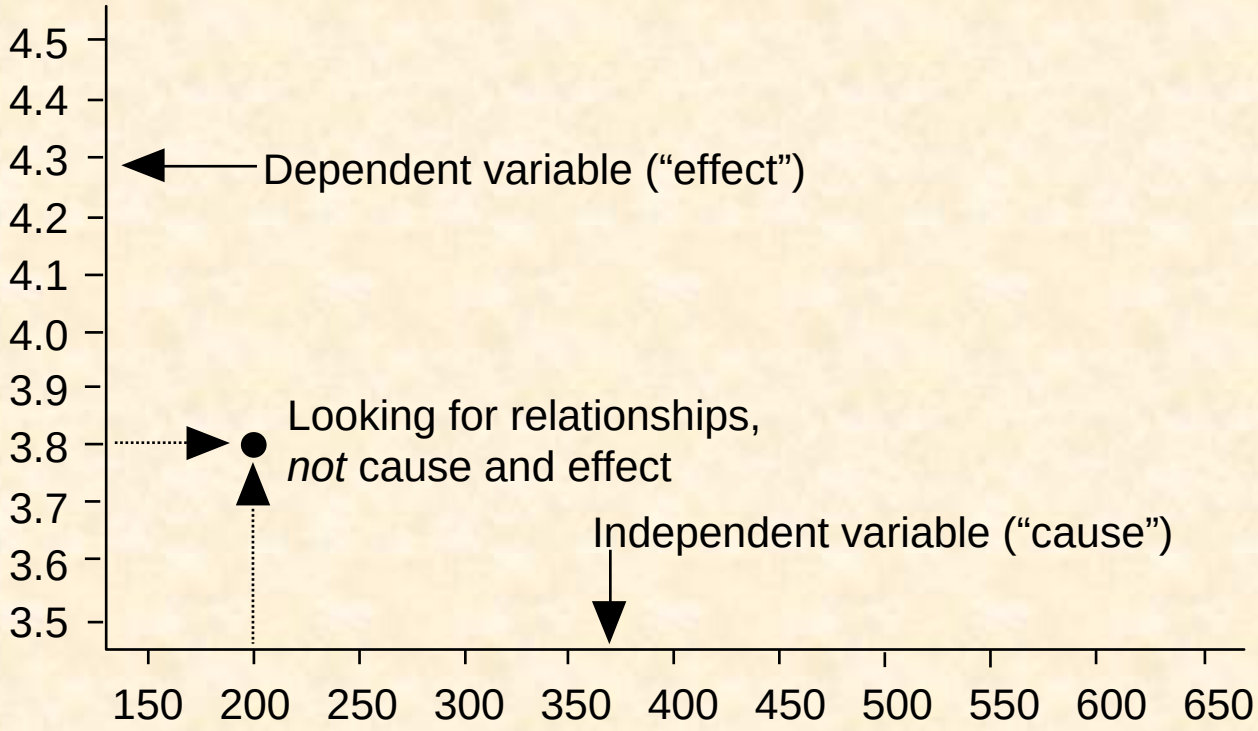
– Step 1 Collect Paired Data

Course	Average Session Rating (on a 1-5 scale)	Average Experience of Training Team (days)
1	4.2	220
2	3.7	270
3	4.3	270
-	-	-
-	-	-
-	-	-
40	3.9	625

Theory: There is a possible relationship between the number of days of experience the training team has received and the ratings of course sessions.

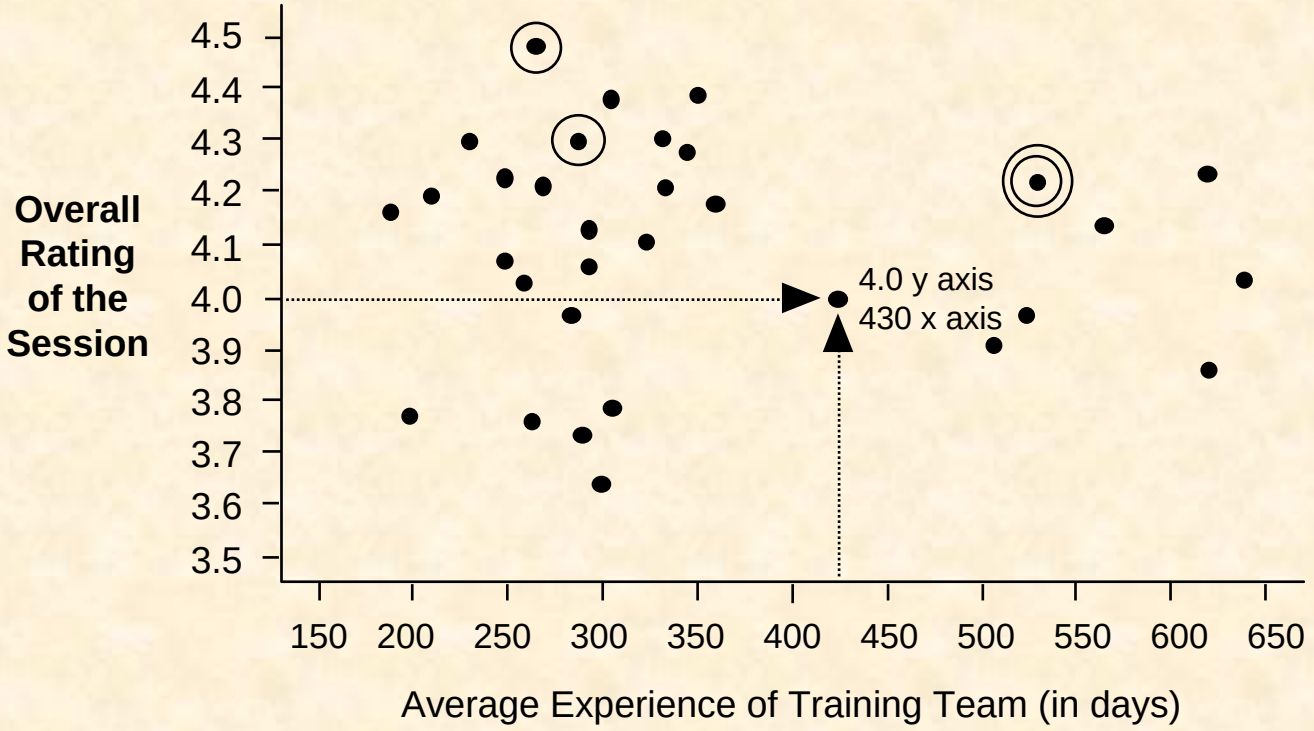
Step-by-Step Construction

– Step 2 Draw the Axes



Step-by-Step Construction

– Step 3 Plot the Data

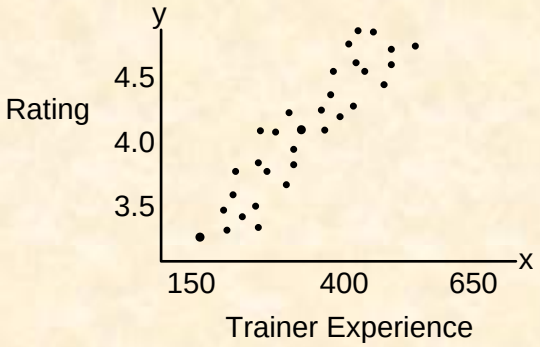


Information provided courtesy of Hamilton Standard

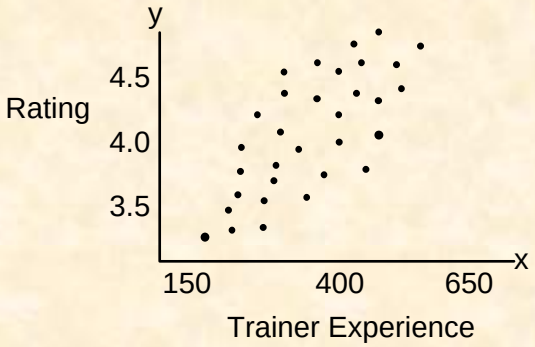
Step-by-Step Construction

- **Step 4 Interpret the Data**

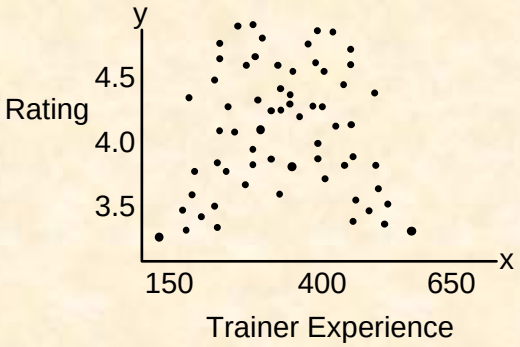
Positive Correlation



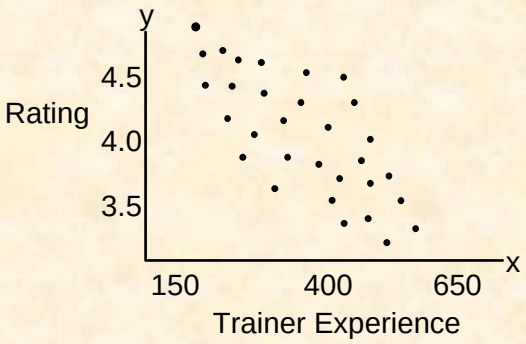
Possible Positive Correlation



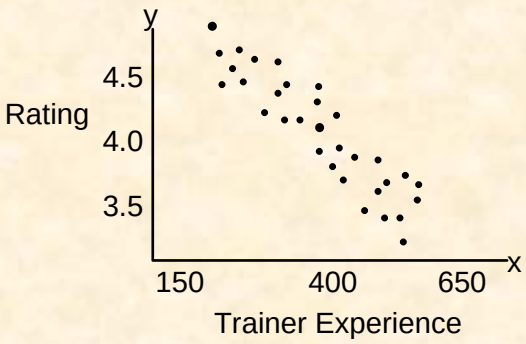
No Correlation



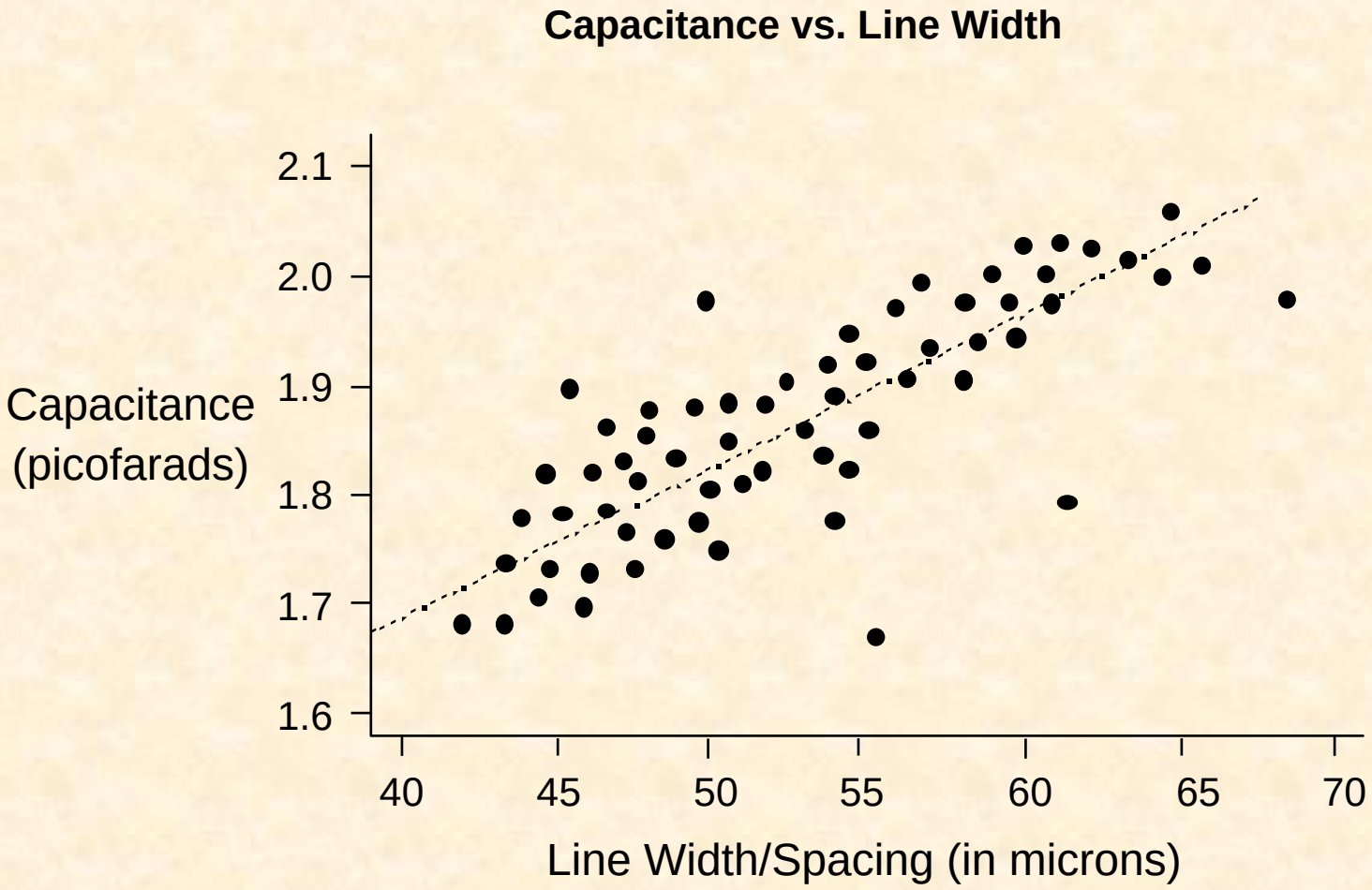
Possible Negative Correlation



Negative Correlation

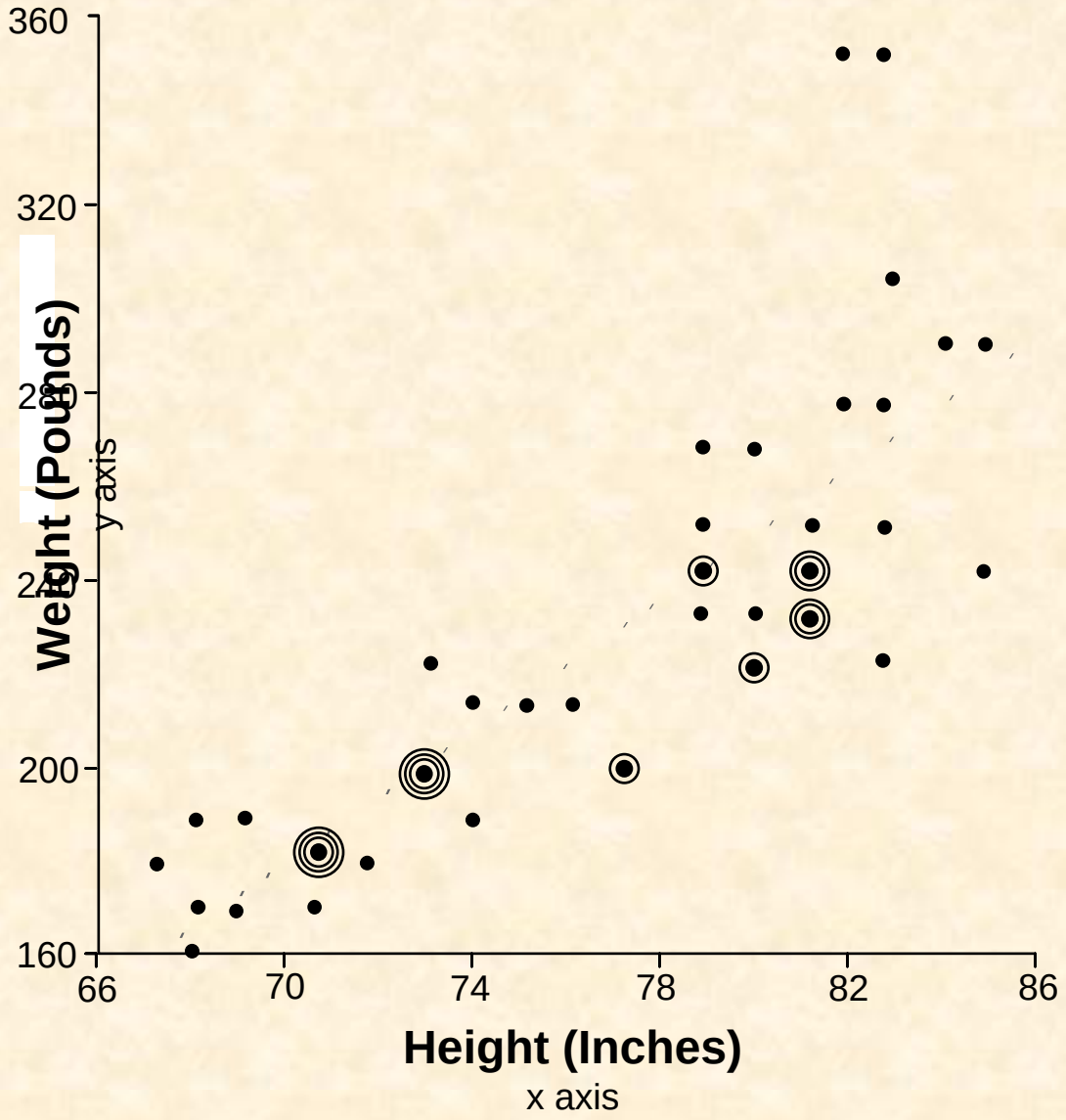


Scatter Example



Information provided courtesy of AT&T

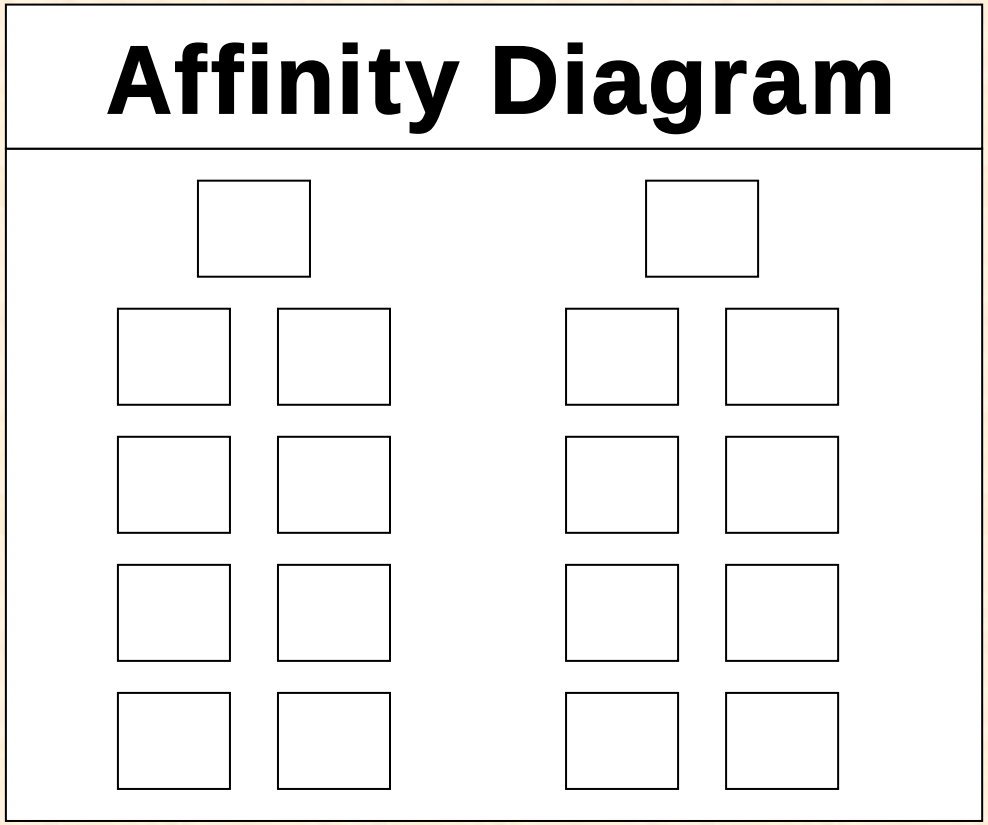
Scatter Example



Back

Affinity Diagram

The **Affinity Diagram** is the result of an interactive data collection method which allows groups of people to identify and process large quantities of ideas in a very short time. It is a non-judgmental way to collect and process ideas.



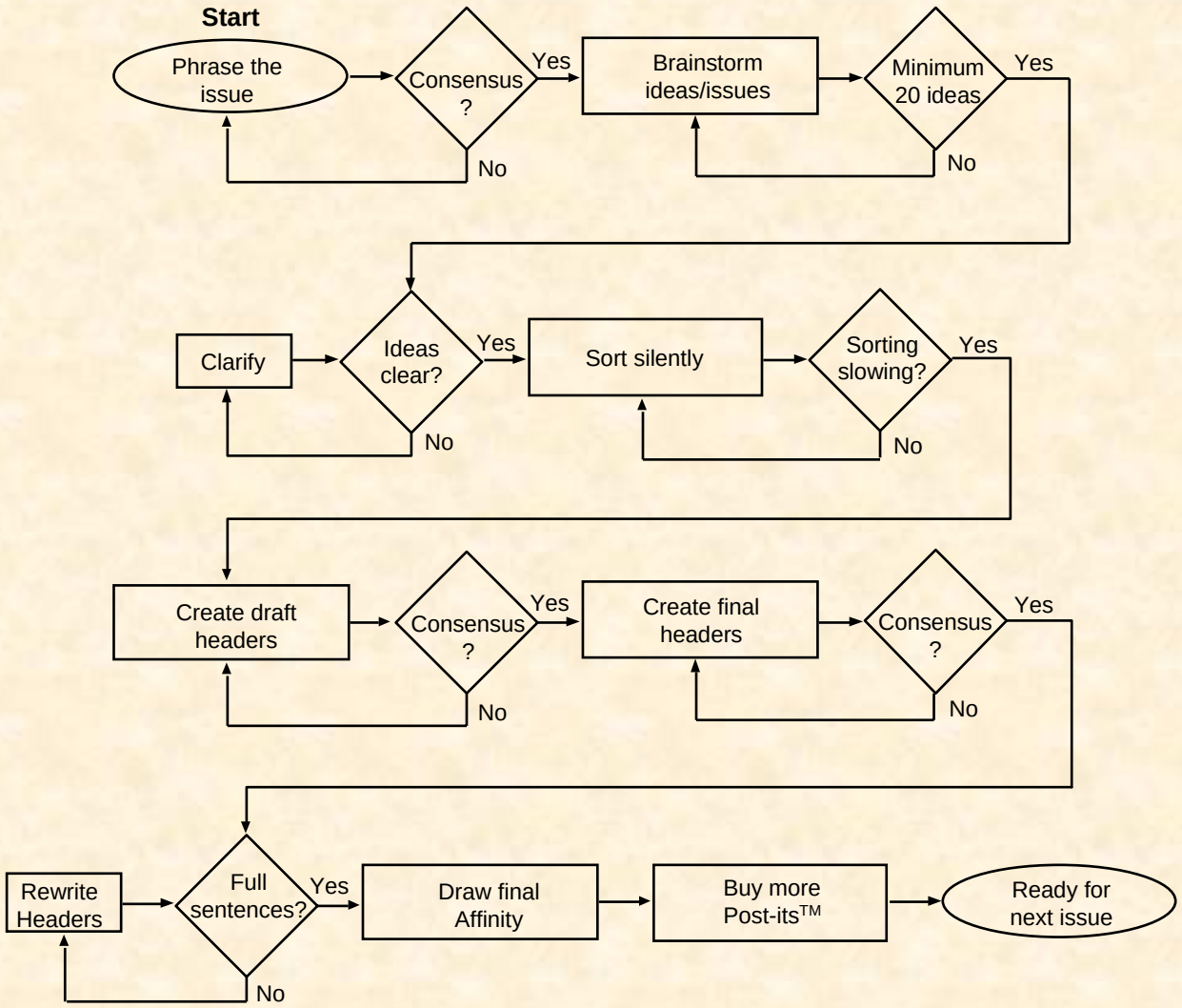
Constructing the Affinity

- Step 1 Phrase the Issue
- Step 2 Brainstorm Ideas
- Step 3 Sort Ideas in Silence
- Step 4 Create Summary Cards

Affinity Essentials

- Key Success Behaviors
  - Discuss, don't dominate
  - Suspend solutions until process is complete
  - Listen, listen, listen; keep your mind and ears engaged
  - Encourage everyone to make unusual connections among ideas

Steps at a Glance: Affinity



Step-by-Step Construction

– Step 1 Phrase the Issue

What are the issues involved in planning fun family vacations?

