Problem-Solving Tools

What they are. When to use them. How to use them.

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Problem Solving Tools: What, When & How

Overview

This document presents 24 tools that are useful and valuable at various times in the course of solving a problem. The tools are listed on the right side of this page.

Not all tools are relevant all the time or in every instance, but some are quite useful much of the time and a few do have a role to play most of the time

The tools are presented one to a page. On the top part of the page is a visual showing an example of what the tool in question might look like. Visual representations of the tool in question can vary quite a bit so keep in mind that what is shown in this document is merely one example. On the bottom part of the page is a three-part table that describes what the tool is, when to use it, and how to use it; hence the title of this document.

You can jump around from tool to tool if you like simply by clicking on the tool name below. To return to this list, simply click on the name of the tool on the page it is presented.

Enjoy your foray through these tools.

List of Problem-Solving Tools

1. Affinity Diagram
2. Benchmarking
3. Brainstorming
4. Check Sheet/Tally Sheet
5. Control Chart/Shewhart Chart
6. Decision Tree
7. Fishbone/Ishikawa Diagram
8. Five Whys
9. Flowchart
10. Force Field Analysis
11. Gantt Chart
12. Goals Grid
13. Histogram
14. Mindmap
15. Nominal Group Technique
16. Paired Comparison
17. Pareto Chart
18. Relationship Diagram
19. Run Chart
20. Scatter Diagram/Scatter Plot
21. Standard Data Displays
22. Stratification
23. Tree Diagram