Step-by-Step Construction

– Step 2 Brainstorm Ideas

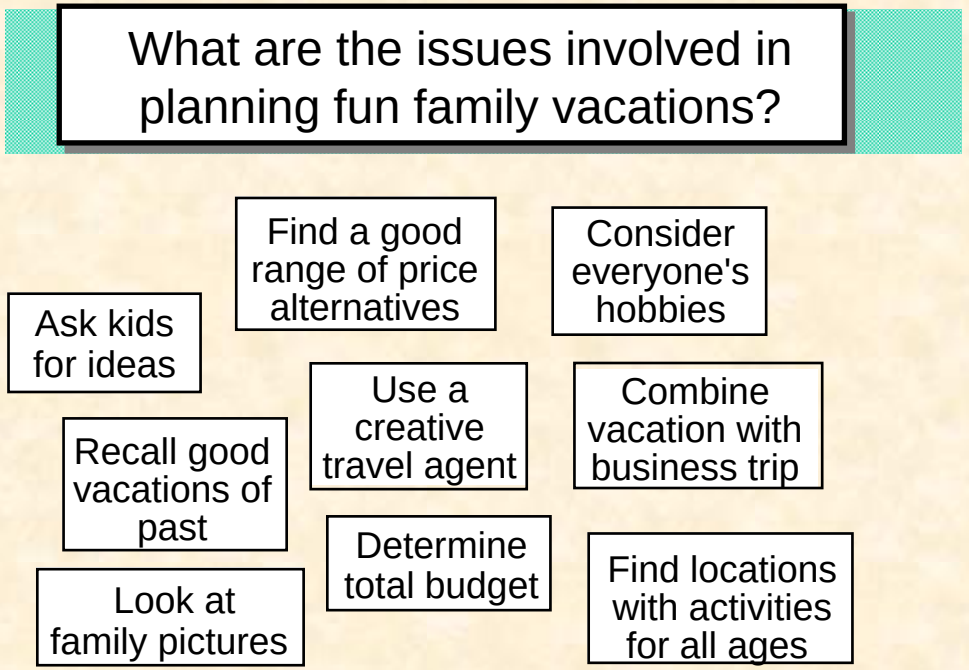


Illustration Note: There are 10 to 40 more ideas in a typical Affinity Diagram

Step-by-Step Construction

– Step 3 Sort Ideas in Silence

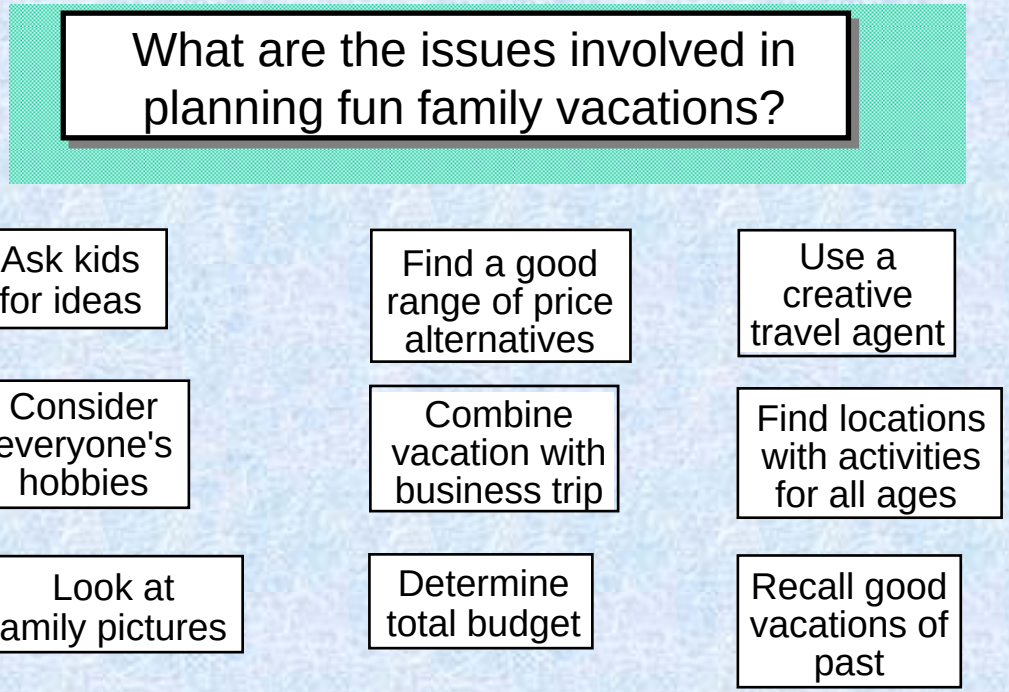


Illustration Note: There are 5 to 10 more groupings of ideas in a typical Affinity Diagram

Step-by-Step Construction

– Step 4 Create Summary Cards

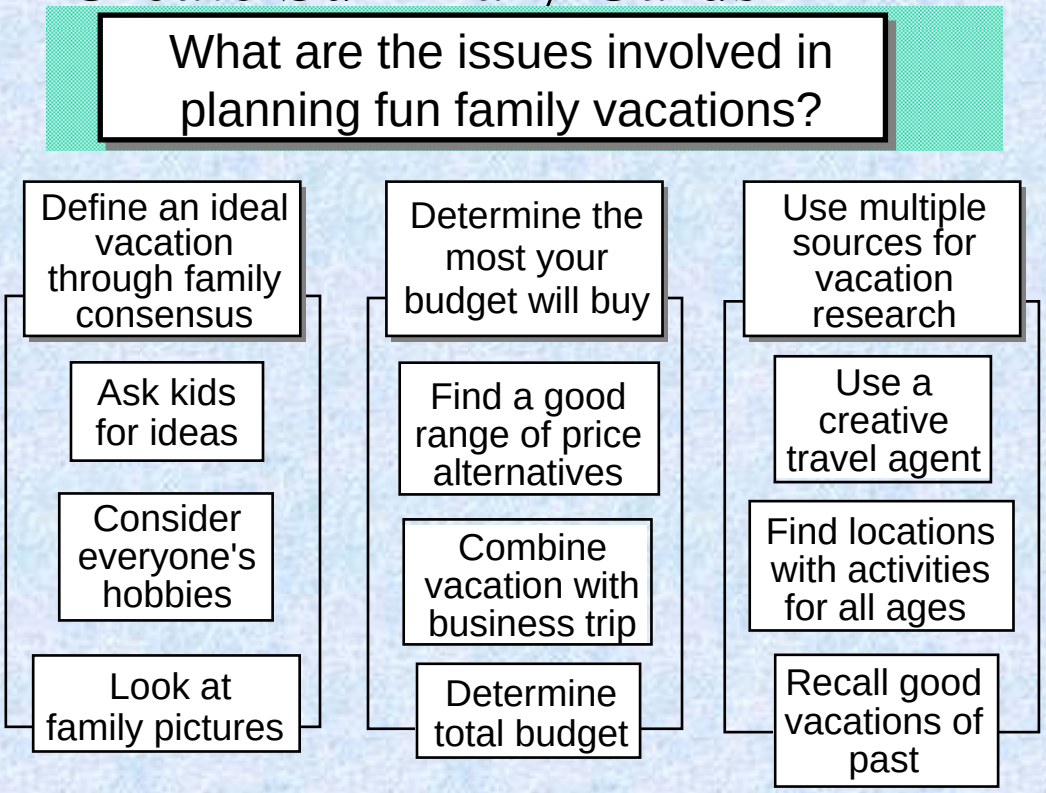
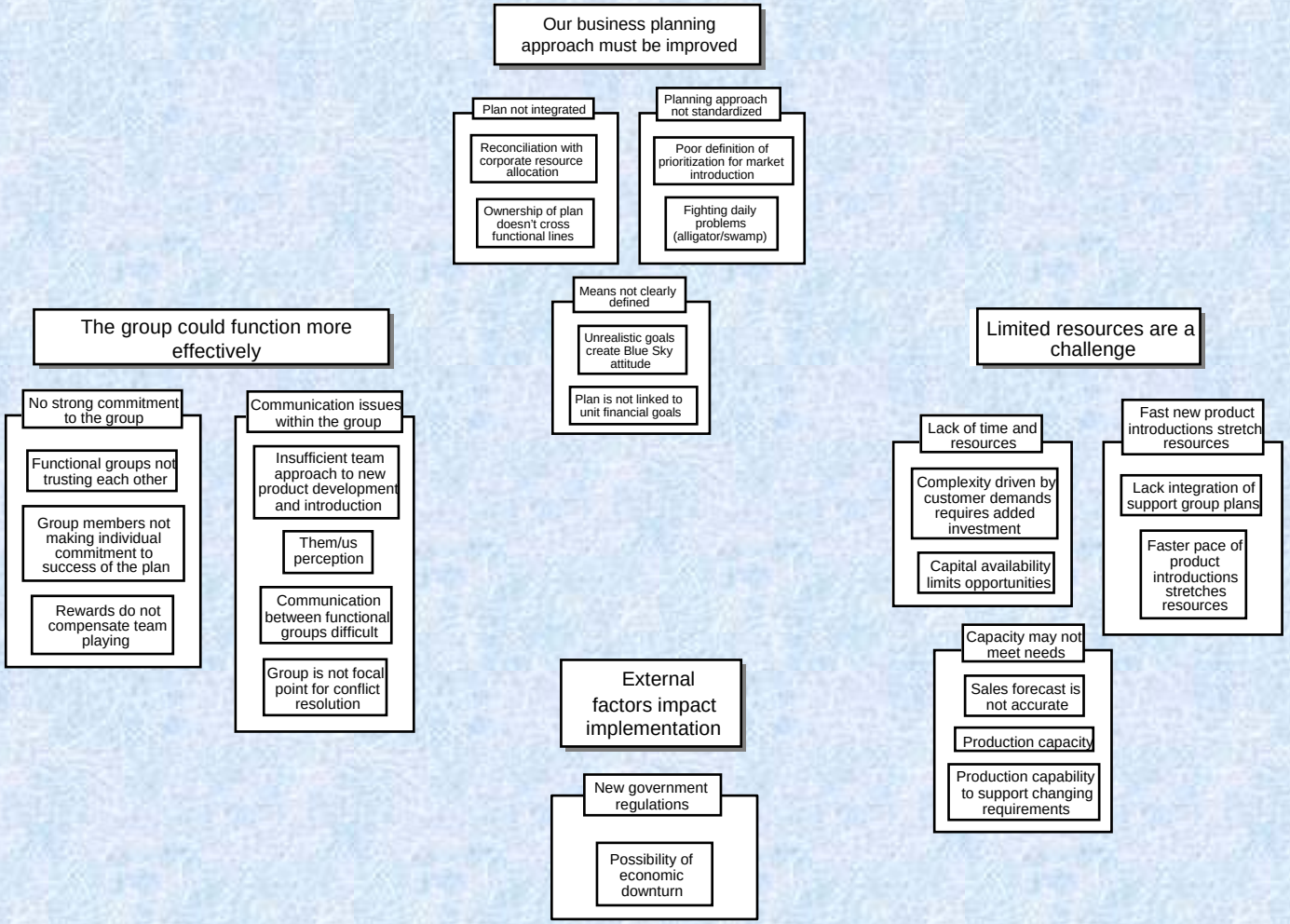


Illustration Note: There are 5 to 10 groupings of ideas in a typical Affinity. This is a partial Affinity.

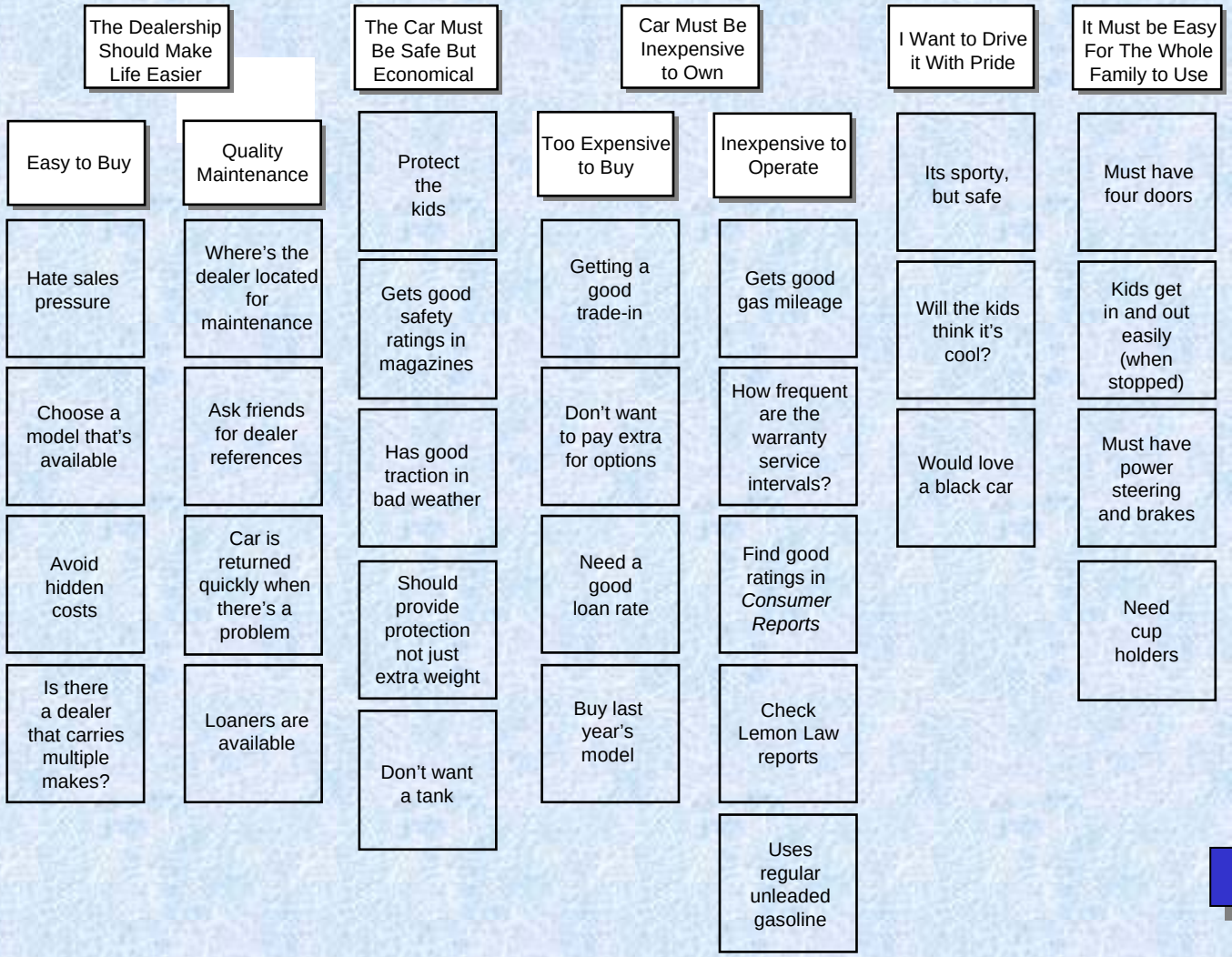
Affinity Example

Issues Surrounding Implementation of the Business Plan



Information provided courtesy of Goodyear

Affinity Example



Back

Pareto Charts

- **Vilfredo Pareto (1848-1923) Italian economist was the first to develop the 80/20 rule.**
- **20% of the population has 80% of the wealth**
- **A Pareto chart was first developed by Joseph Juran who adapted the histogram to be used with the 80/20 rule.**
- **Pareto charts identify and prioritize problems that need to be solved.**

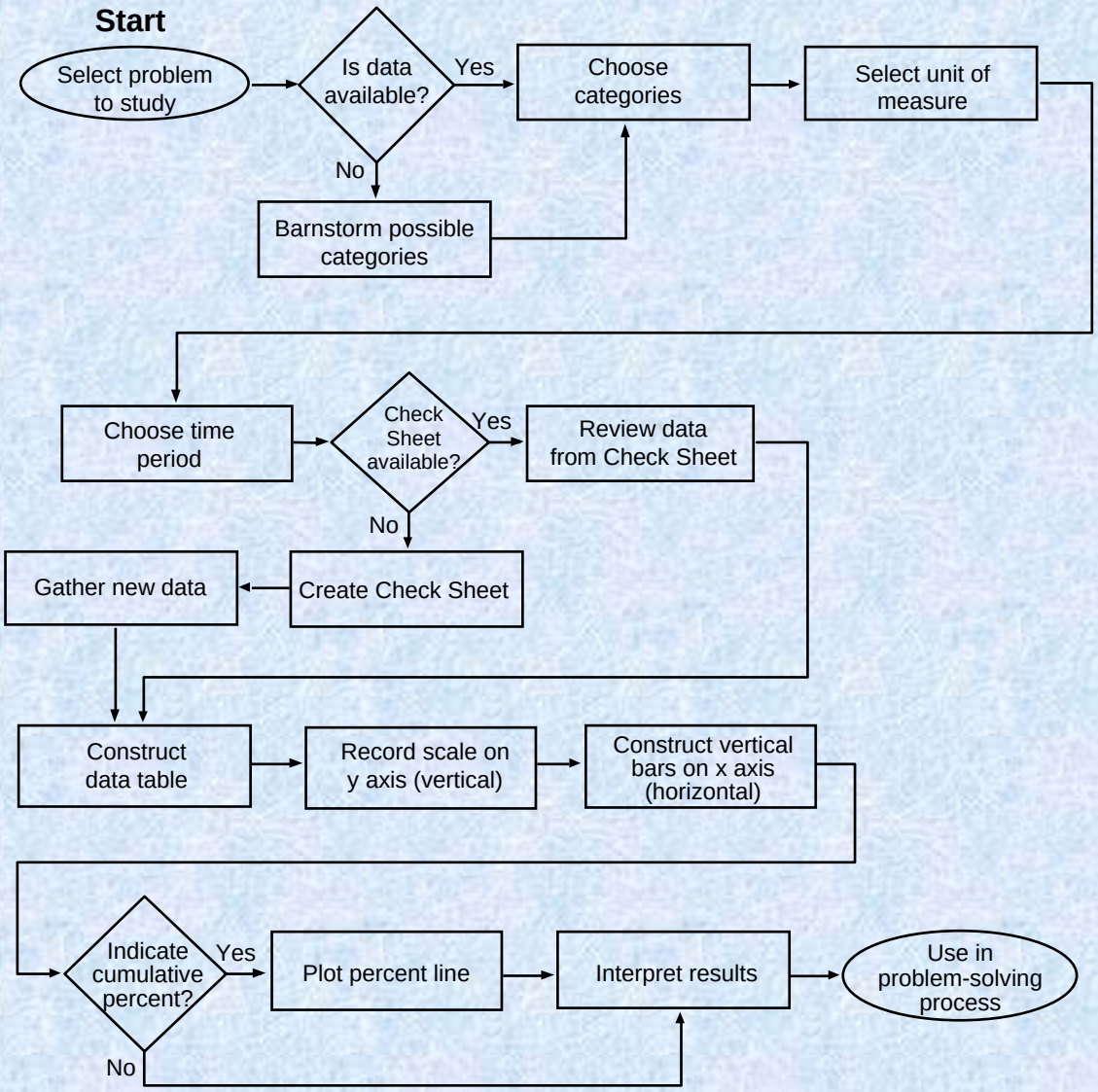
Constructing the Pareto Chart

- Step 1 Choose a Problem to Study
- Step 2 Choose Categories
- Step 3 Select a Unit of Measure
- Step 4 Choose a Time Period
- Step 5 Gather Data
- Step 6 Compare Data
- Step 7 Construct the Chart
- Step 8 Show Cumulative Percents
- Step 9 Interpret the Results

Pareto Chart Essentials

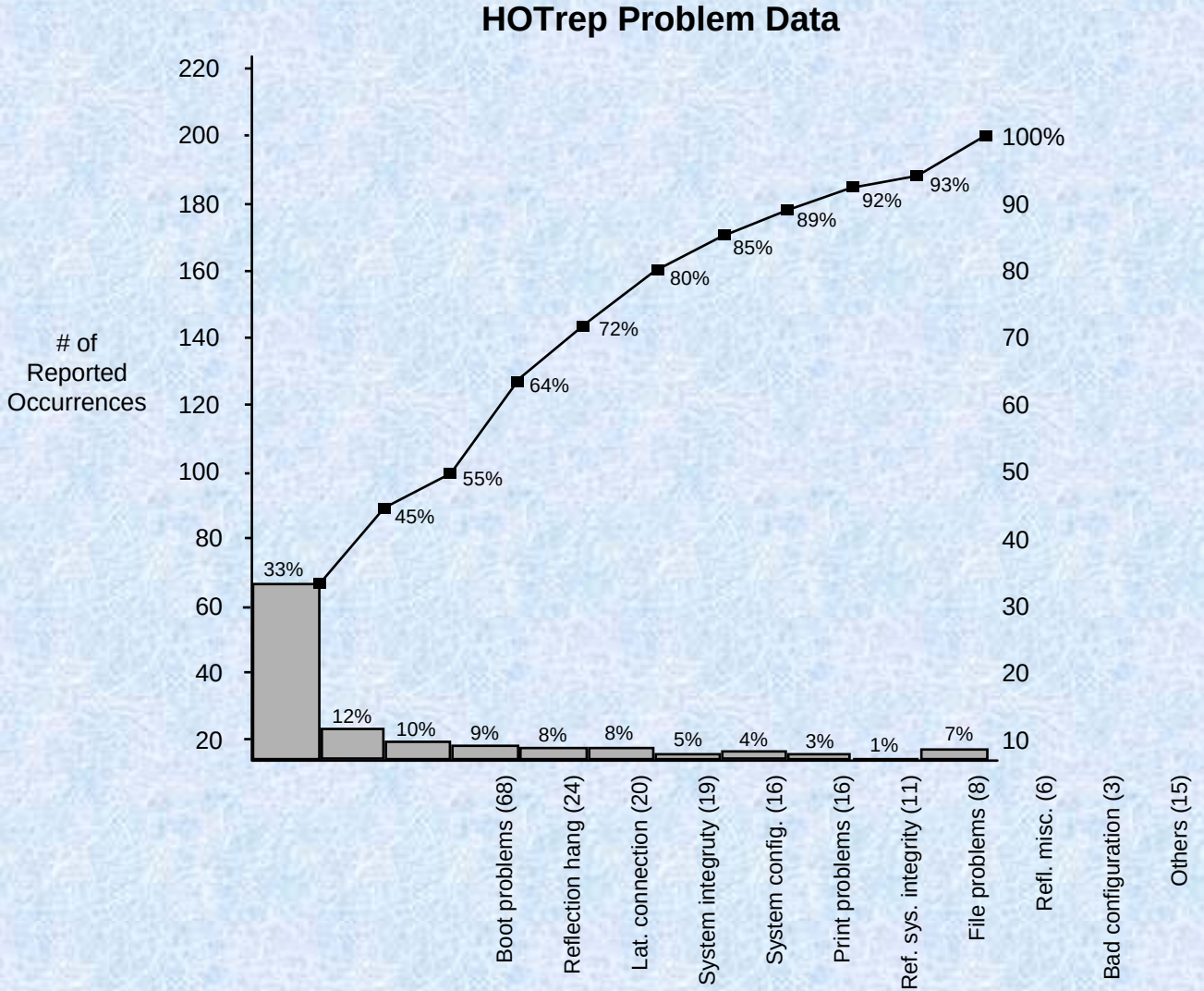
- Key Success Behaviors
  - Clarify the data collection plan
  - Collect data consistently
  - Use consistent legend and format
  - Explore Pareto variations

Steps at a Glance: Pareto



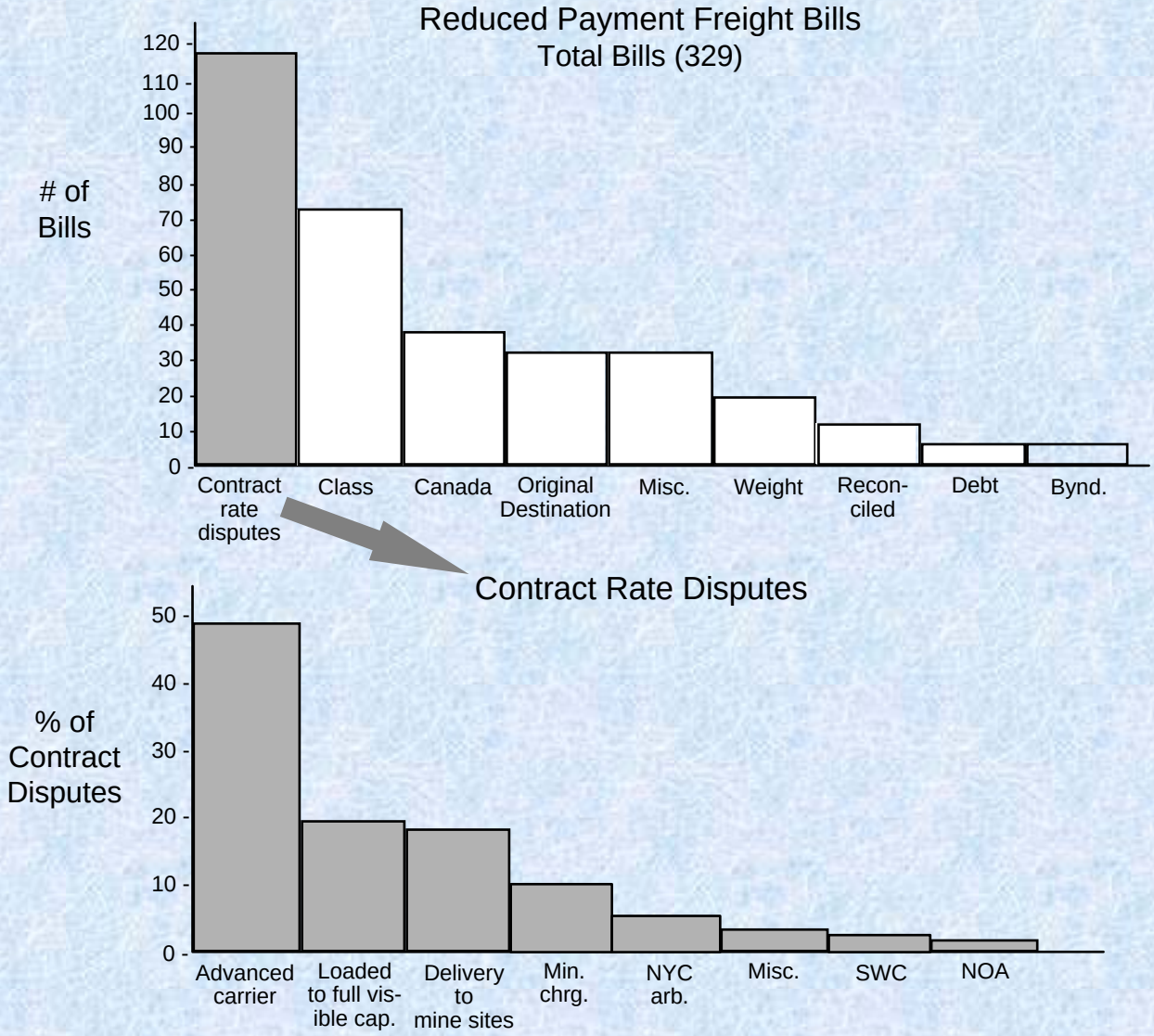
Step-by-Step Construction

- **Step 8** Show Cumulative Percents



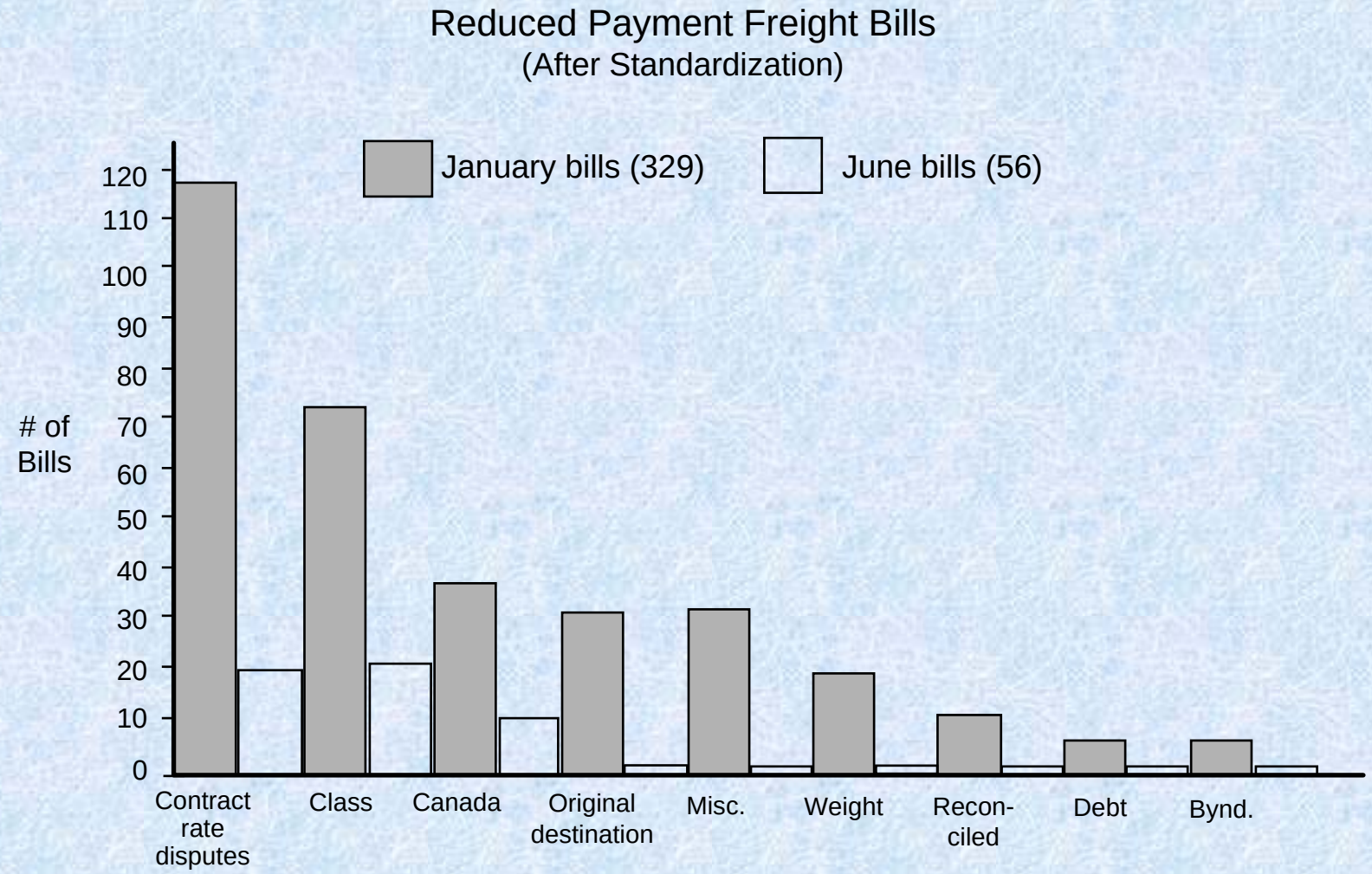
Information provided courtesy of SmithKline Beecham

Pareto Example



Information provided courtesy of Goodyear

Pareto Example



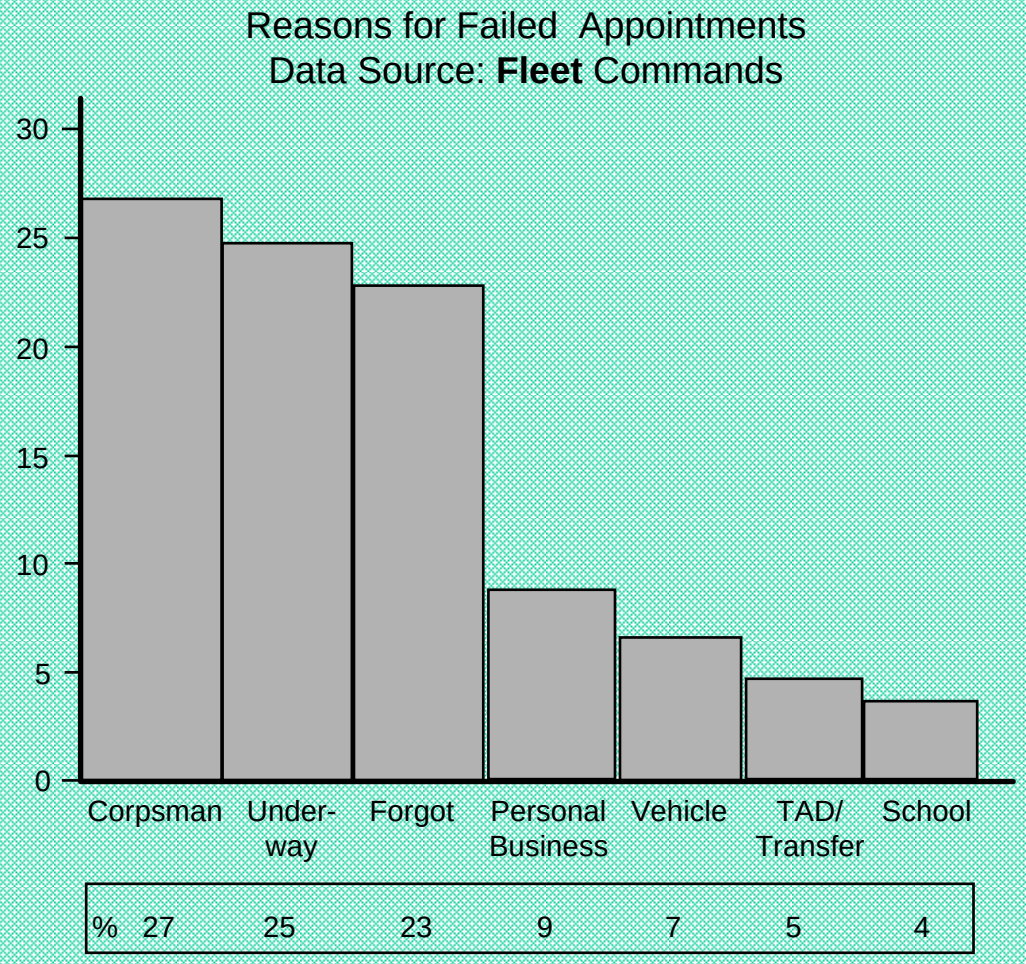
Information provided courtesy of Goodyear

Pareto Example

Reasons for Failed Appointments
Data Source: **Shore** Commands

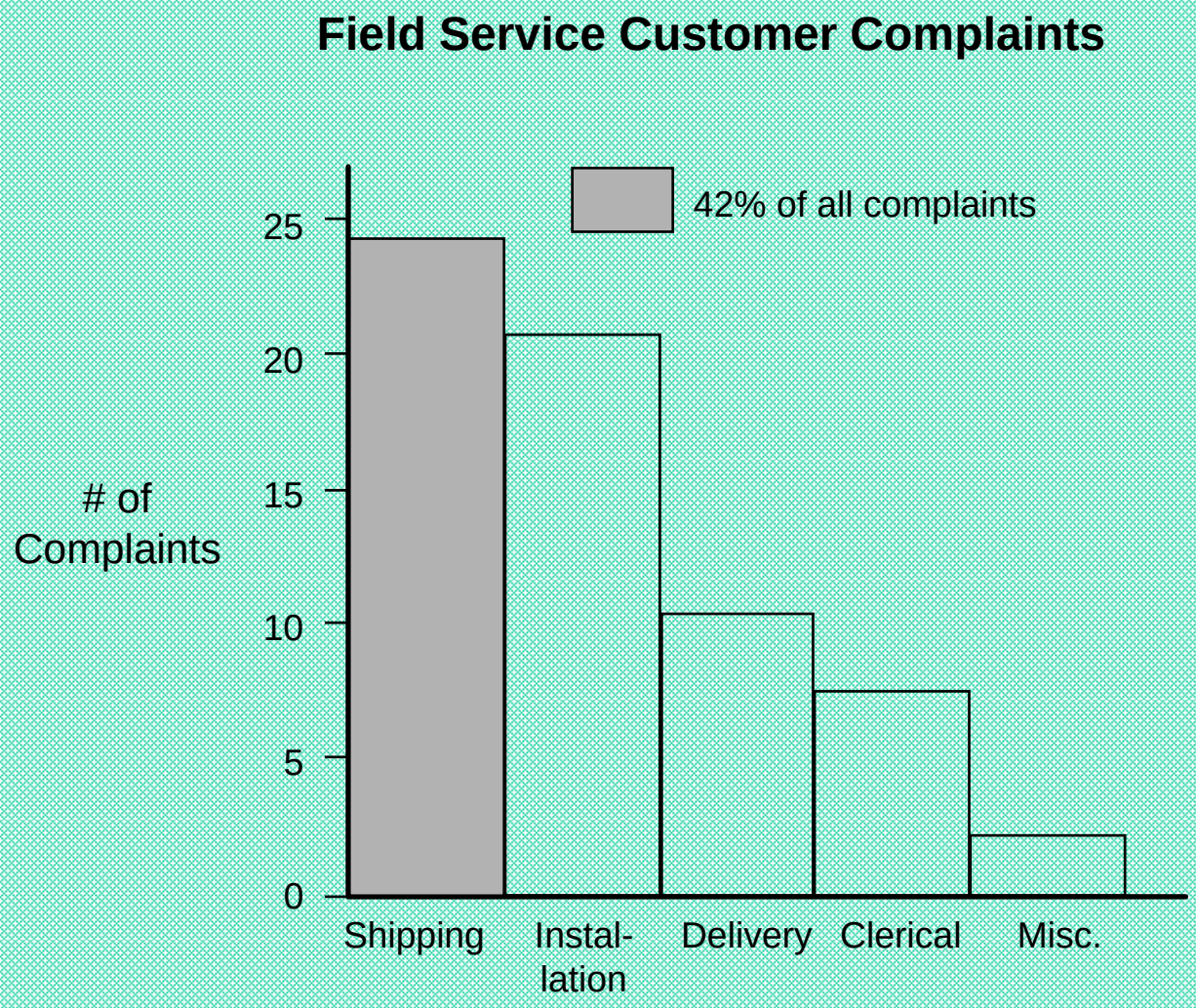
Information provided courtesy of U.S. Navy, Naval Dental Center, San Diego

Pareto Example

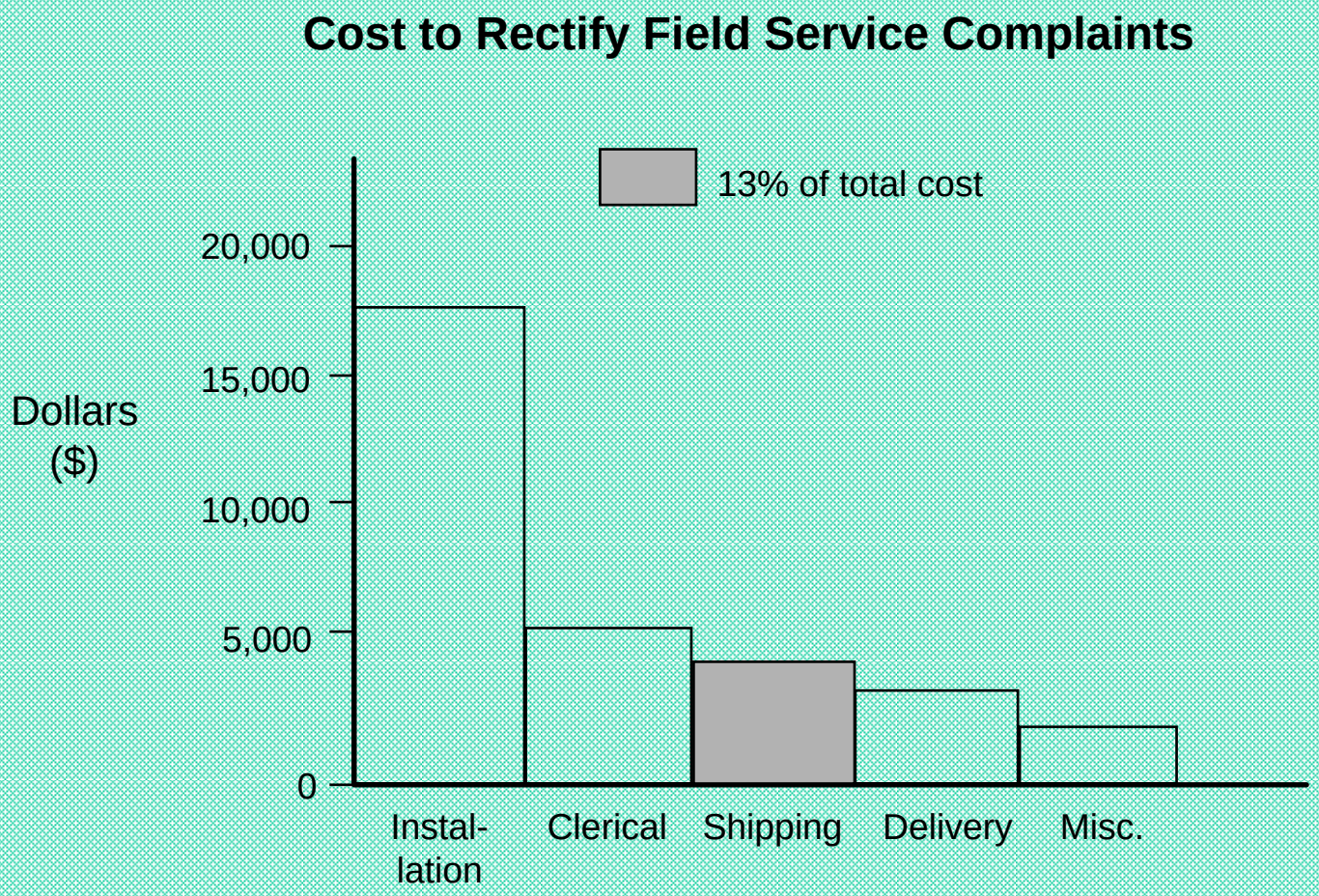


Information provided courtesy of U.S. Navy, Naval Dental Center, San Diego

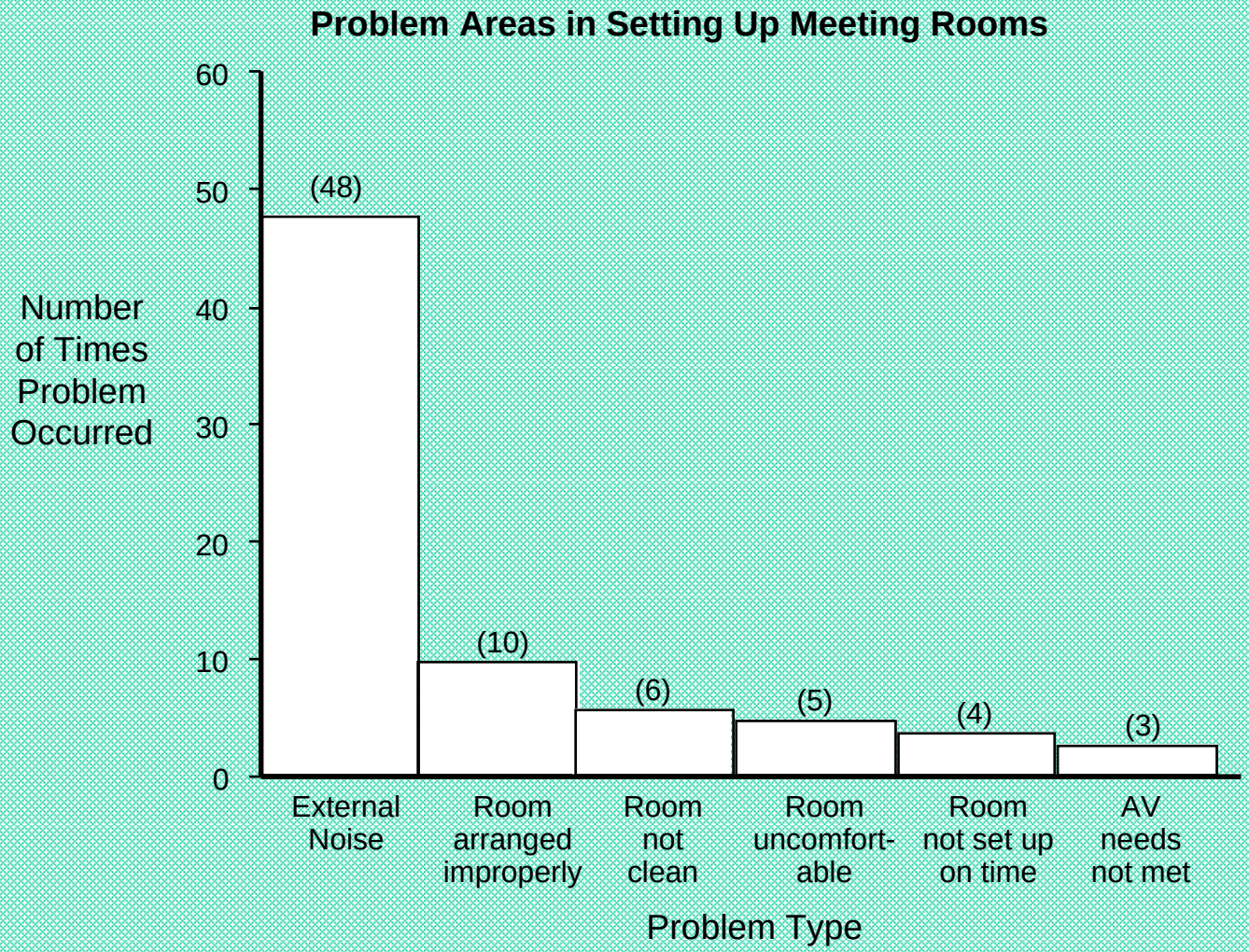
Pareto Example



Pareto Example



Pareto Example



Information provided courtesy of Sewickley Valley Hospital, PA

Back

PDPC (Tree Variation)

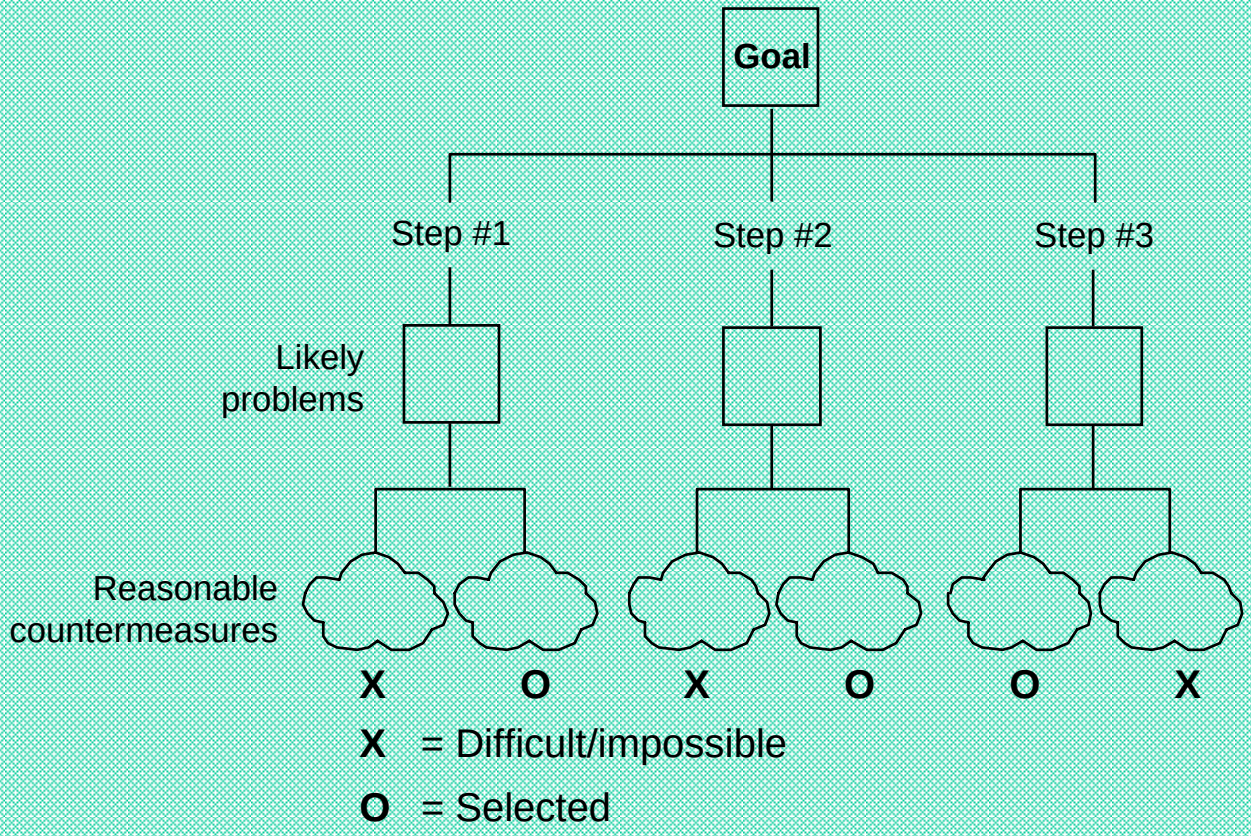
- Step 1 Assemble the Right Team
- Step 2 Determine Proposed Steps
- Step 3 Generate Likely Problems
- Step 4 Generate Reasonable Solutions
- Step 5 Choose Countermeasures

PDPC Essentials

- Key Success Behaviors
  - Keep the project steps that form the first level of the chart at the broadest level possible
  - Exercise creative thinking at all levels of the chart without losing touch with reality
  - Keep “what if’s” likely and the countermeasures reasonable
  - Always modify the original project steps to include the countermeasures that are selected

Step-by-Step Construction

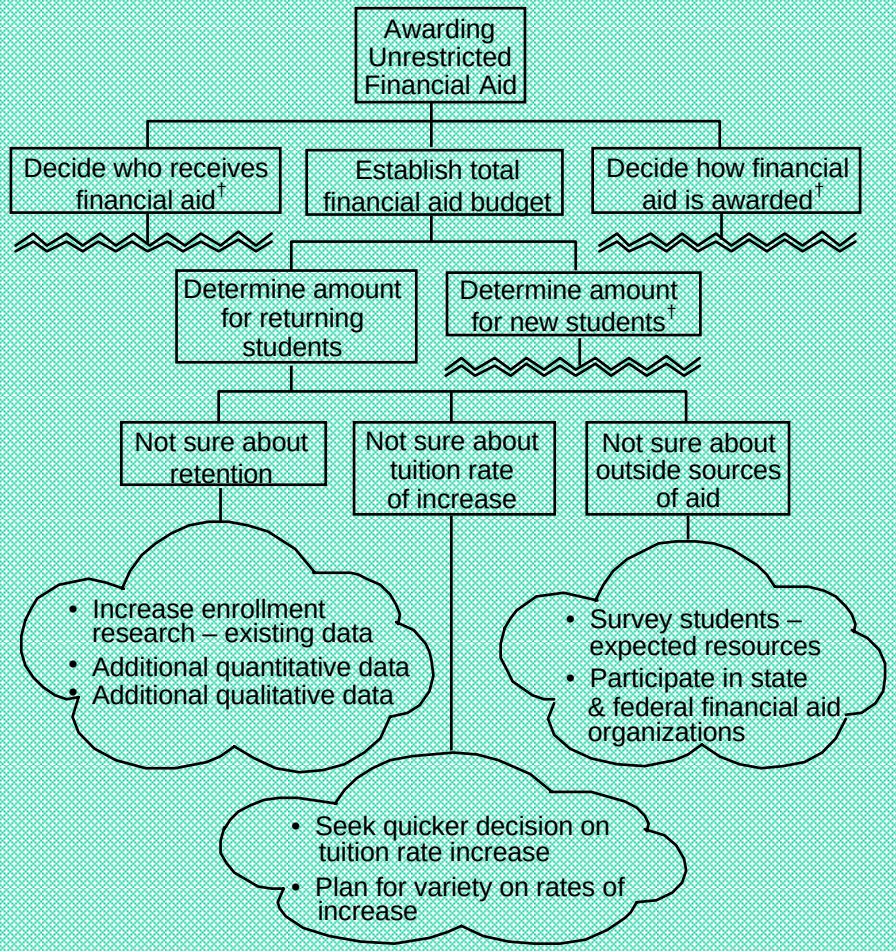
– Step 5 Choose Countermeasures



PDPC Example

Tree Variation

Awarding Unrestricted Financial Aid



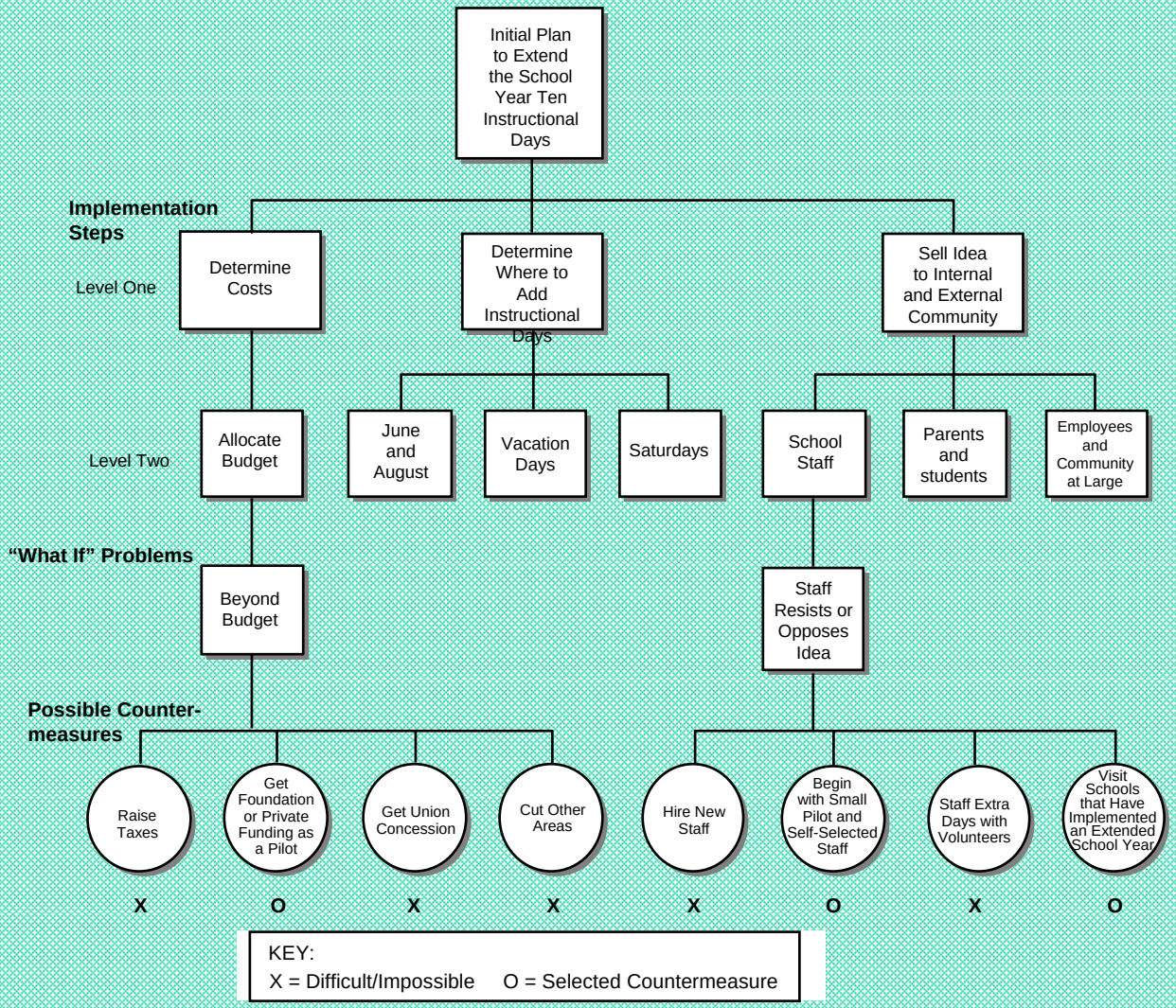
† Further information exists but is not shown

Information provided courtesy of St. John Fisher College

PDPC Example

A: Modified Tree Diagram

Extending the School Year by Ten Days



PDPC Example

B: Numbered Outline

Extending the School Year by Ten Days

Implementation Steps	1.0	Determine Costs
	1.1	Allocate Budget
	1.2	Get Budget
	2.0	Decide Where to Add Instructional Days
	2.1	Summer/June and August
	2.2	Vacation Days
	2.3	Saturdays
	3.0	Sell Idea to Internal and External Community
	3.1	School Staff
	3.2	Parents and Students
	3.3	Employer and Community at Large
"What If" Problems	1.1.1	Beyond Budget
	3.1.1	Staff Resists or Opposes Idea
Possible Countermeasures	X 1.1.1.1	Raise
	O 1.1.1.2	Get Foundation or Private Funding as a Pilot
	X 1.1.1.3	Get Union Concessions
	X 1.1.1.4	Cut Other Areas
	X 3.1.1.1	Hire New Staff
	O 3.1.1.2	Begin with Small Pilot and Self-Selected Staff
	X 3.1.1.3	Staff extra Days with Volunteers
	O 3.1.1.4	Visit Schools that Have Implemented Extended School

KEY:
X = Difficult/Impossible O = Selected Countermeasure

Back

Prioritization Matrix

Purpose

To prioritize tasks, issues, alternatives, etc., to aid in selecting which tasks, issues, alternatives to pursue.

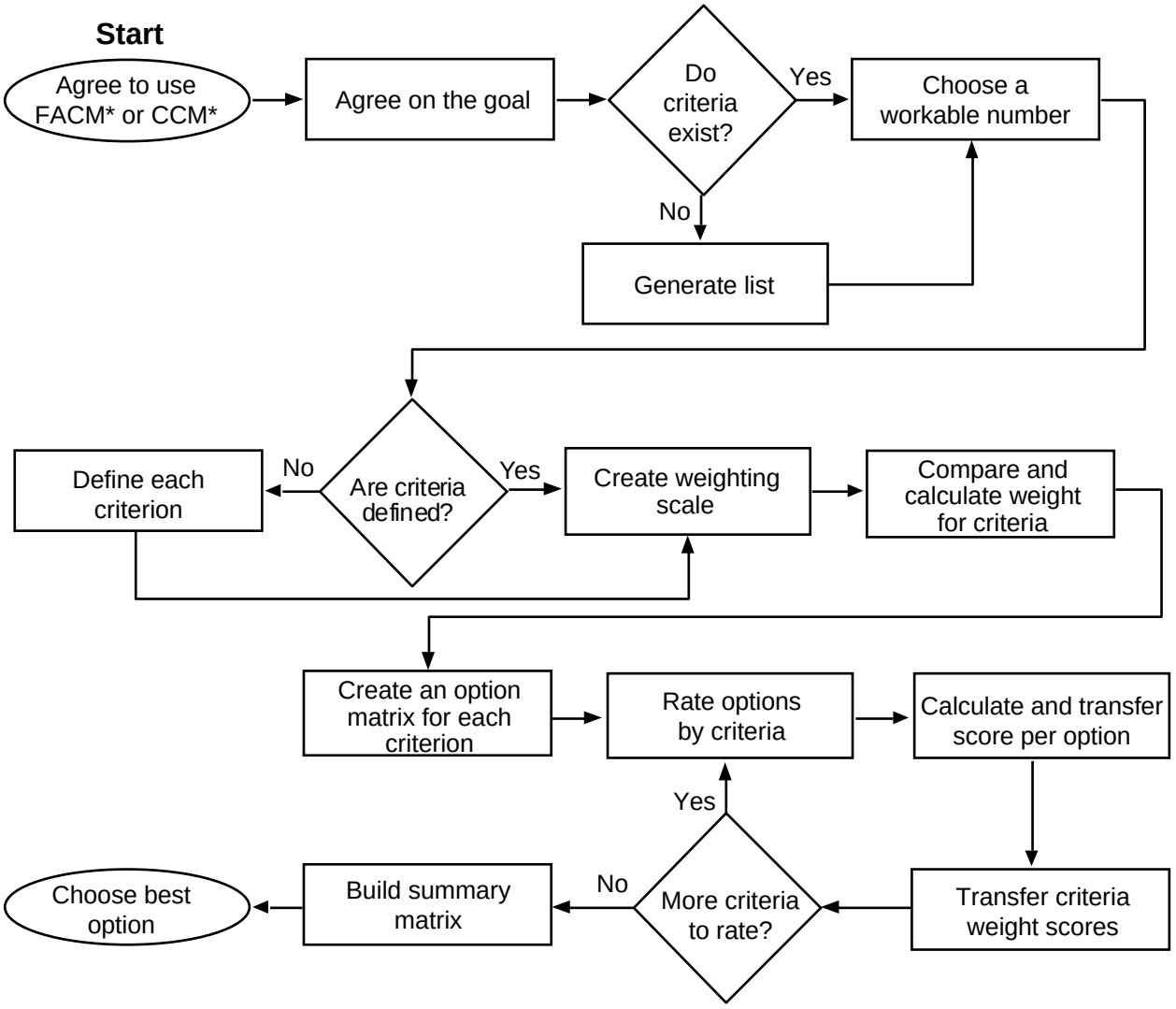
Constructing the Prioritization Matrices

- Step 1 Agree on the Goal
- Step 2 Agree on the Criteria
- Step 3 Weight Criteria
- Step 4 Rate Options by Criteria
- Step 5 Build A Summary Matrix
- Step 6 Choose the Best Options

Prioritization Matrices Essentials

- Key Success Behaviors
  - Make each decision independently, don't try to "build" patterns
  - Communicate your own logic, listen to another person's logic, be prepared to change your own
  - Work toward valuing each person's perspective, not simply tolerating it
  - Keep personal agendas personal; put your efforts into the team goal

Steps at a Glance: Prioritization Matrices



* FACM = Full Analytical Criteria Method

** CCM = Consensus Criteria Method

Step-by-Step Construction

– Step 1 Agree on the Goal

Choose the most enjoyable vacation
for the whole family

Step-by-Step Construction

– Step 2 Agree on the Criteria

- **Cost**
- **Educational value**
- **Diverse activity**
- **Escape reality**

Step-by-Step Construction

– Step 3 Weight Criteria

Full Analytical Criteria Method

Criterion vs. Criterion

Criteria / Criteria	Cost	Educ. value	Diverse activity	Escape reality	Row Total	Relative Decimal Value (RT ÷ GT)
Cost		1/5	1/10	5	5.3	.15
Educ. value	5		1/5	5	10.2	.28
Diverse activity	10	5		5	20	.55
Escape reality	1/5	1/5	1/5		.60	.02
				Grand Total	36.1	

1 = Equally important
5 = More important
10 = Much more important
1/5 = Less Important
1/10 = Much less important

Row Total
Rating scores added

Grand Total
Row totals added

Relative Decimal Value
Each row total ÷ by the grand total

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Full Analytical Criteria Method

Options vs. Each Criterion (Cost Criterion)

Cost	Disney World	Gettys-burg	New York City	Uncle Henry's	Row Total	Relative Decimal Value (RT ÷ GT)
Disney World		1/5	5	1/10	5.3	.12
Gettys-burg	5		10	1/5	15.2	.33
New York City	1/5	1/10		1/10	.40	.01
Uncle Henry's	10	5	10		25	.54
				Grand Total	45.9	1.00

1 = Equal cost
5 = Less expensive
10 = Much less expensive
1/5 = More expensive
1/10 = Much more expensive

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Full Analytical Criteria Method

Options vs. Each Criterion (Educational Value)

Educational value	Disney World	Gettys-burg	New York City	Uncle Henry's	Row Total	Relative Decimal Value (R ÷ GT)
Disney World		1/5	1/5	10	10.4	.24
Gettys-burg	5		1	10	16	.375
New York City	5	1		10	16	.375
Uncle Henry's	1/10	1/10	1/10		.30	.01
				Grand Total	42.7	1.00

1 = Equal educational value
5 = More educational value
10 = Much more educational value
1/5 = Less educational value
1/10 = Much less educational value

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Full Analytical Criteria Method

Options vs. Each Criterion (Diverse Activity)

Diverse activity	Disney World	Gettys-burg	New York City	Uncle Henry's	Row Total	Relative Decimal Value (RT ÷ GT)
Disney World		10	1/5	10	20.2	.40
Gettys-burg	1/10		1/10	5	5.2	.10
New York City	5	10		10	25	.49
Uncle Henry's	1/10	1/5	1/10		.40	.01
				Grand Total	50.8	1.00

1 = Equally diverse activity
5 = More diverse activity
10 = Much more diverse activity
1/5 = Less diverse activity
1/10 = Much less diverse activity

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Full Analytical Criteria Method

Options vs. Each Criterion (Escape Reality)

Escape reality	Disney World	Gettys-burg	New York City	Uncle Henry's	Row Total	Relative Decimal Value (RT ÷ GT)
Disney World		10	10	10	30	.65
Gettys-burg	1/10		5	5	10.1	.22
New York City	1/10	1/5		5	5.3	.12
Uncle Henry's	1/10	1/5	1/5		.50	.01
				Grand Total	45.9	1.00

1 = Equal escape from reality
5 = Greater escape from reality
10 = Much greater escape from reality
1/5 = Less of an escape from reality
1/10 = Much less of an escape from reality

Step-by-Step Construction

– Step 5 Build A Summary Matrix

Full Analytical Criteria Method

Summary Matrix - Options vs. All Criteria

Criteria / Optns.	Cost (.15)	Educa-tional value (.28)	Diverse activity (.55)	Escape reality (.02)	Row Total	Relative Decimal Value (RT ÷ GT)
Disney World	.12 x .15 (.02)	.24 x .28 (.07)	.40 x .55 (.22)	.65 x .02 (.01)	.32	.32
Gettys-burg	.33 x .15 (.05)	.37 x .28 (.10)	.10 x .55 (.06)	.22 x .02 (0)	.22	.22
New York City	.01 x .15 (0)	.37 x .28 (.10)	.49 x .55 (.27)	.12 x .02 (0)	.37	.38
Uncle Henry's	.54 x .15 (.08)	.01 x .28 (0)	.01 x .55 (.01)	.01 x .02 (0)	.09	.09
				Grand Total	1.00	

.54 (from Step 4 matrix) x .15 (from Step 3 matrix)

(.08)
Option score

Step-by-Step Construction

– Step 3 Weight Criteria

Consensus Criteria Method

Criteria Matrix

Members / Criteria	Mom	Dad	Rick	Karen	Row Total Weight
Cost	.25	.10	.10	.30	.75
Educa-tional value	.15	.45	.25	.20	1.05
Diverse activity	.50	.20	.45	.40	1.55
Escape reality	.10	.25	.20	.10	.65
Total	1.00	1.00	1.00	1.00	4.0

Each column represents a value of 1.00 distributed across the criteria.

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Consensus Criteria Method

Options vs. Each Criterion (Cost)

Members / Options	Mom	Dad	Rick	Karen	Total	Rank
Disney World	2	2	2	2	8	2
Gettys-burg	3	3	3	2	11	3
New York City	1	1	1	1	4	1
Uncle Henry's	4*	4	4	4	16	4

*Doesn't account for the cost of marriage counseling after the week at Uncle Henry's.

1 = Most expensive

4 = Least expensive

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Consensus Criteria Method

Options vs. Each Criterion (Educational Value)

Members / Options	Mom	Dad	Rick	Karen	Total	Rank
Disney World	2	2	3	3	10	2
Gettys-burg	3	4	2	2	11	3
New York City	4	3	4	4	15	4
Uncle Henry's	1	1	1	1	4	1

1 = Least educational value
4 = Most educational value

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Consensus Criteria Method

Options vs. Each Criterion (Diverse Activity)

Members / Options	Mom	Dad	Rick	Karen	Total	Rank
Disney World	3	4	3	3	13	3
Gettys-burg	2	2	2	2	8	2
New York City	4	3	4	4	15	4
Uncle Henry's	1	1	1	1	4	1

1 = Least diverse activity

4 = Most diverse activity

Step-by-Step Construction

– Step 4 Rate Options by Criteria

Consensus Criteria Method

Options vs. Each Criterion (Escape Reality)

Members / Options	Mom	Dad	Rick	Karen	Total	Rank
Disney World	4	3	4	3	14	4
Gettys-burg	3	4	2	2	11	3
New York City	2	1	3	4	10	2
Uncle Henry's*	1	2	1	1	5	1

* Uncle Henry hasn't touched reality in years.

1 = Least escape reality

4 = Most escape reality

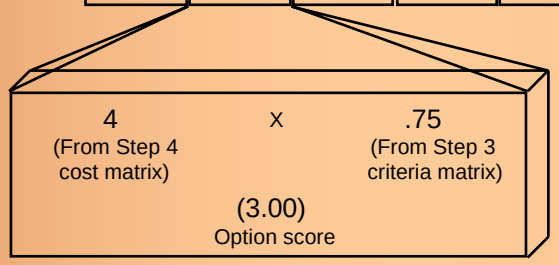
Step-by-Step Construction

– Step 5 Build A Summary Matrix

Consensus Criteria Method

Summary Matrix
Options vs. All Criteria

Criteria / Options	Cost (.75)	Educa-tional value (1.05)	Diverse activity (1.55)	Escape reality (.65)	Row Total	Rank
Disney World	2 x .75 (1.50)	2 x 1.05 (2.10)	3 x 1.55 (4.65)	4 x .65 (2.60)	10.85	3
Gettys-burg	3 x .75 (2.25)	3 x 1.05 (3.15)	2 x 1.55 (3.10)	3 x .65 (1.95)	10.45	2
New York City	1 x .75 (.75)	4 x 1.05 (4.20)	4 x 1.55 (6.20)	2 x .65 (1.30)	12.45	4
Uncle Henry's	4 x .75 (3.00)	1 x 1.05 (1.05)	1 x 1.55 (1.55)	1 x .65 (.65)	6.25	1



1 = Lowest rated option

4 = Highest rated option

Prioritization Matrices Example

Choosing a Standard Corporate Spreadsheet Program

① Weighting criteria (described in Step 3)

This is a portion of a full matrix with 14 criteria in total.

Criteria	Best use of hardware	Ease of use	Maximum functionality	Best performance	Total (14 criteria)	Relative decimal value
Best use of hardware		.20	.10	.20	3.7	.01
Ease of use	5.0		.20	.20	35.4	.08
Maximum functionality	10.0	5.0		5.0	69.0	.17
Best performance	5.0	5.0	.20		45.2	.11
				Grand Total (14 criteria)	418.1	

Information provided courtesy of Novacor Chemicals

Prioritization Matrices Example

Choosing a Standard Corporate Spreadsheet Program

② Comparing options (described in Step 4)

These are just 2 of 14 matrices.

Best integration - internal	Program A	Program B	Program C	Total	Relative Decimal Value
Program A		1.00	1.00	2.00	.33
Program B	1.00		1.00	2.00	.33
Program C	1.00	1.00		2.00	.33
			Grand Total	6.00	

Lowest ongoing cost	Program A	Program B	Program C	Total	Relative Decimal Value
Program A		.10	.20	.30	.02
Program B	10.00		5.00	15.00	.73
Program C	5.00	.20		5.20	.25
			Grand Total	20.50	

Information provided courtesy of Novacor Chemicals

Prioritization Matrices Example

Choosing a Standard Corporate Spreadsheet Program

③ Summarize Option Ratings Across All Criteria
(described in Step 5)

This is a portion of a full matrix with 14 criteria in total.

Criteria / Options	Easy to use (.08)	Best integration int. (.9)	Lowest ongoing cost (.08)	Total	Relative Decimal Value
Program A	.03 (.01)	.33 (.03)	.02 (0)	.16	.18
Program B	.48 (.04)	.33 (.03)	.73 (.06)	.30	.33
Program C	.48 (.04)	.33 (.03)	.25 (.02)	.44	.49
			Grand Total	.90	

Information provided courtesy of Novacor Chemicals

Back

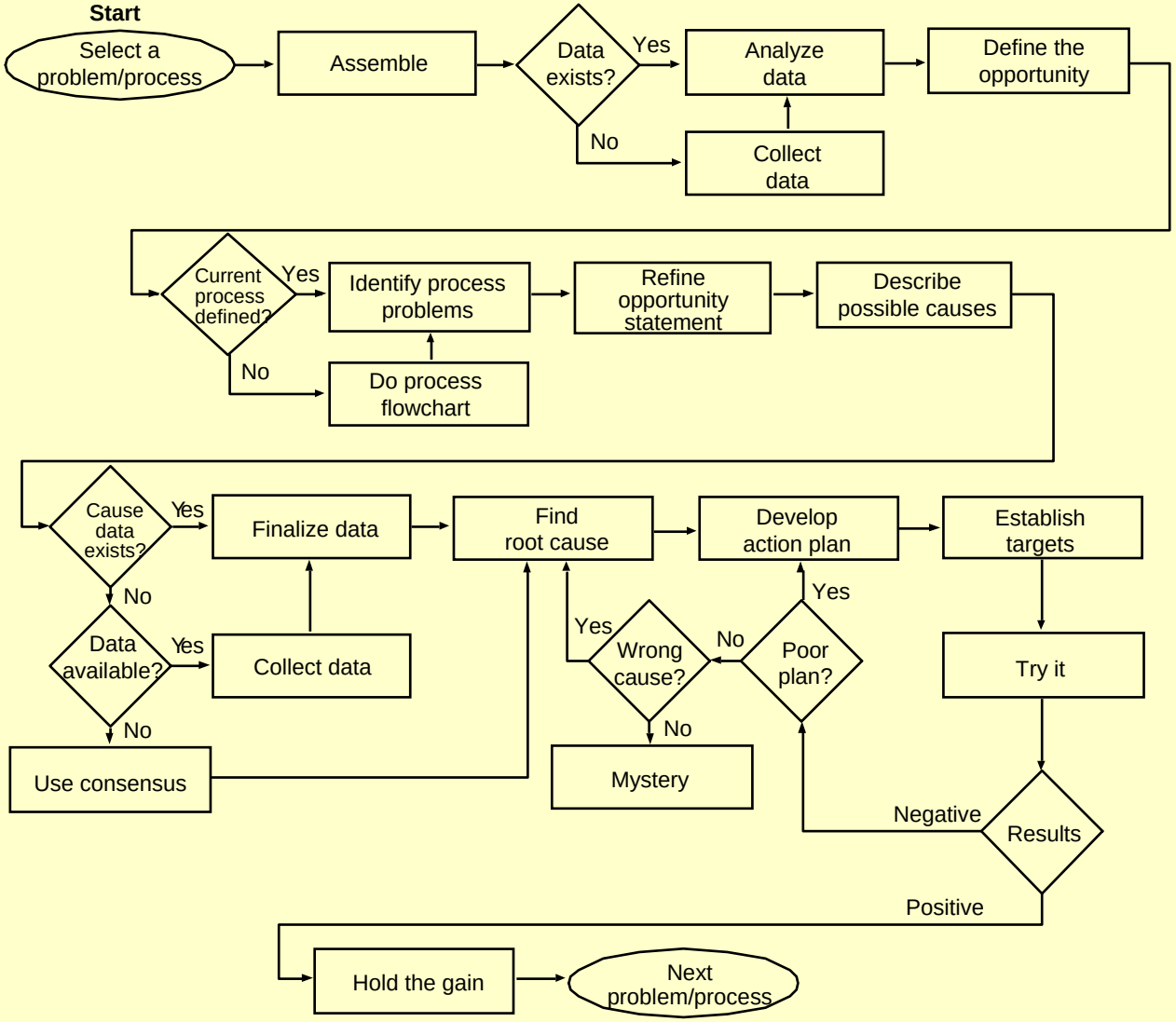
Steps of the PS/PI Model

- Step 1 Select a Problem/Process (Plan)
- Step 2 Define Current Process
- Step 3 Find Root Causes
- Step 4 Develop Action Plans
- Step 5 Try It (Do)
- Step 6 Review Results (Check)
- Step 7 Make Changes/Hold Gains (Act)

PS/PI Model Essentials

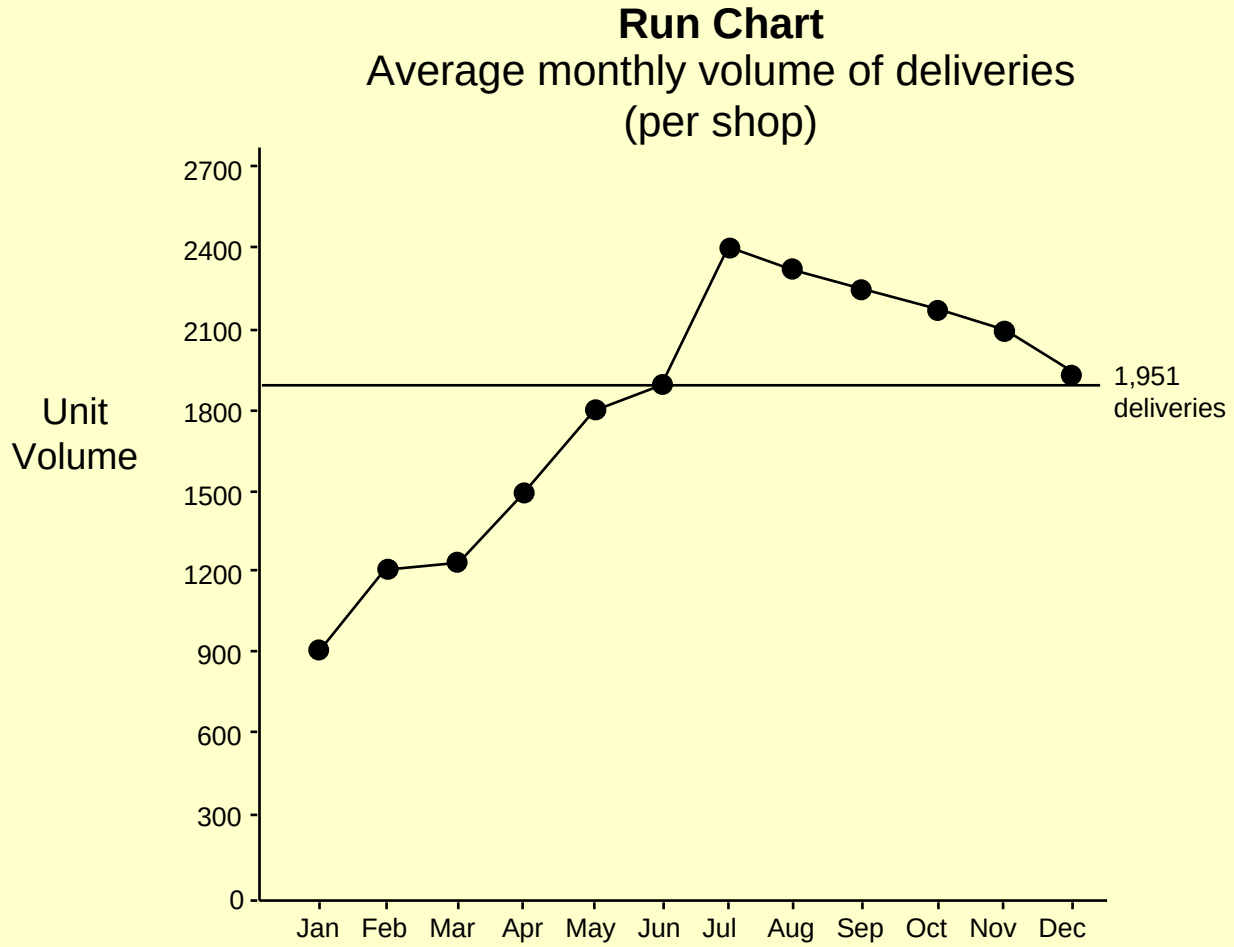
- Key Success Behaviors
  - Treat both data and knowledge as resources to be tapped, not weapons to be wielded
  - Get agreement and support for the goal to prevent unnecessary team conflict
  - A simple “What do you think?” usually opens up a quiet team member

Steps at a Glance: PS/PI Model



Step-by-Step: Using the PS/PI Model

- **Step 1 Select a Problem (Plan)**



Step-by-Step: Using the PS/PI Model

- **Step 1 Select a Problem (Plan)**

Pareto Chart

Types of customer complaints
Total=2520 October-December
(across 6 shops)

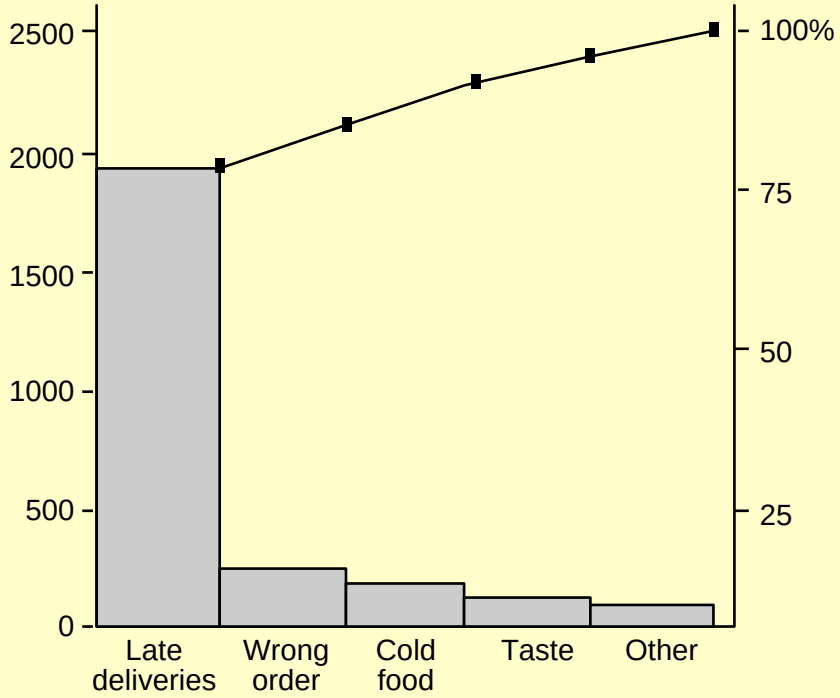
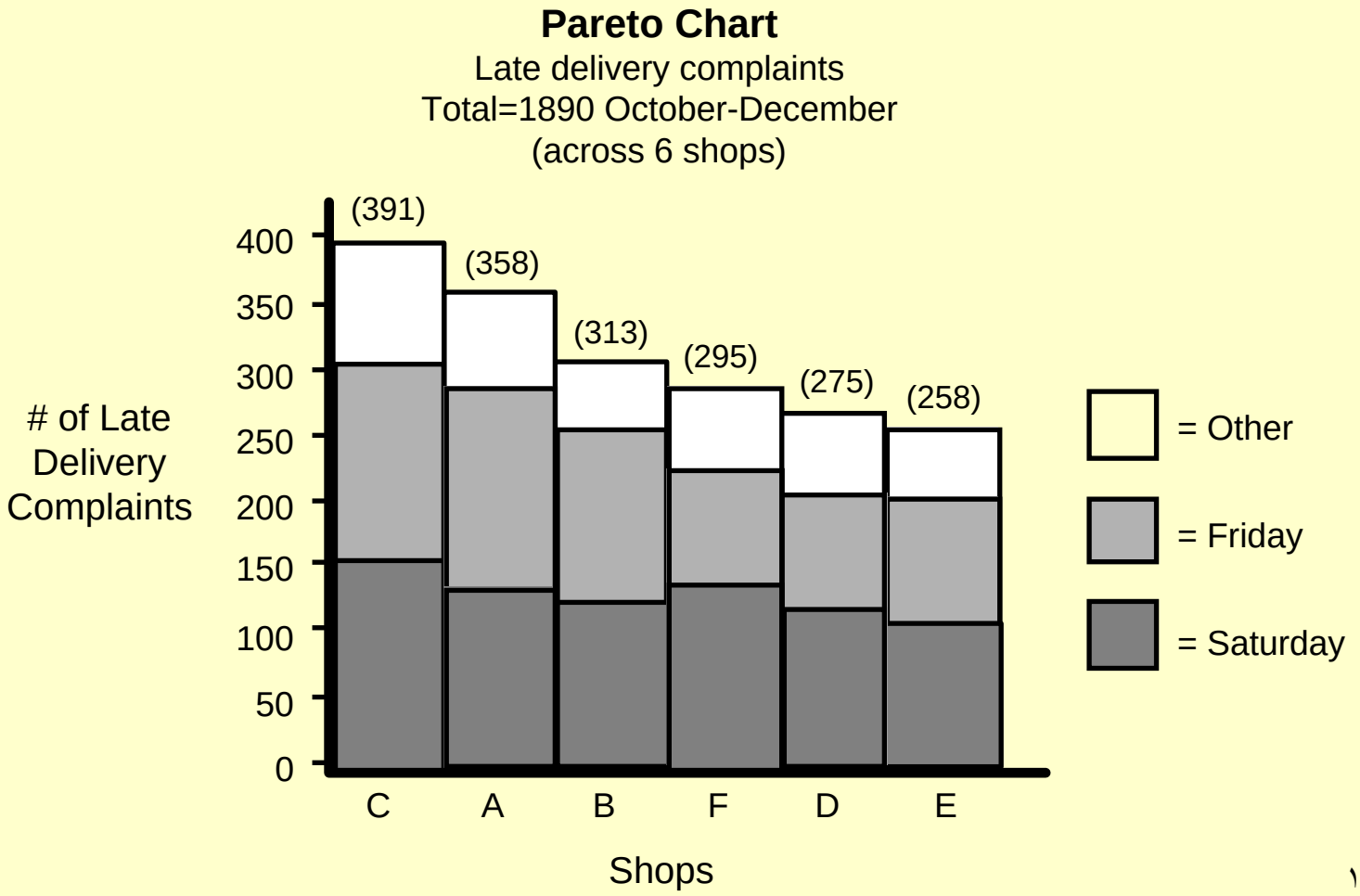


Illustration note: Delivery time was defined by the total time from when the order was placed to when the customer received it.

Step-by-Step: Using the PS/PI Model

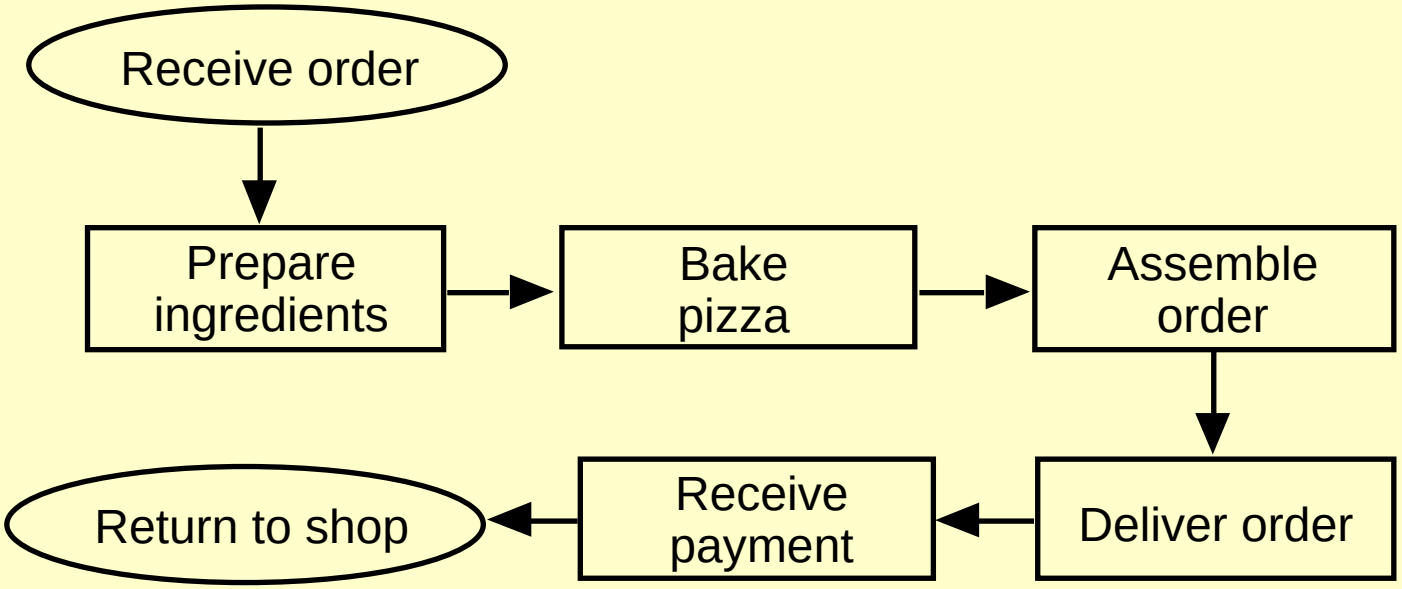
- **Step 1 Select a Problem (Plan)**



Step-by-Step: Using the PS/PI Model

- **Step 2 Define Current Process (Plan)**

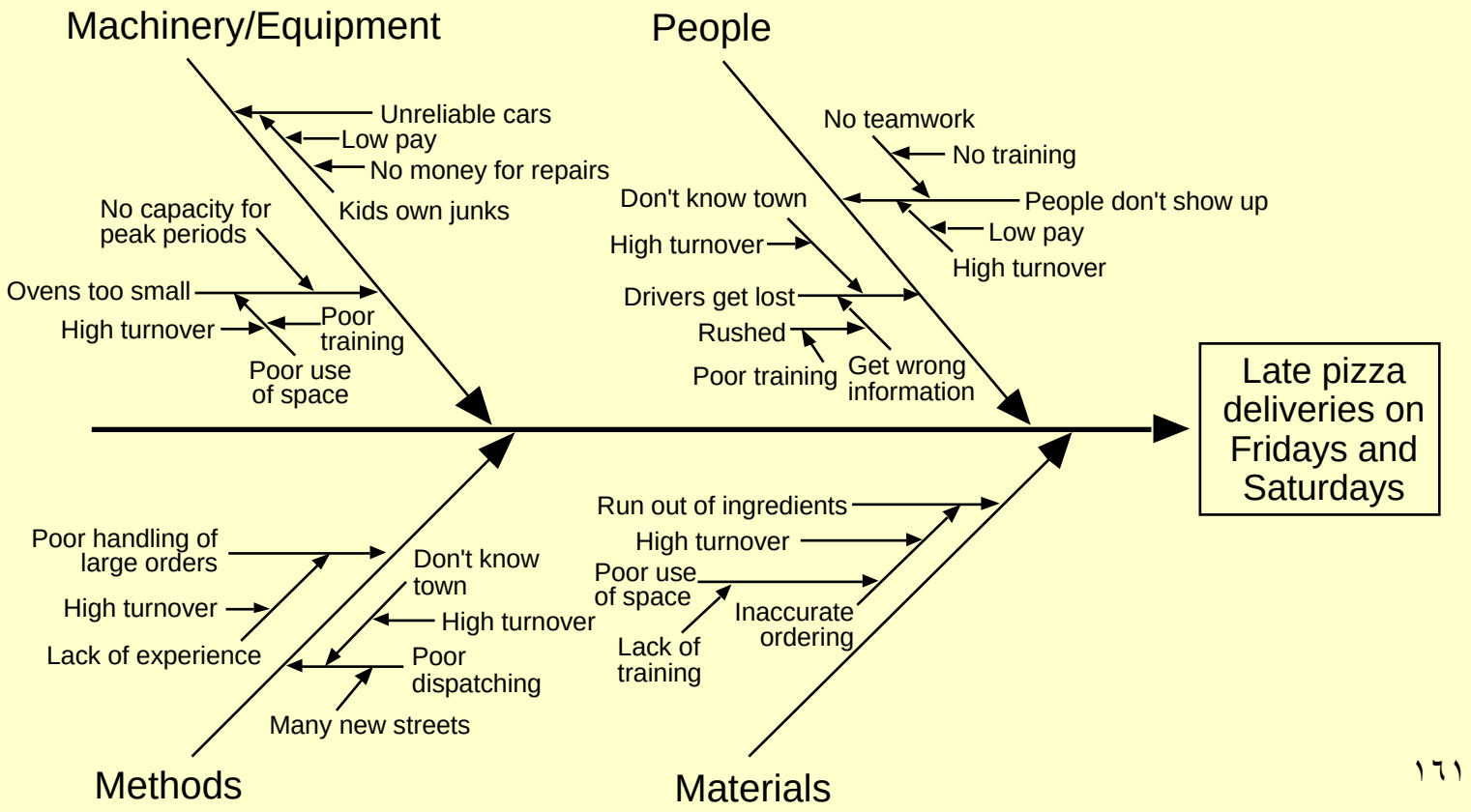
Process for producing and delivering Stop 'N Go Pizza



Step-by-Step: Using the PS/PI Model

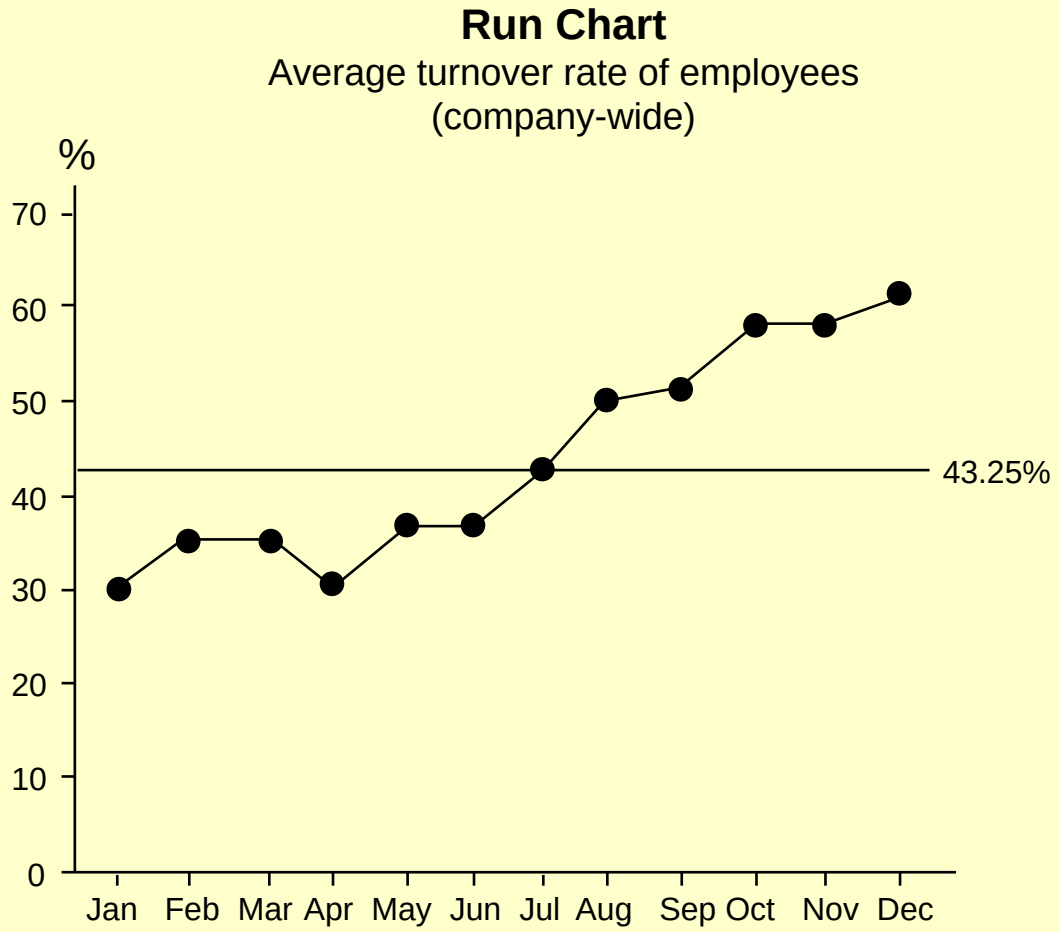
- **Step 3 Find Root Causes (Plan)**

C & E Diagram



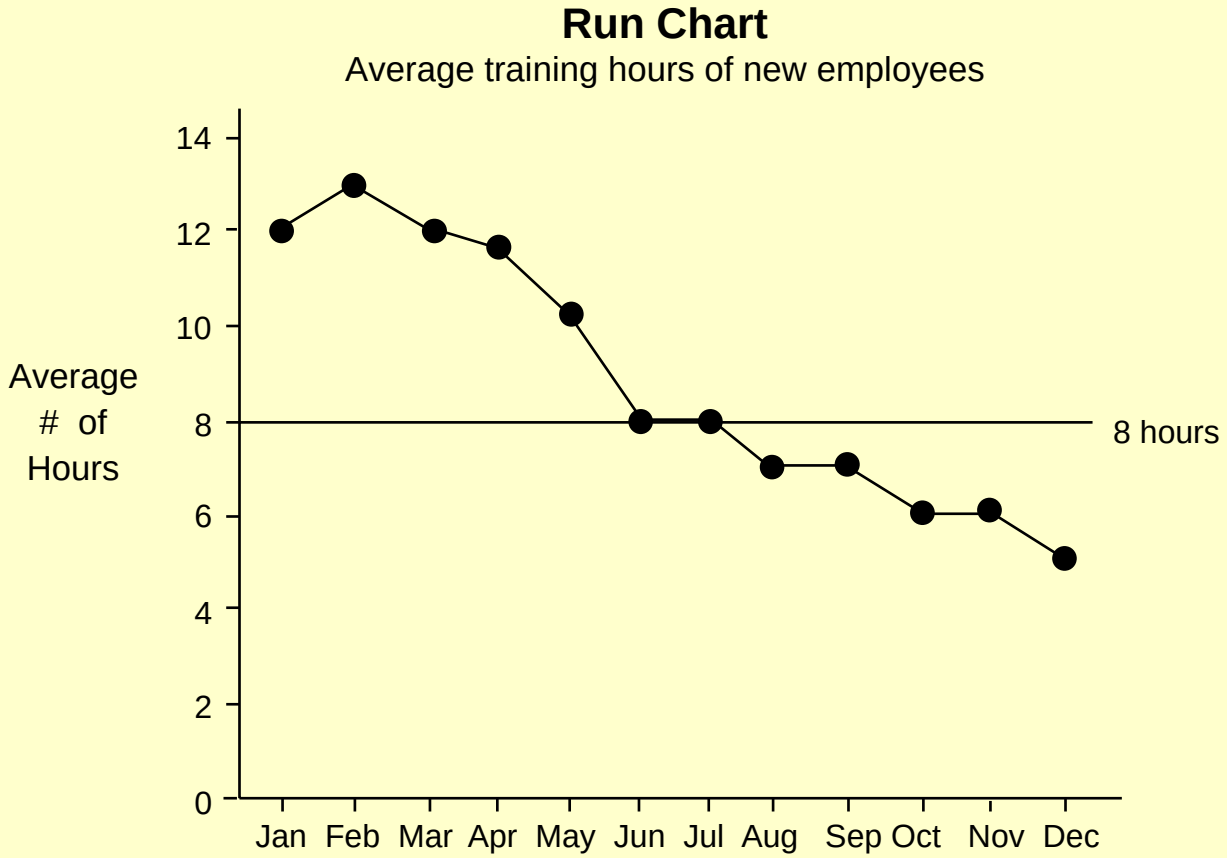
Step-by-Step: Using the PS/PI Model

- **Step 3 Find Root Causes (Plan)**



Step-by-Step: Using the PS/PI Model

- **Step 3 Find Root Causes (Plan)**

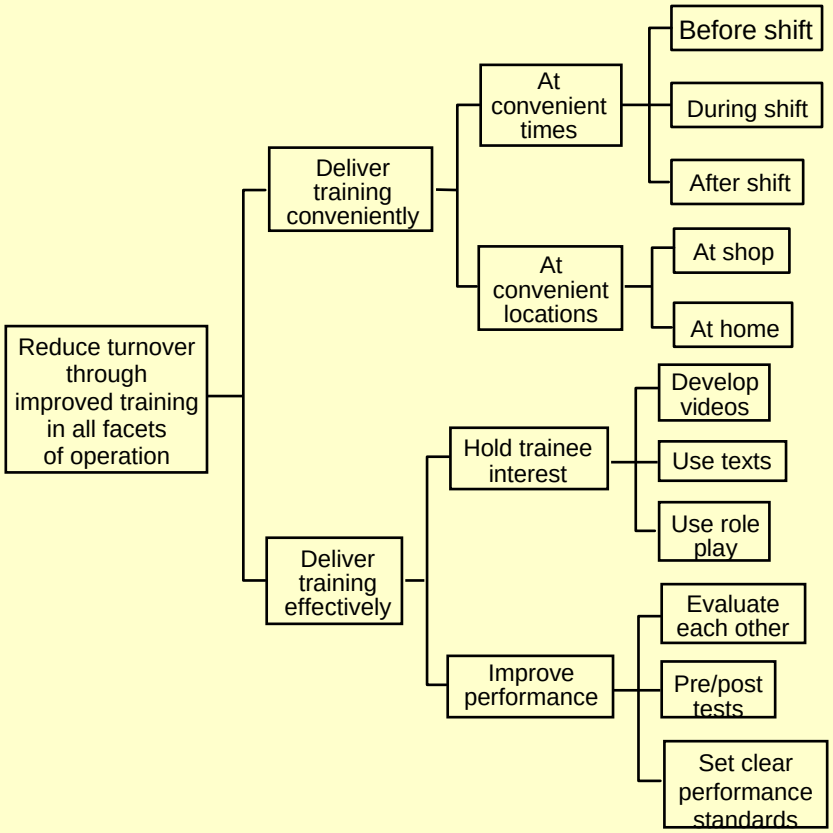


Step-by-Step: Using the PS/PI Model

- **Step 4 Develop Action Plans (Plan)**

Tree Diagram

Reduce turnover rate of employees (company-wide)



Step-by-Step: Using the PS/PI Model

- **Step 4 Develop Action Plans (Plan)**

The total = the sum of [rating values x criteria weighting], for example, to find the total of the "Train before shift" row, do the following:
[9 x .60] + [9 x .19] + [3 x .19] + {3 x .01] = 7.70

Note: **Weighting values** of each criterion came from a matrix not shown.

Task options come from the most detailed level of the Tree Diagram shown on PS/PI Model 11.

Prioritization Matrix

Selecting the best training program components

Criteria & Weighting / Tasks & Options	Effectiveness (.60)	Feasibility (.19)	Time (.19)	Cost (.01)	Total
Train before shift	⊙	⊙	○	○	7.70
Train during shift	○	△	⊙	⊙	3.78
Train after shift	△	○	○	○	1.77
Train at the shop	⊙	⊙	○	○	7.70
Train at home	○	⊙	⊙	⊙	5.29
Develop videos	⊙	⊙	⊙	○	8.83
Use texts	○	⊙	○	⊙	4.16
Use role play	⊙	⊙	⊙	⊙	8.89
Evaluate each other	⊙	⊙	○	○	7.70
Pre/post test	⊙	⊙	⊙	○	8.83
Set clear performance standards	⊙	⊙	⊙	⊙	8.89

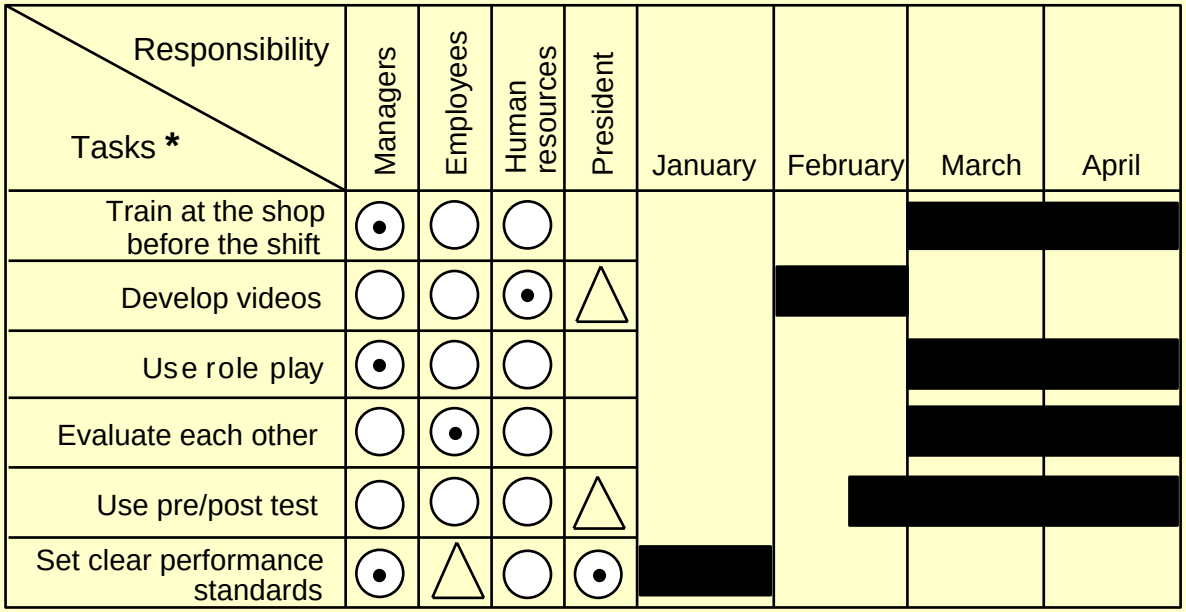
⊙ = 9 Excellent ○ = 3 Fair △ = 1 Poor

Step-by-Step: Using the PS/PI Model

- **Step 4 Develop Action Plans (Plan)**

Matrix & Gantt Chart Combined

New training program timeline



= Primary responsibility

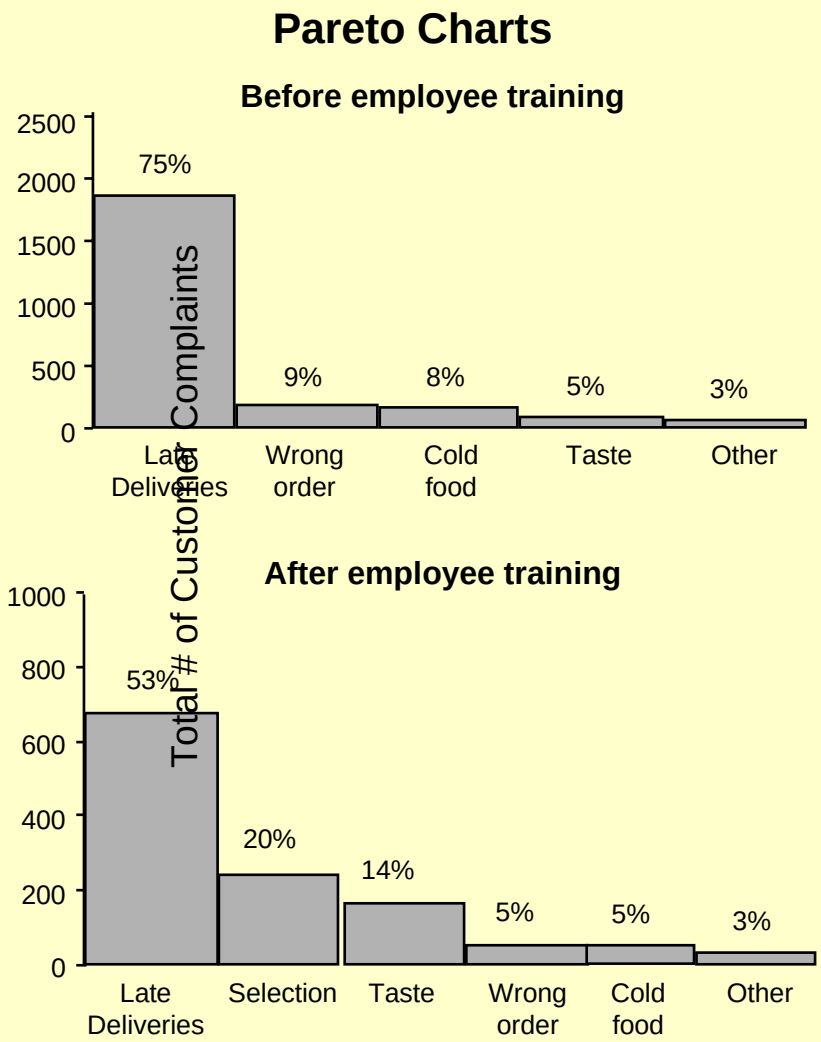
= Secondary/team member

= Need information to/from

* These were the highest rated tasks from the Prioritization Matrix on the previous overhead.

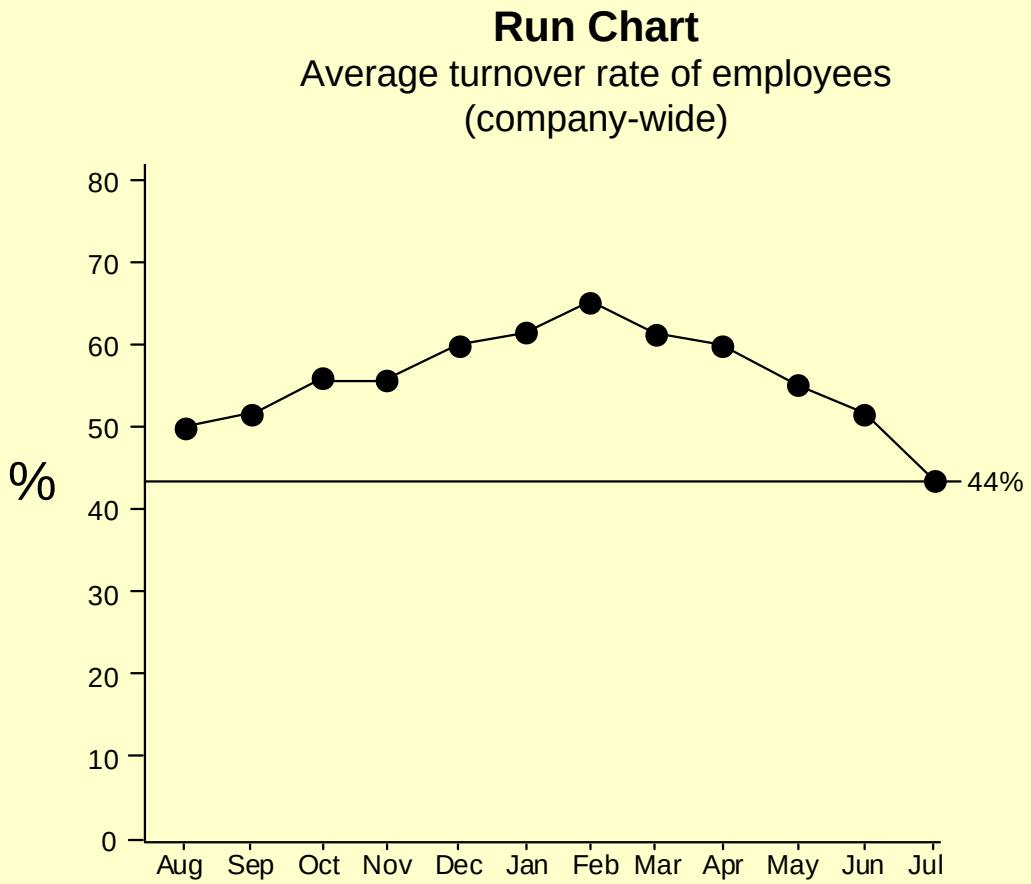
Step-by-Step: Using the PS/PI Model

- **Step 6 Review Results (Check)**



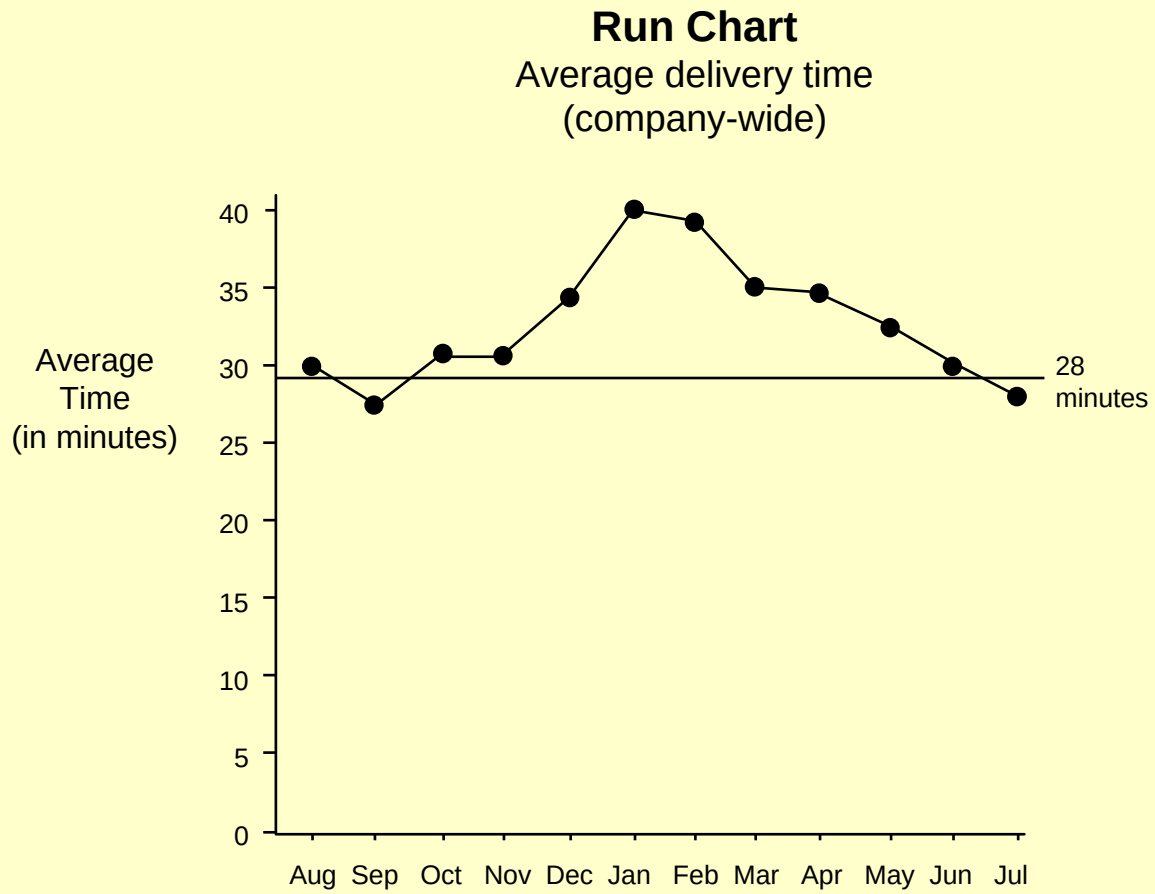
Step-by-Step: Using the PS/PI Model

- **Step 6 Review Results (Check)**



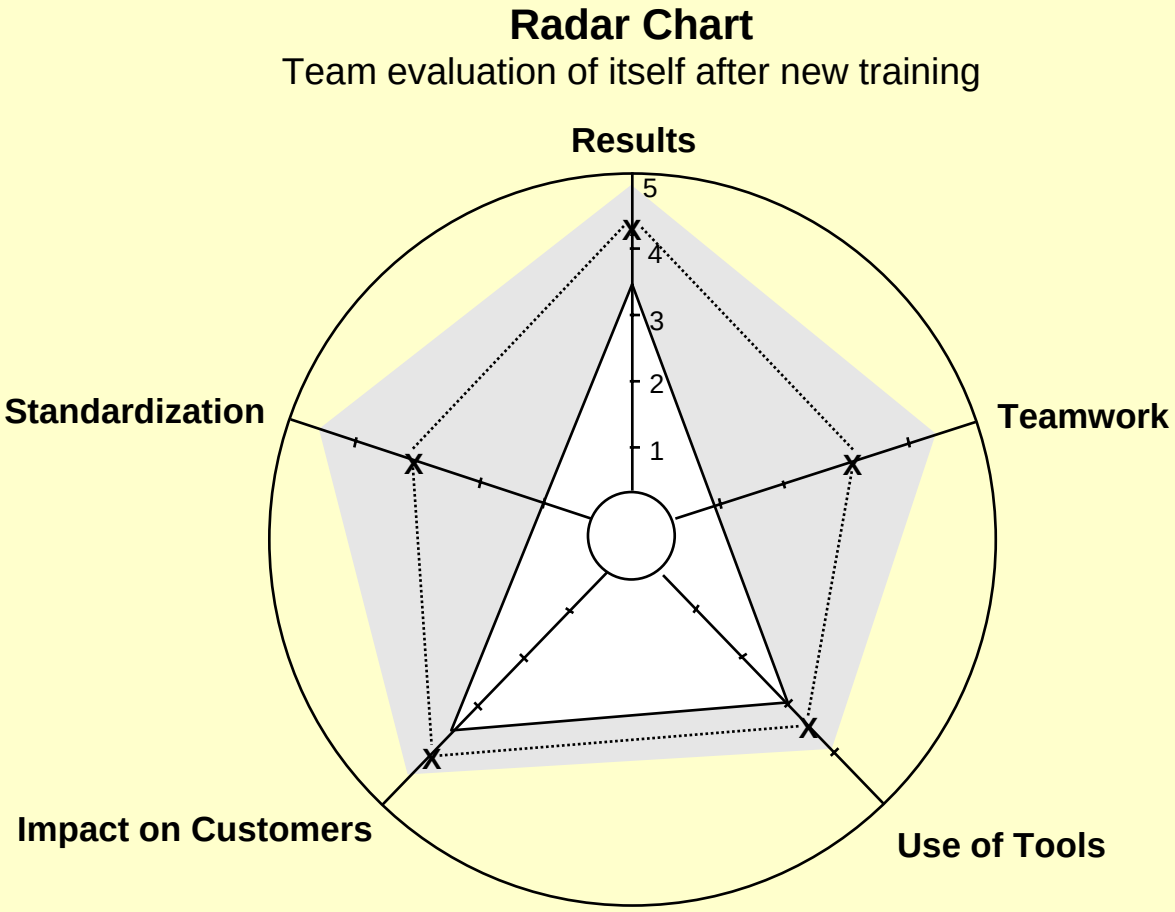
Step-by-Step: Using the PS/PI Model

- **Step 6 Review Results (Check)**



Step-by-Step: Using the PS/PI Model`

- **Step 7 Make Changes/Hold Gains (Act)**



Note: The “x” mark indicates the team’s average performance rating while the shaded area indicates the range of ratings within the team.

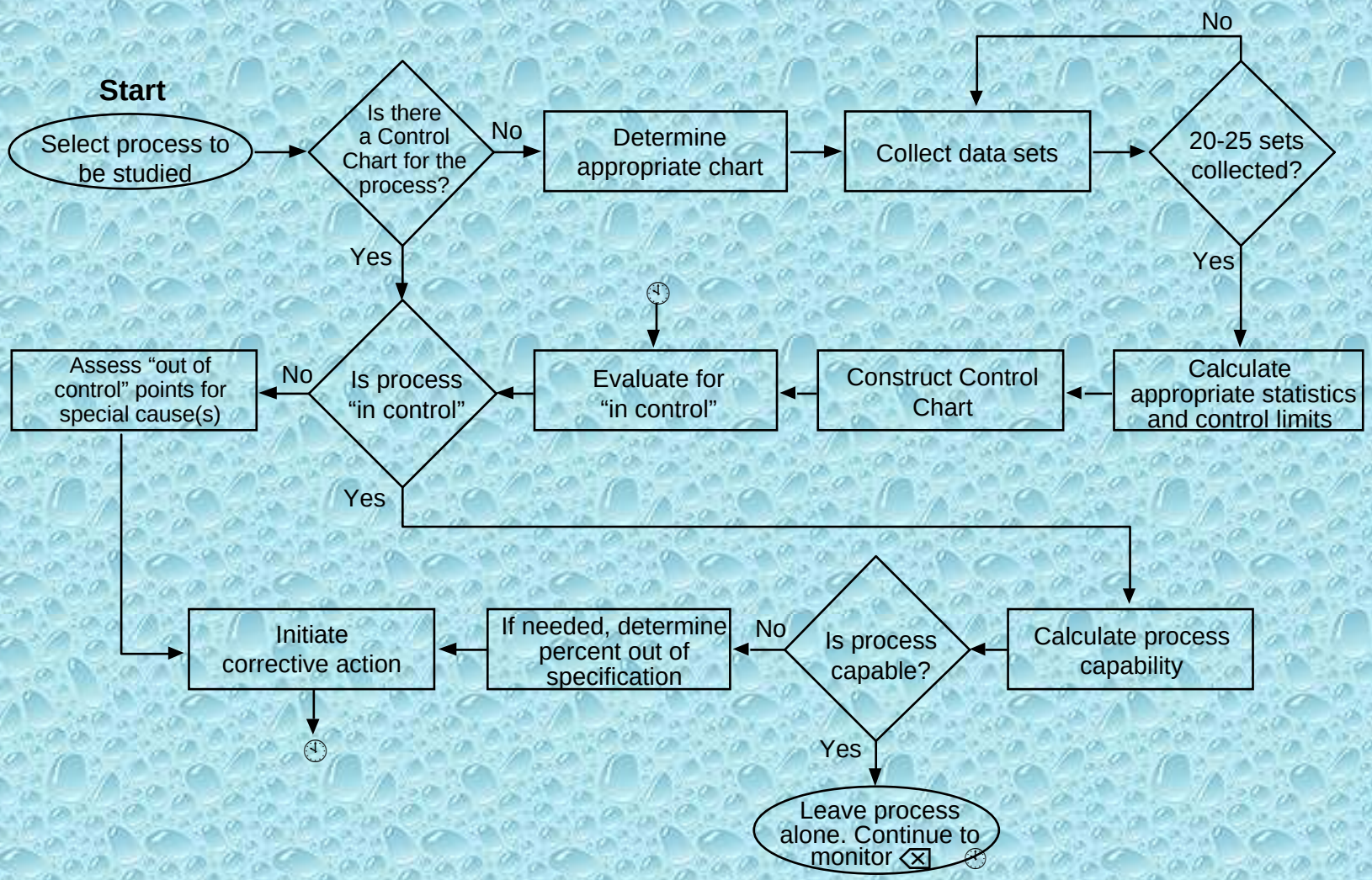
Calculating Process Capability

- Step 1 Determine Process Averages (Process Grand Average & Average Range)
- Step 2 Determine Upper and Lower Specification Limits, USL and LSL
- Step 3 Calculate Process Standard Deviation
- Step 4 Calculate Process Capability

Process Capability Essentials

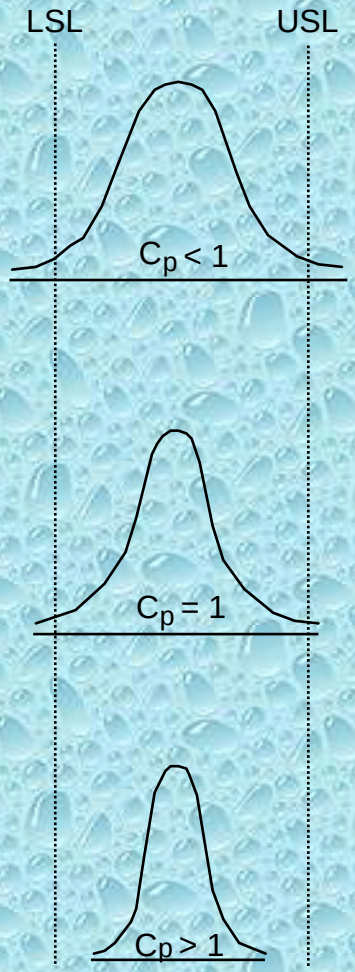
- Key Success Behaviors
  - Before calculating Process Capability, make sure process is in-control, normal, and variable data was used
  - Processes that are not capable, i.e., not meeting specifications, will need a team to investigate ways to change the process to bring it within specifications—variation reduction and/or shifting the target

Steps at a Glance: Process Capability



Step-by-Step Calculation

- **Step 4 Calculate Process Capability**



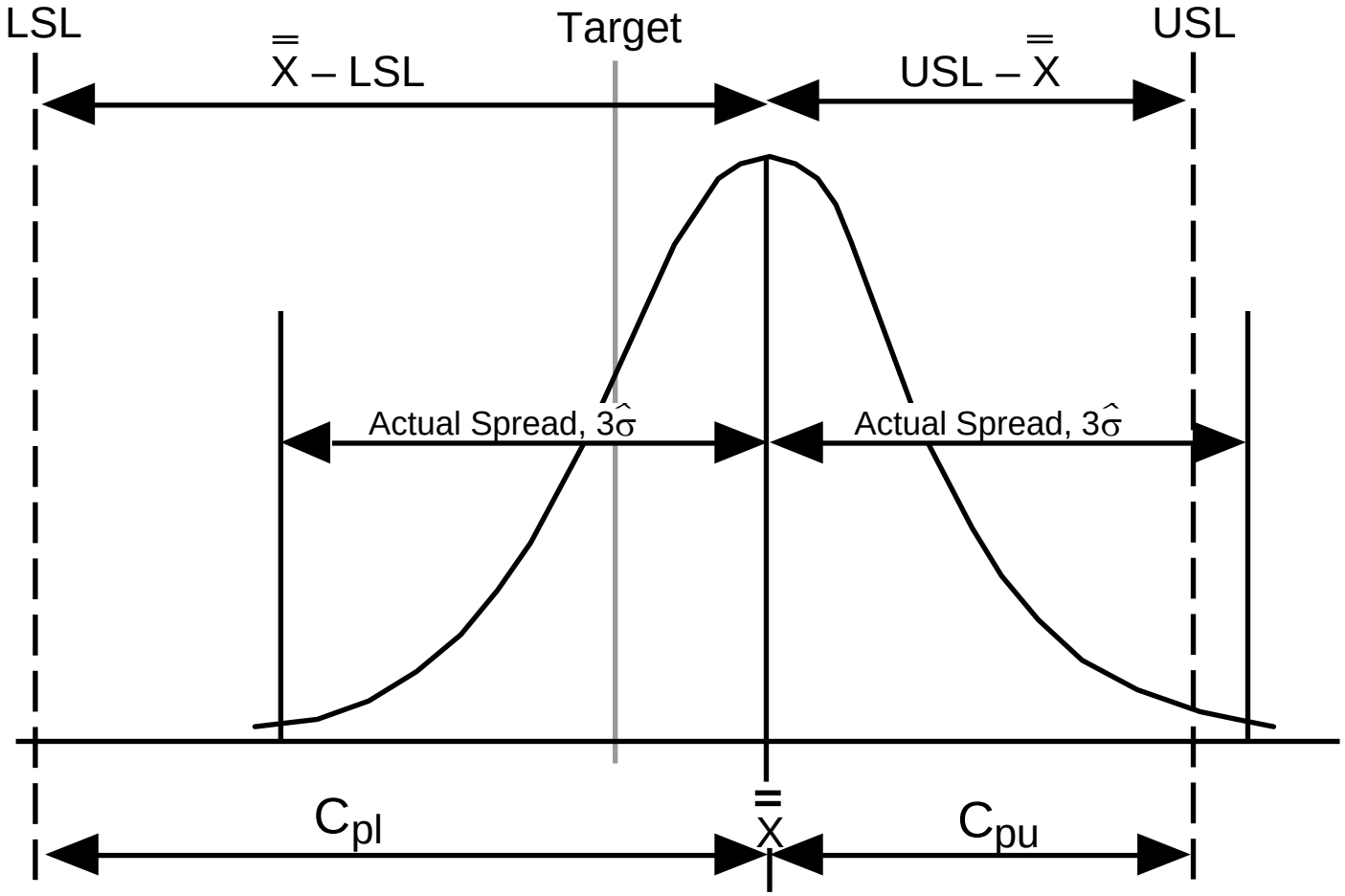
When $C_p < 1$, process variation exceeds specification limits. 99.73% of the data will not fit within these limits. Defectives are being made.

When $C_p = 1$, process variation just meets specification limits. 99.73% of the data fits just within these limits. A minimum of 0.3% defectives will be made, more if the process is not centered.

When $C_p > 1$, process variation is less than specification limits. 99.73 % of the data will easily fit within these limits. Defectives are possible if the process is not centered on the target value.

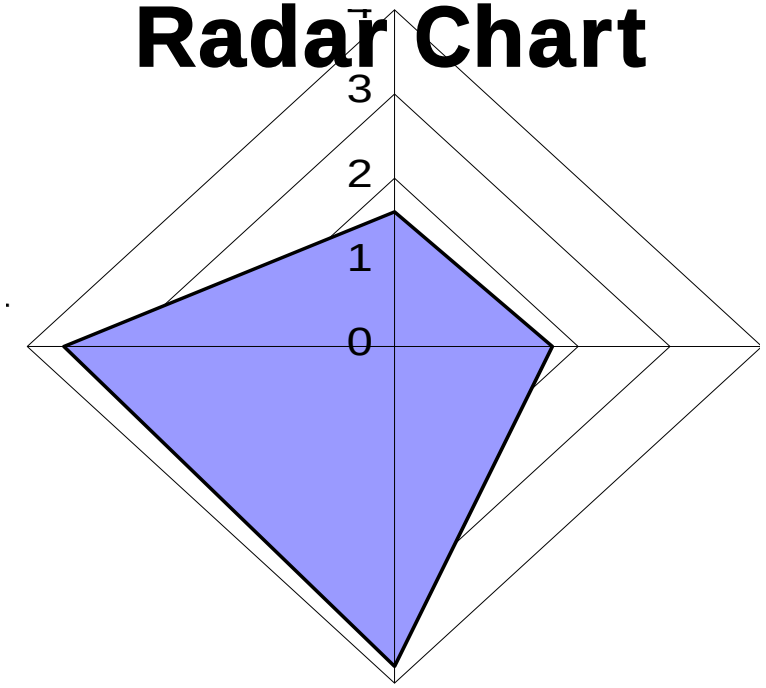
Step-by-Step Calculation

C_{pl}, C_{pu}, C_{pk}: Indices of Process Variation



Back

Radar Chart



A **Radar Chart** illustrates relationships between characteristics of plotted data points in relation to the whole picture. Radar Charts can give a second interpretation to the same set of data in a Bar or Column Chart.

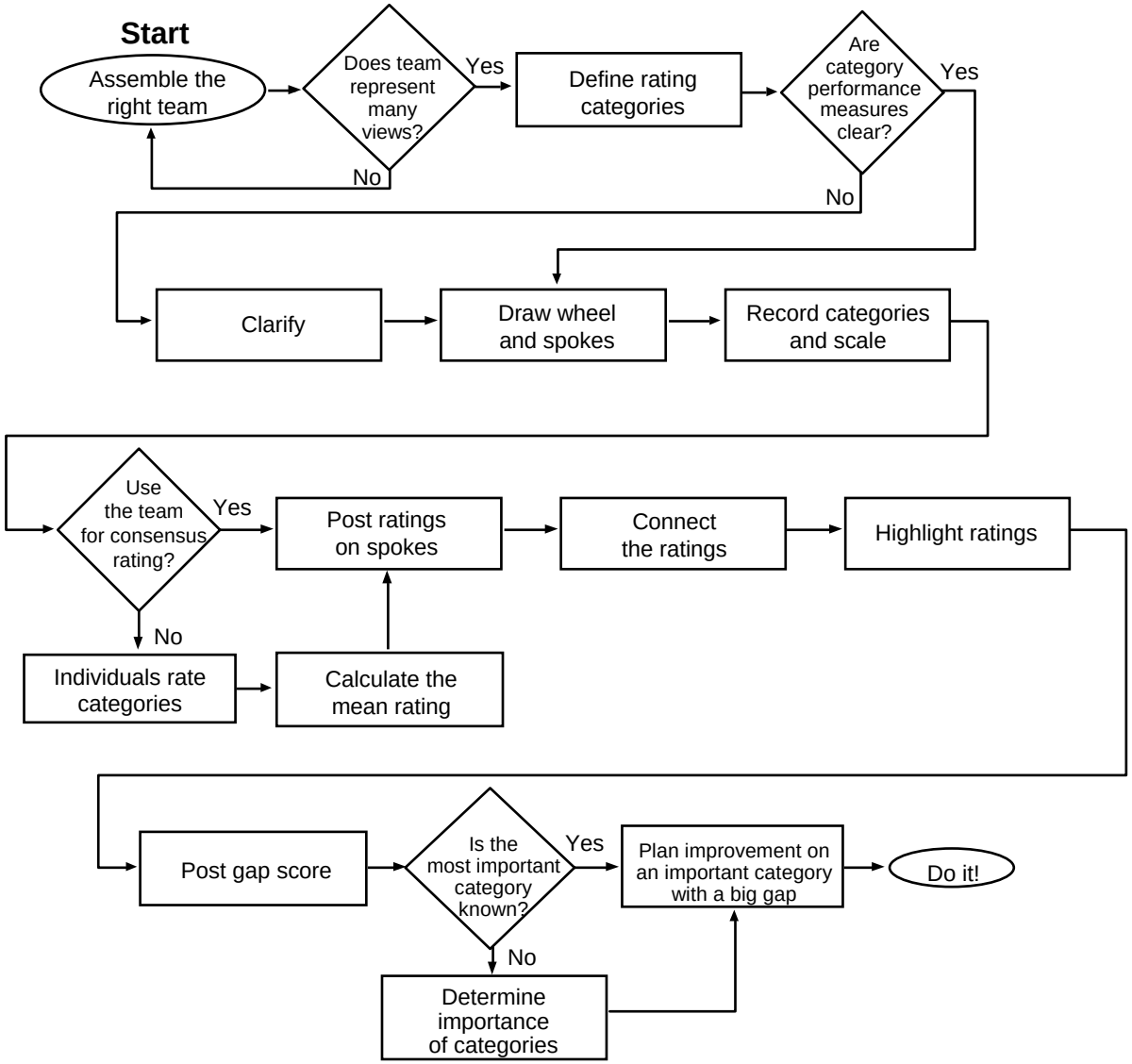
Constructing the Radar Chart

- Step 1 Assemble the Right Team
- Step 2 Define Rating Categories
- Step 3 Construct the Chart
- Step 4 Rate Performance
- Step 5 Connect the Ratings
- Step 6 Interpret the Results

Radar Chart Essentials

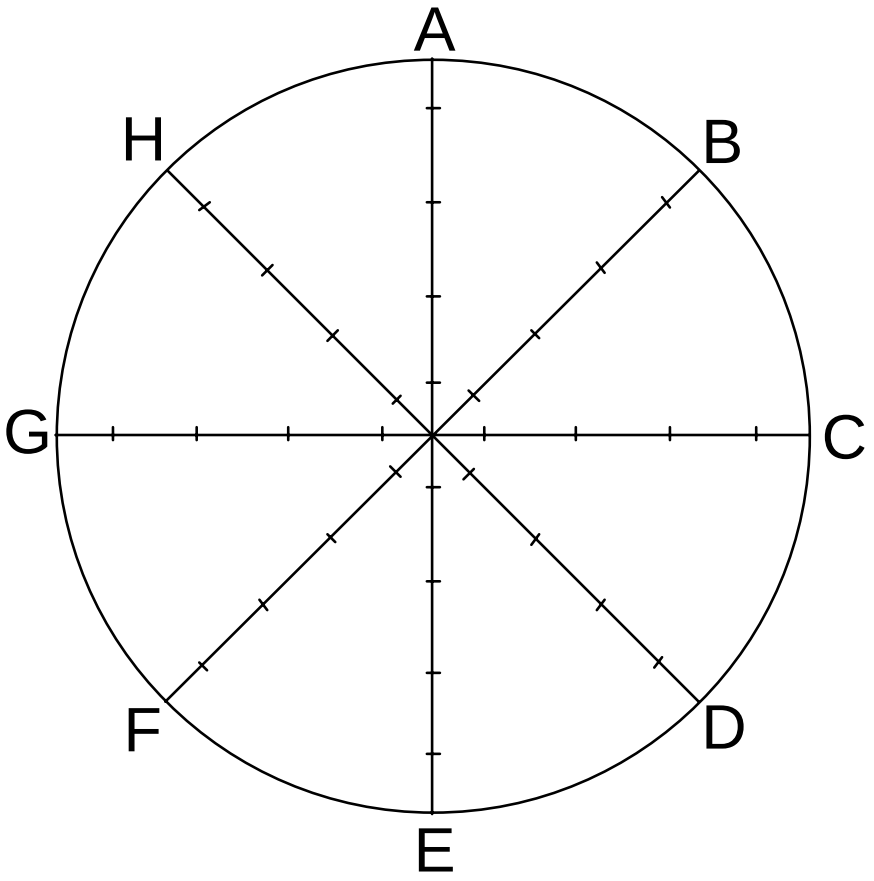
- Key Success Behaviors
  - Define performance measures
  - Examine causes of disagreement
  - Welcome new information and new ideas
  - Connect with other tools for a richer interpretation

Steps at a Glance: Radar Chart



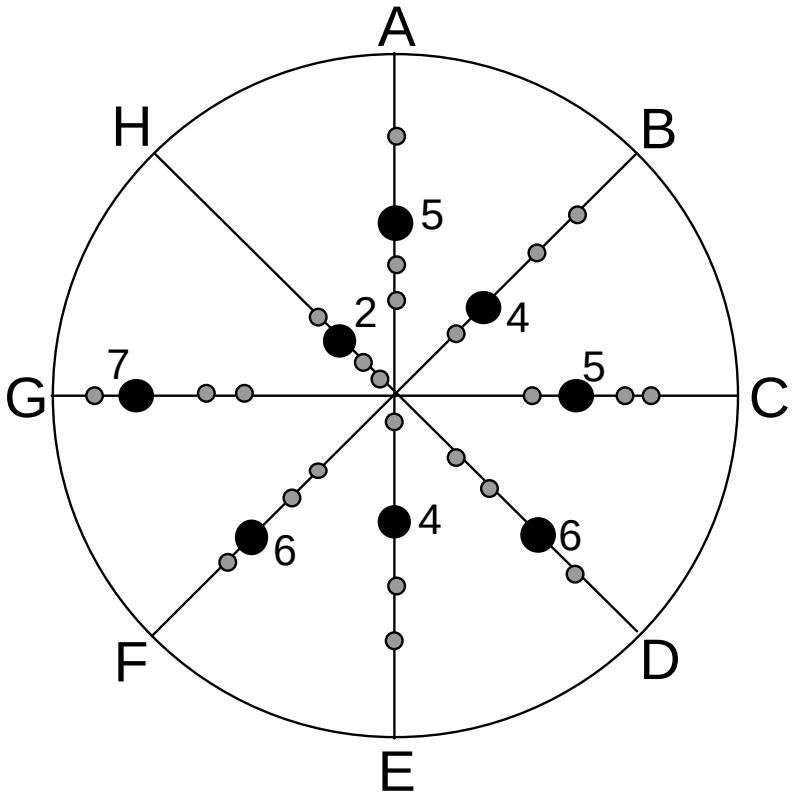
Step-by-Step Construction

– Step 3 Construct the Chart



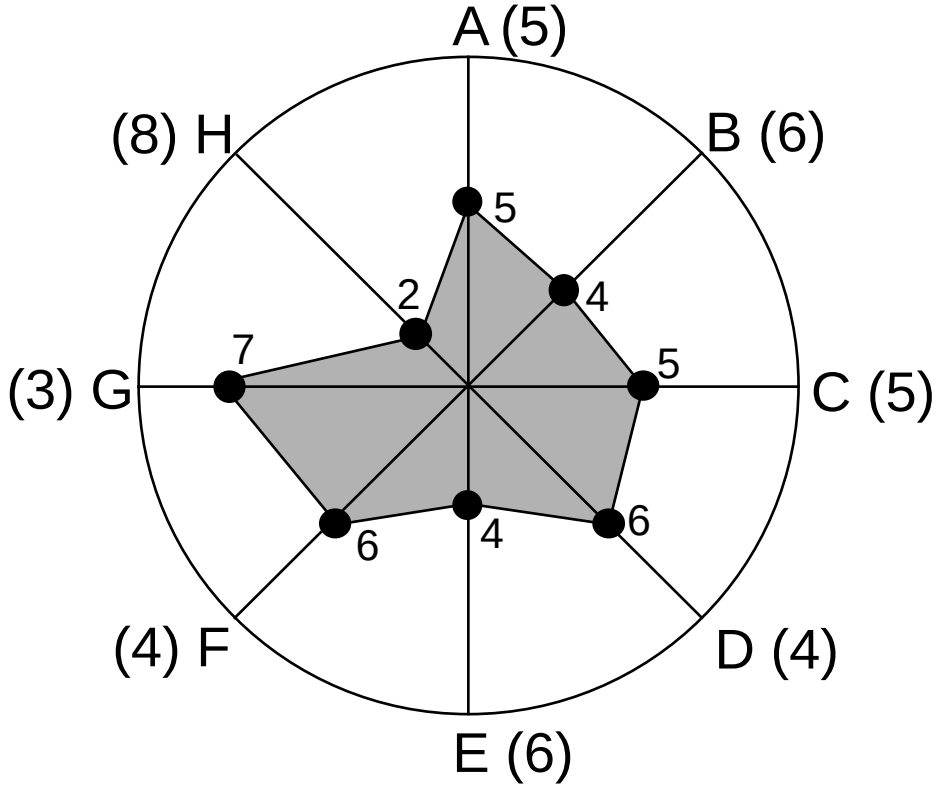
Step-by-Step Construction

– Step 4 Rate Performance



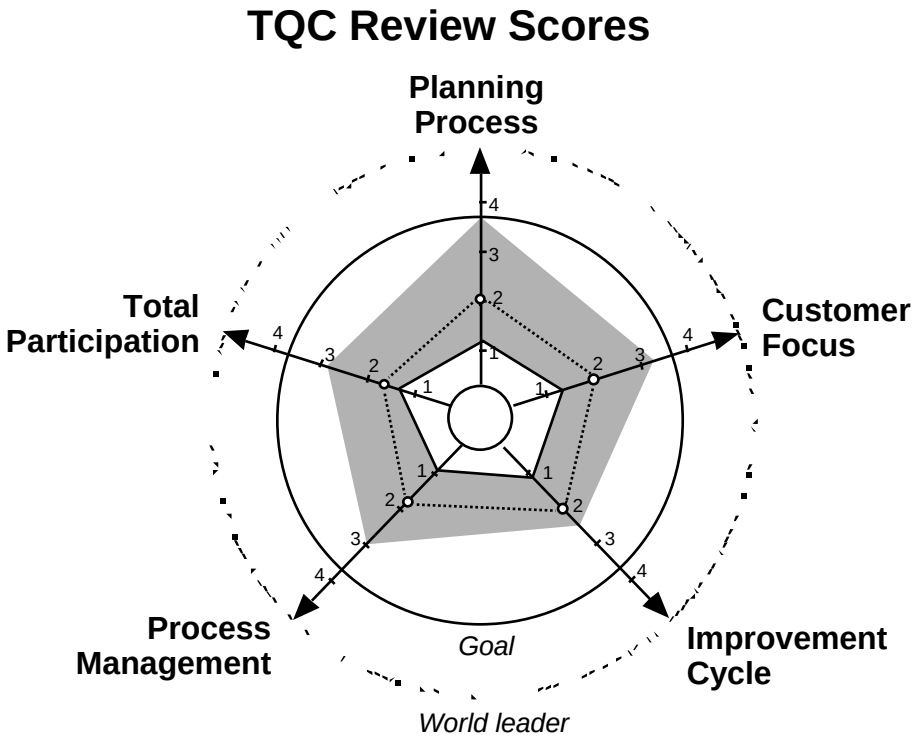
Step-by-Step Construction

– Step 5 Connect the Ratings



Gap scores are in parentheses.

Radar Chart Example



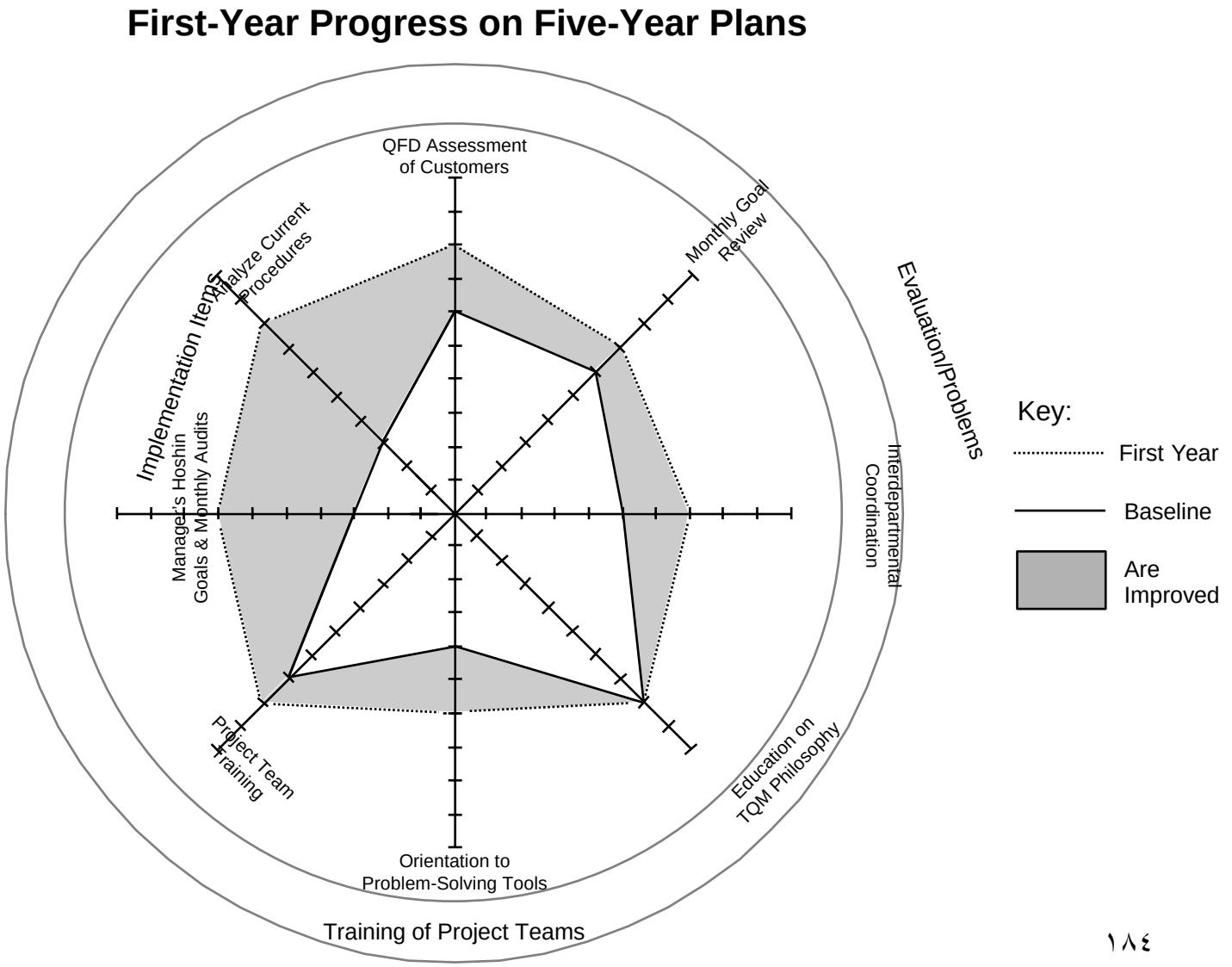
Company's goal: to have 80% of all entities (34) achieve an overall score of >3.5.

To compute overall score:

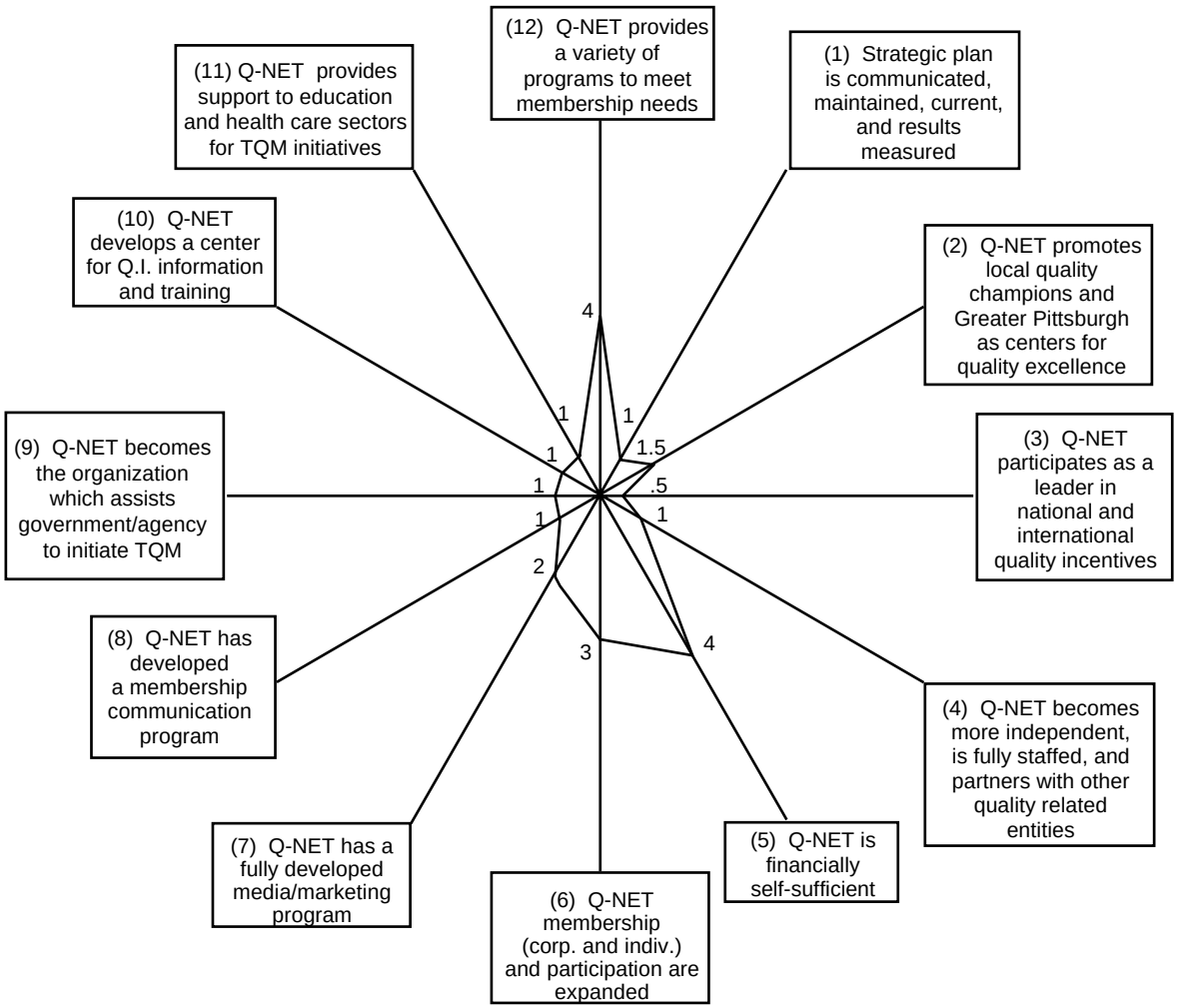
$$\frac{\text{Sum of average scores from each category}}{\text{\# of categories}} = \frac{12.52}{5} = 2.5 \text{ (maximum is 5)}$$

Information provided courtesy of Hewlett Packard

Radar Chart Example



Radar Chart Example



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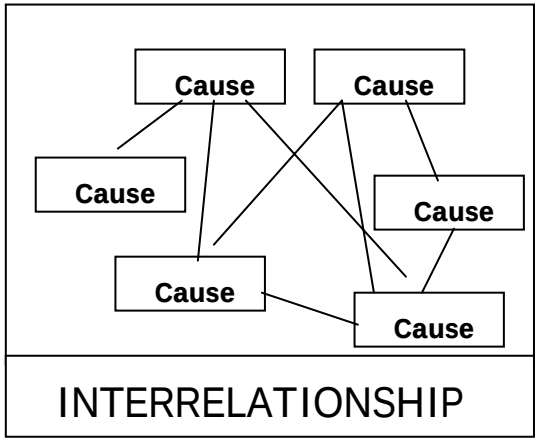
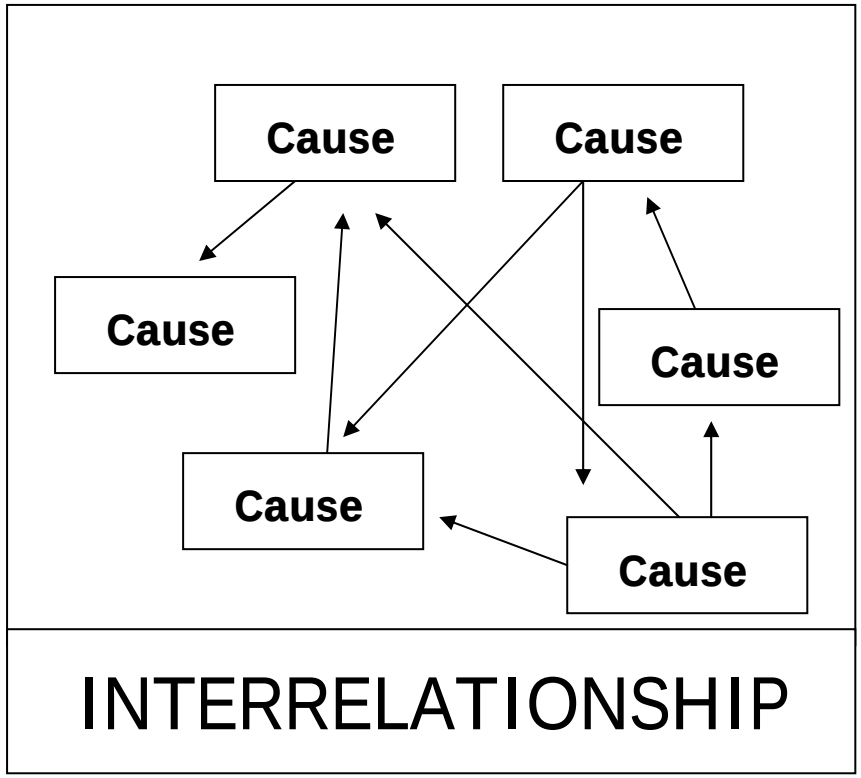
Information provided courtesy of The Greater Pittsburgh Quest for Quality Network

An **Interrelationship Diagraph** is used to study the relationship between the causes and discover the “root cause” of a problem.



If a relationship can be established, lines are drawn between two causes. Analysis leads to drawing arrows between causes and effects.



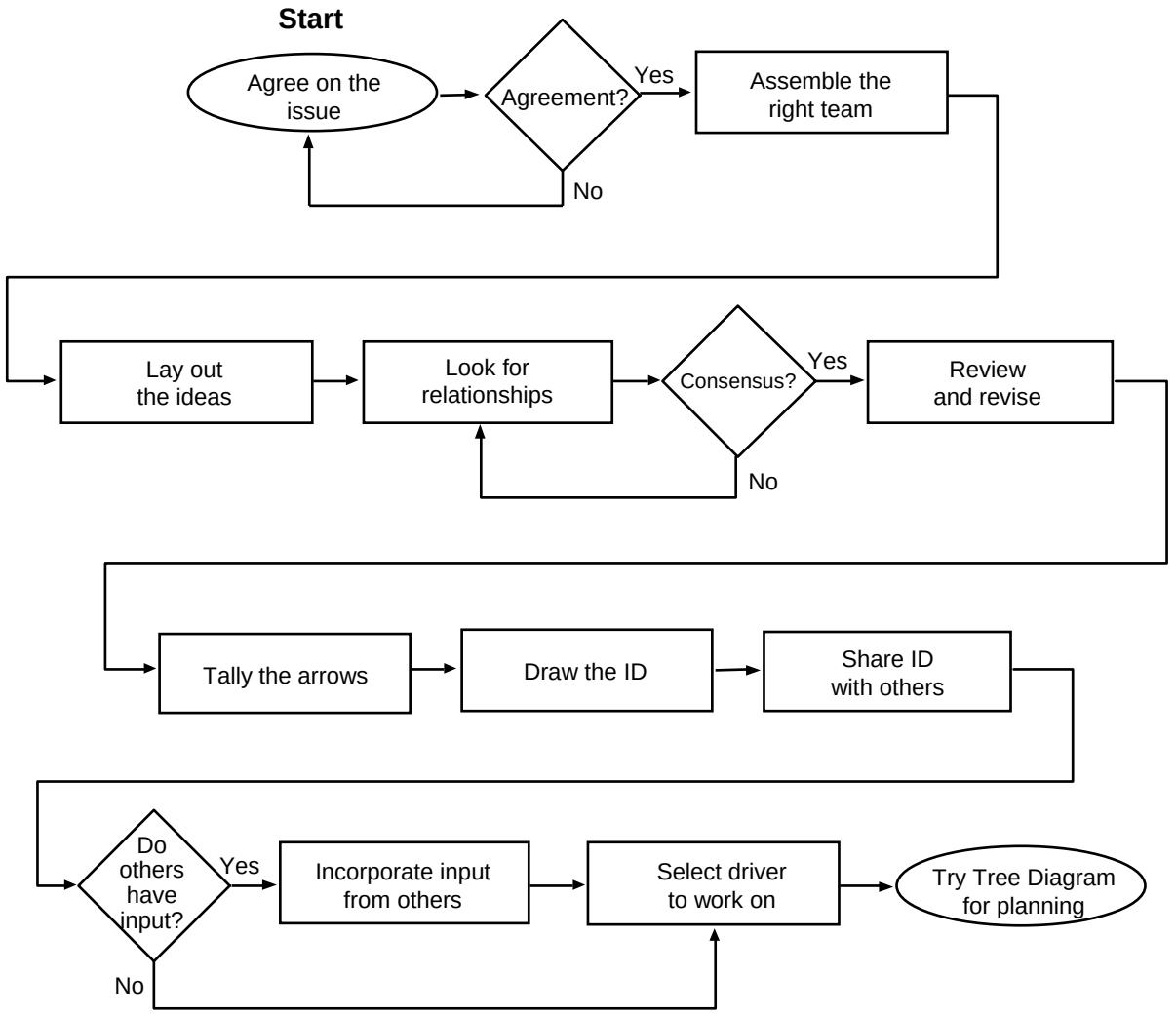
Constructing the Interrelationship Digraph

- Step 1 Agree on the Issue
- Step 2 Assemble the Right Team
- Step 3 Lay Out the Ideas
- Step 4 Look for Relationships
- Step 5 Review and Revise
- Step 6 Tally the Arrows
- Step 7 Draw the ID

Interrelationship Digraph Essentials

- Key Success Behaviors
  - Suspend assumptions about the outcome until the tool is complete
  - Listen—try to understand the logic of other team members
  - Value discussion
  - Trust the process

Steps at a Glance: ID



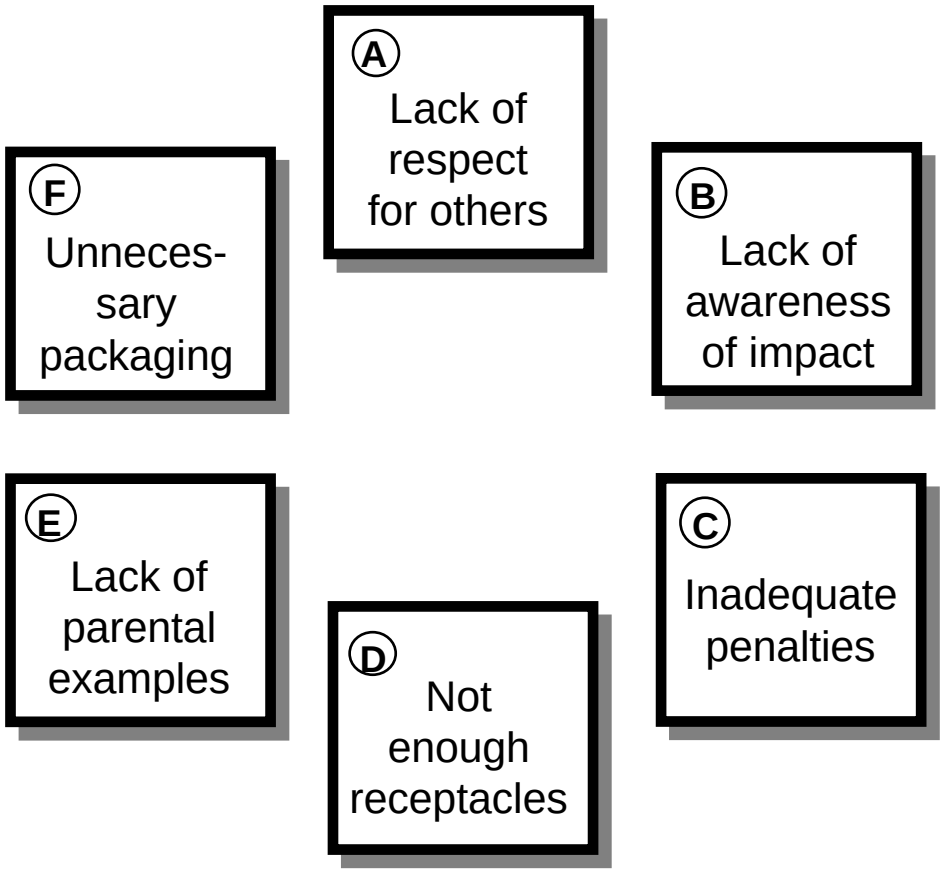
Step-by-Step Construction

– Step 1 **Agree on the Issue**

What are the issues related
to reducing litter?

Step-by-Step Construction

– Step 3 Lay Out the Ideas

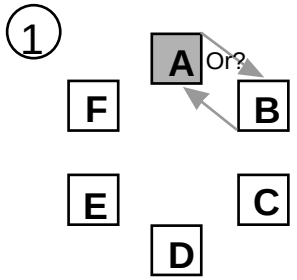


Step-by-Step Construction

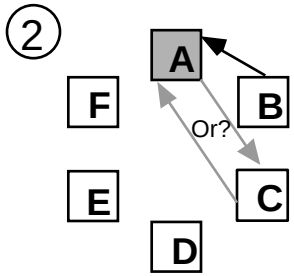
- **Step 4** Look for Relationships

Ask of each combination?

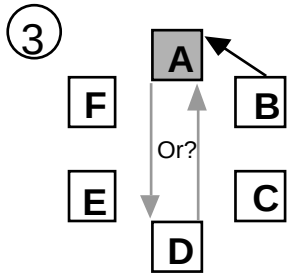
1) Is there a cause/influence relationship?
2) If yes, which direction of cause/influence is stronger.



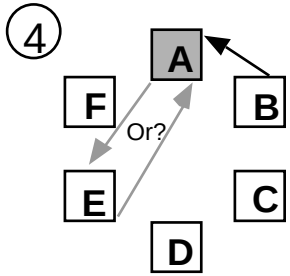
Decision: “B” causes or influences “A”



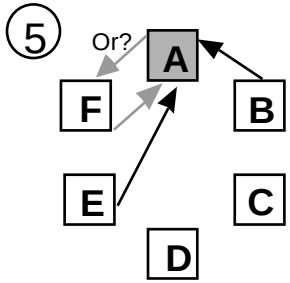
Decision: No relationship



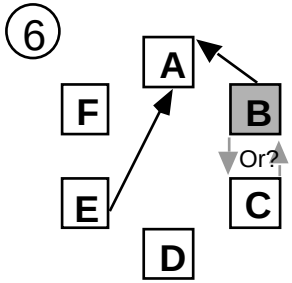
Decision: No relationship



Decision: “E” causes or influences “A”



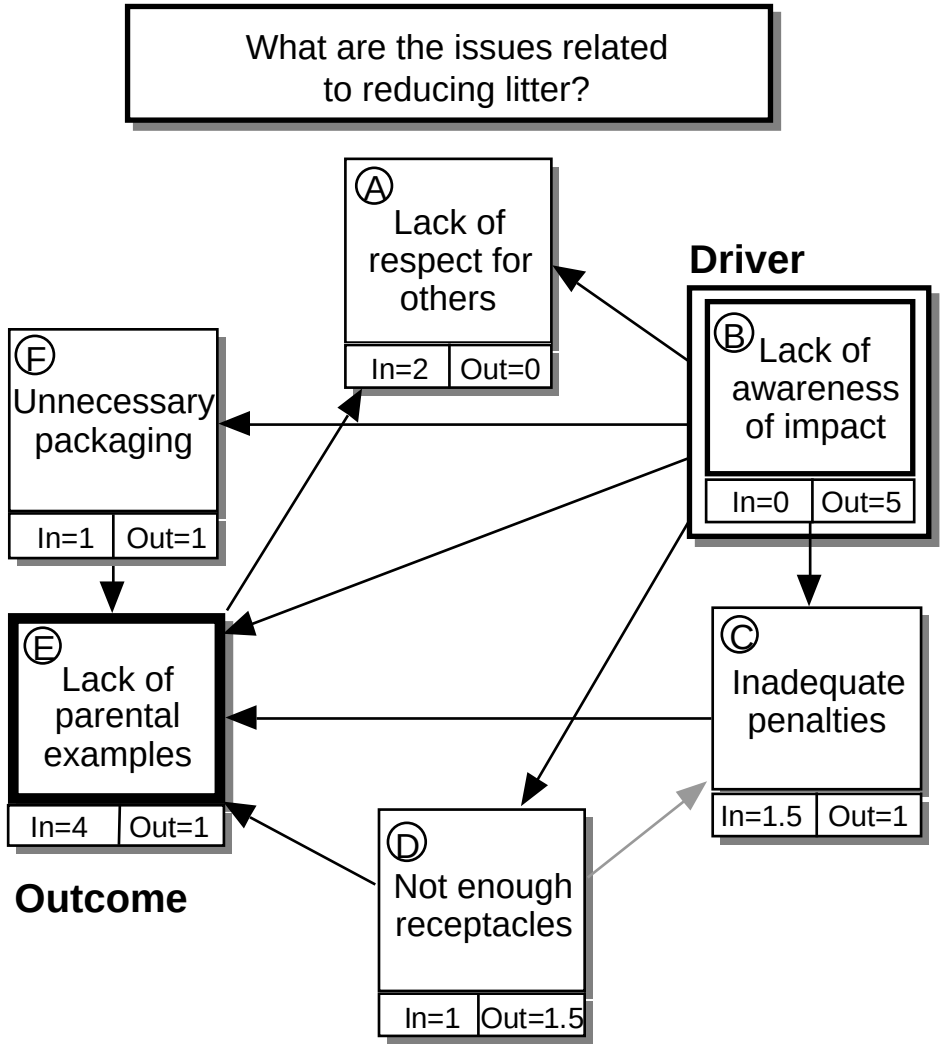
Decision: No relationship
“A” is completed



Decision: “B” causes or influences “C”
Now begin with “B” and repeat the questions for all remaining combinations

Step-by-Step Construction

- **Step 7** Draw the ID



Information provided courtesy of CUE Consulting

ID Example (Variation)

Maintaining Quality Initiatives:
Exploring Leadership Involvement and Customer Satisfaction

ID – Matrix Format

	Log-istic Support	Cust-omer Satis-faction	Edu-cation & Training	Person-nel Incent-ives	Leader-ship	Cause Driver ↑	Result /Rider ←	Total
Logistic Support		⊙ ↑	○ ↑	△ ↑	○ ←	**3**	**1**	**16**
Customer Satisfaction	⊙ ←		○ ←	⊙ ←	○ ←	**0**	**4**	**24**
Education & Training	○ ←	○ ↑		○ ↑	⊙ ←	**2**	**2**	**18**
Personnel Incentives	△ ←	⊙ ↑	○ ←		⊙ ←	**1**	**3**	**22**
Leadership	○ ↑	○ ↑	⊙ ↑	⊙ ↑		**4**	**0**	**24**

Relationship Strength:

⊙ = 9 Significant

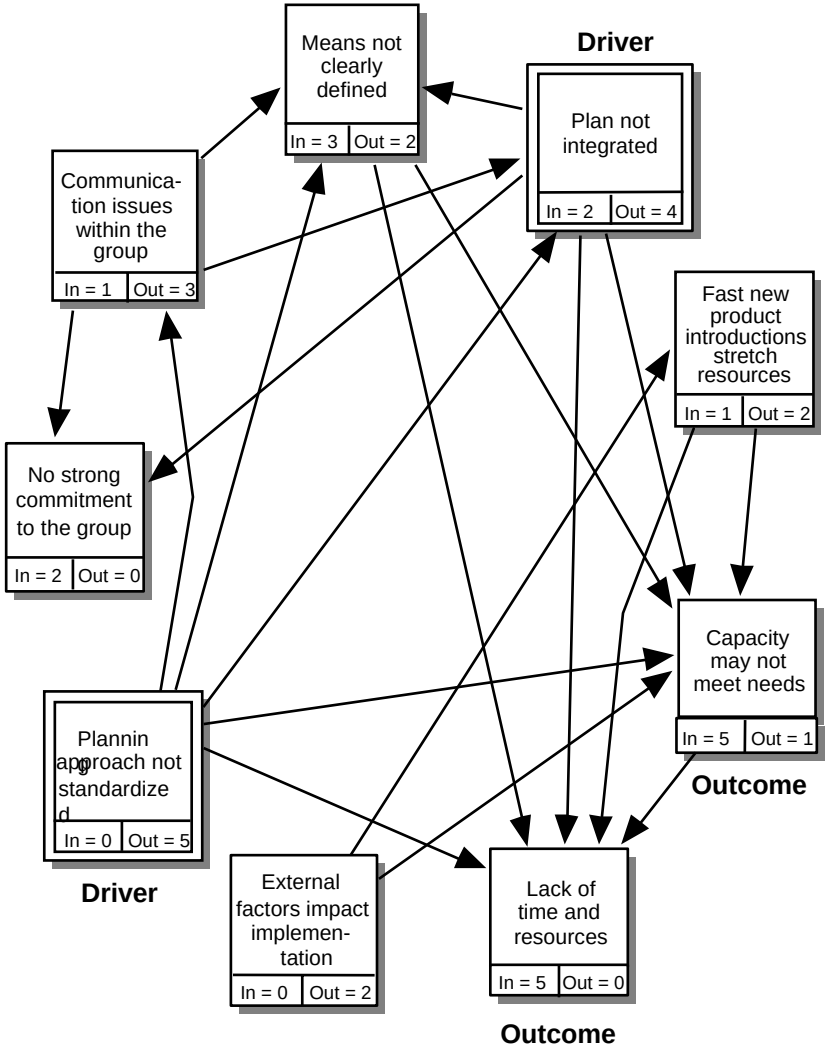
○ = 3 Medium

△ = 1 Weak or none

Information provided courtesy of U.S. Air Force, Air Combat Command

ID Example

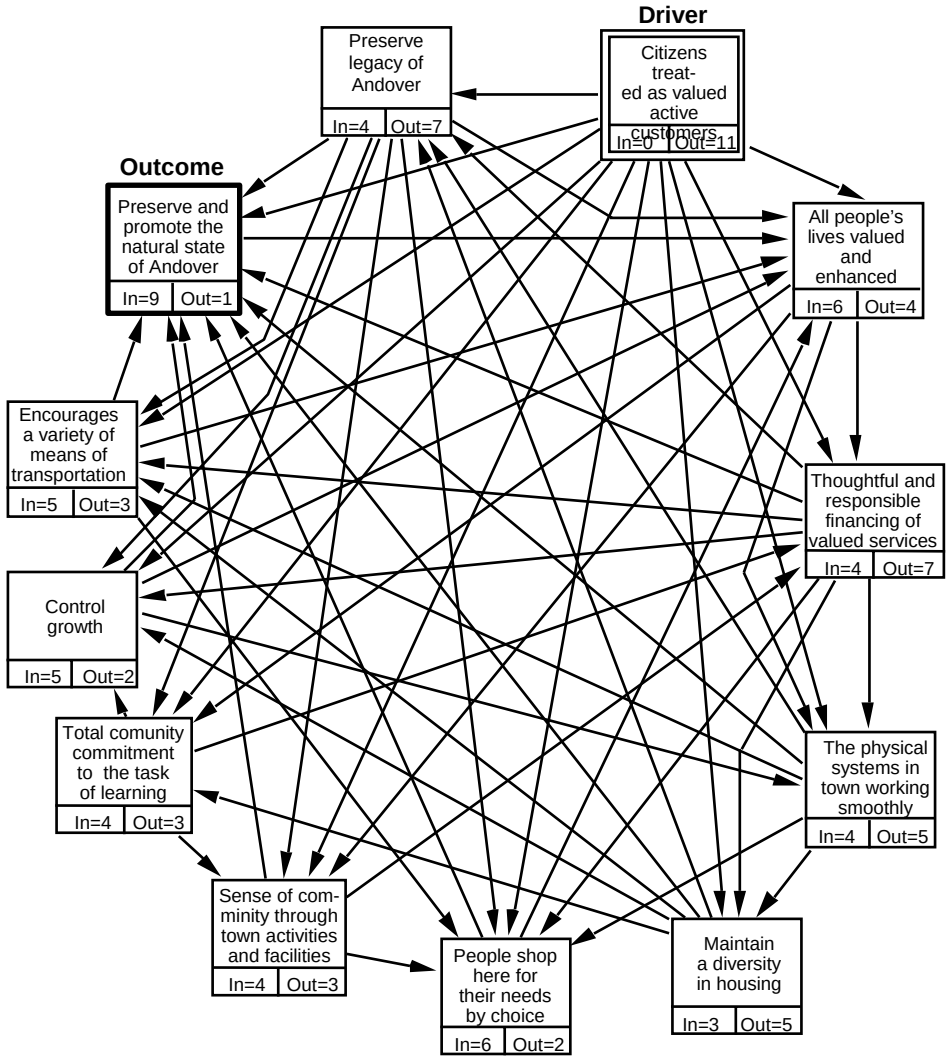
Issues Surrounding Implementation of the Business Plan



Information provided courtesy of Goodyear

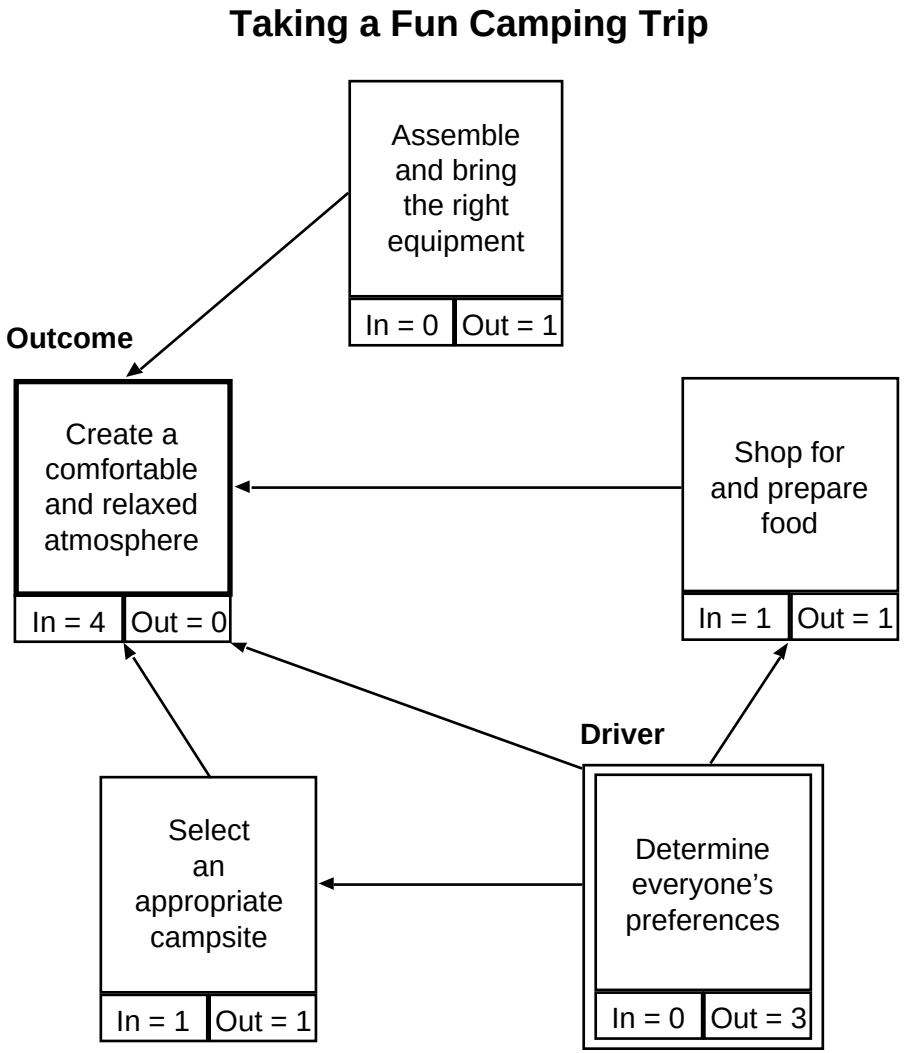
ID Example

A Vision of Andover in the 21st Century



Information provided courtesy of Town of Andover, MA

ID Example



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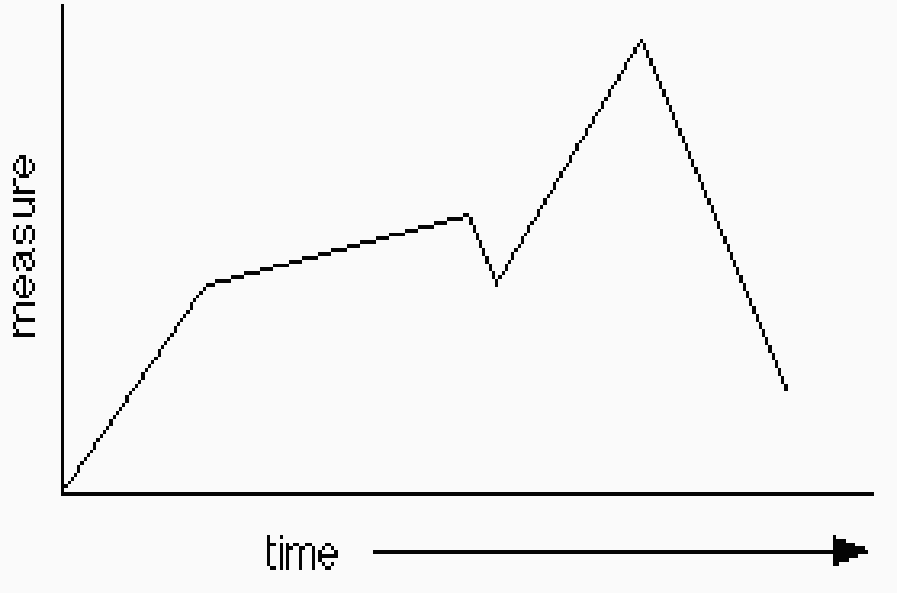
Run Charts

- Run Charts Defined
  - Run charts are used to analyze processes according to time or order.



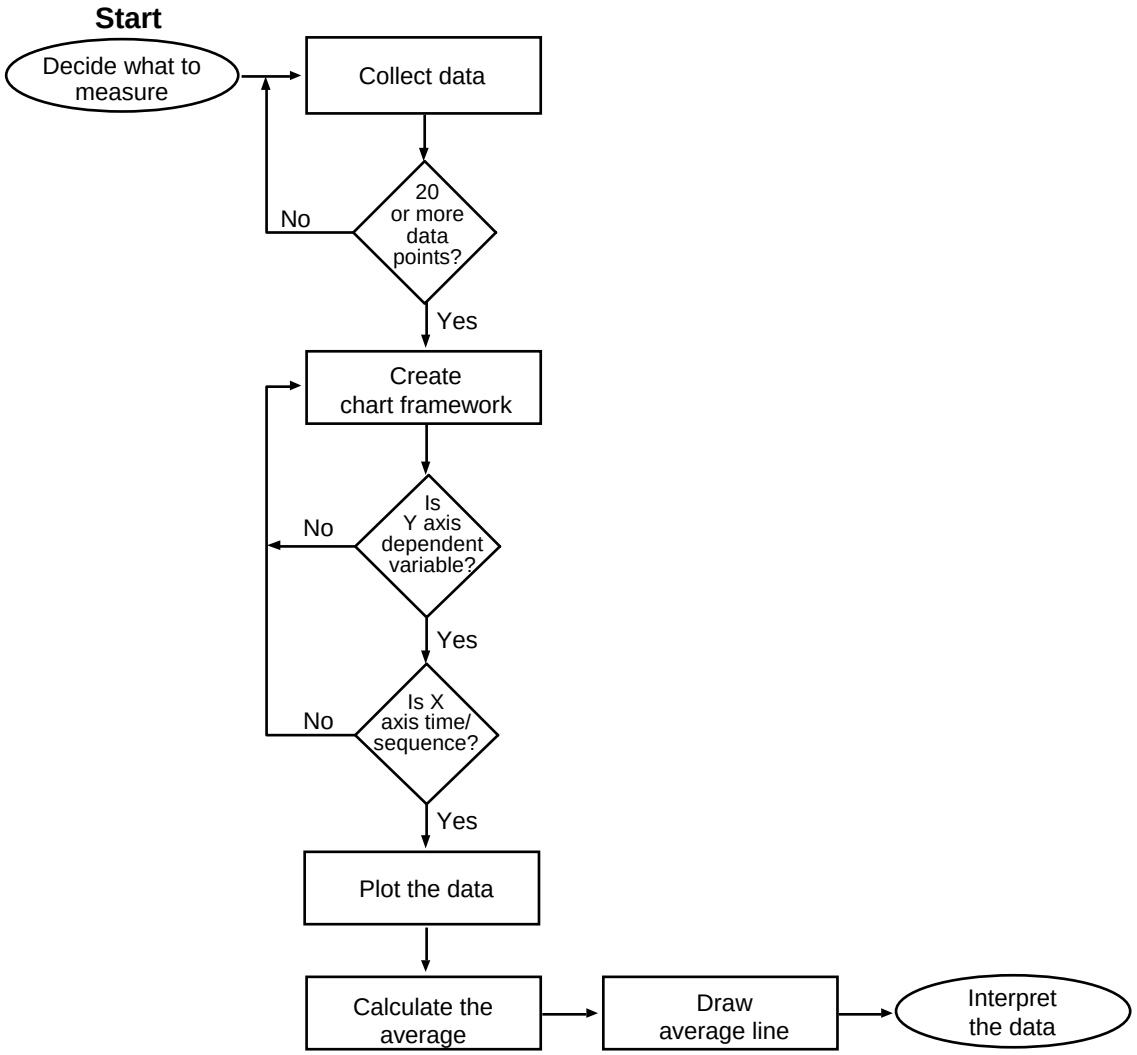
Constructing the Run Chart

- Step 1 Decide What to Measure
- Step 2 Gather the Data
- Step 3 Create the Graph
- Step 4 Plot the Data
- Step 5 Interpret the Chart

Run Chart Essentials

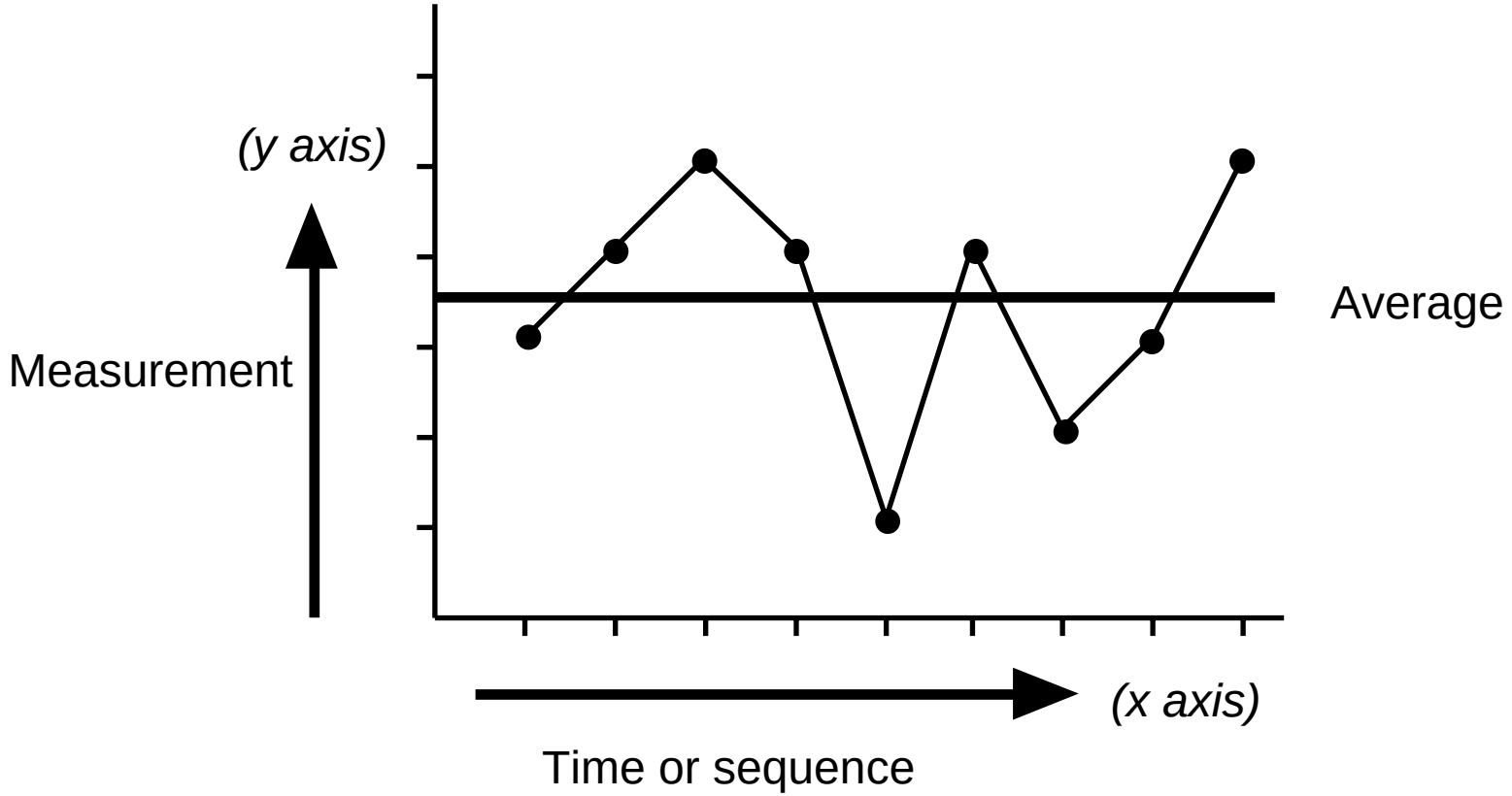
- Key Success Behaviors
  - Continue to ask questions
  - Appreciate the “aha’s” revealed through time
  - Don’t jump to conclusions

Steps at a Glance: Run Chart

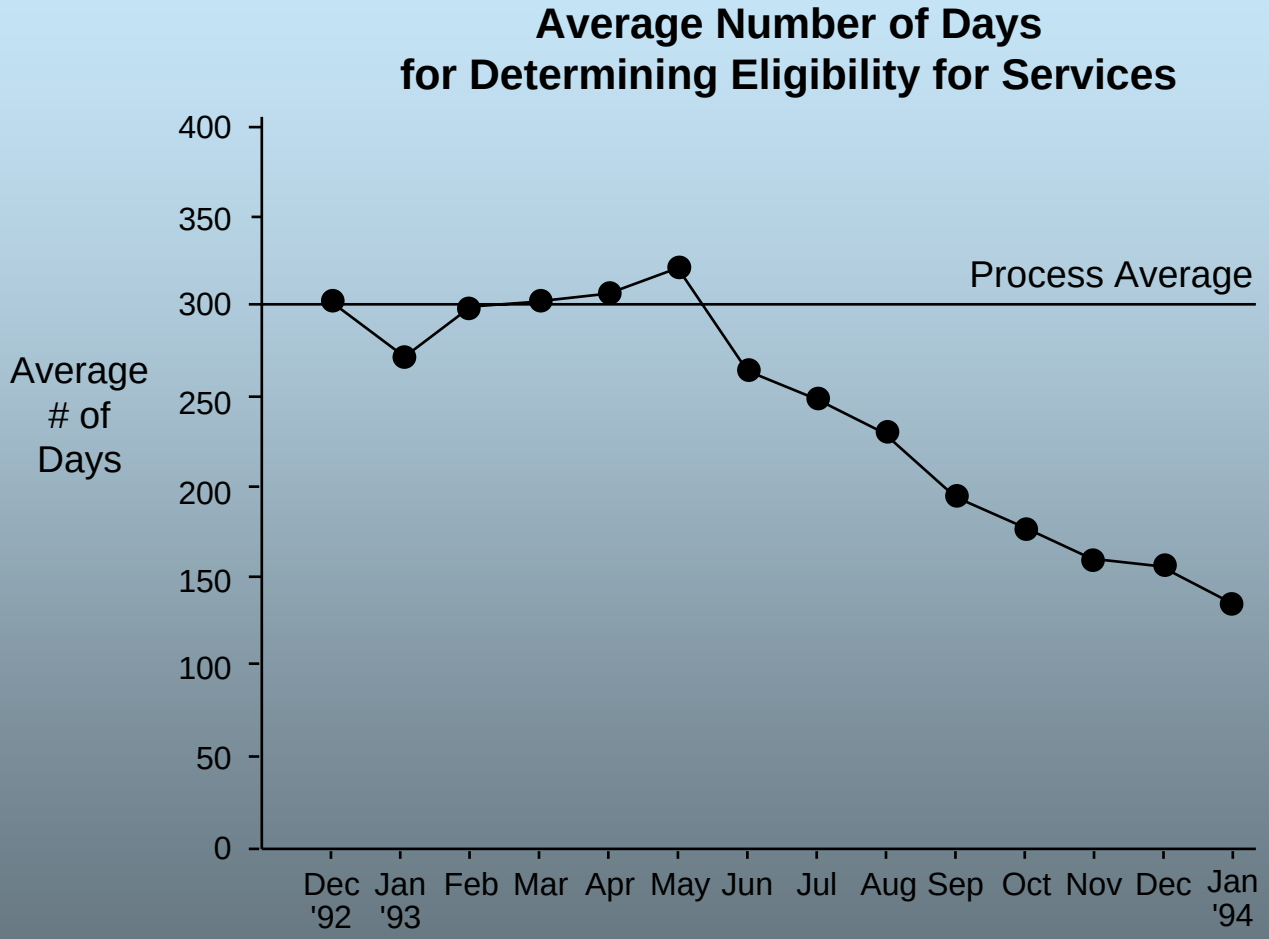


Step-by-Step Construction

– Step 4 Plot Data

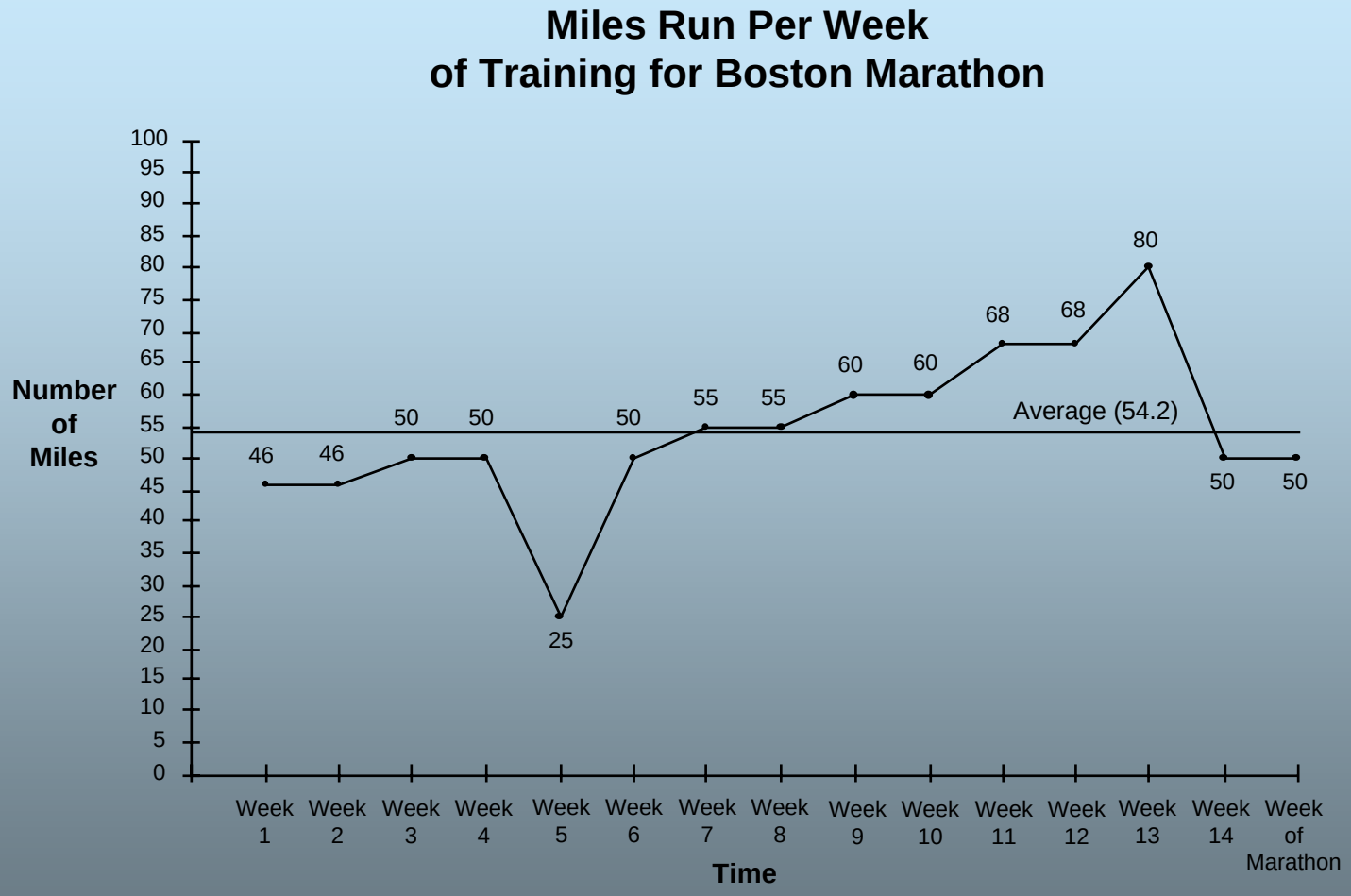


Run Chart Example



Information provided courtesy of Georgia State Department of Human Resources, Division of Rehabilitation Services

Run Chart Example



Analysis: (1) Dip in Week 5 is a result of getting the flu.

(2) Increased 10–15% every 2 weeks as part of training plan.

(3) Took one 22 mile run 2 weeks before marathon, which raised total to 80.

(4) Tapered of f in last 2 weeks to rest before marathon.

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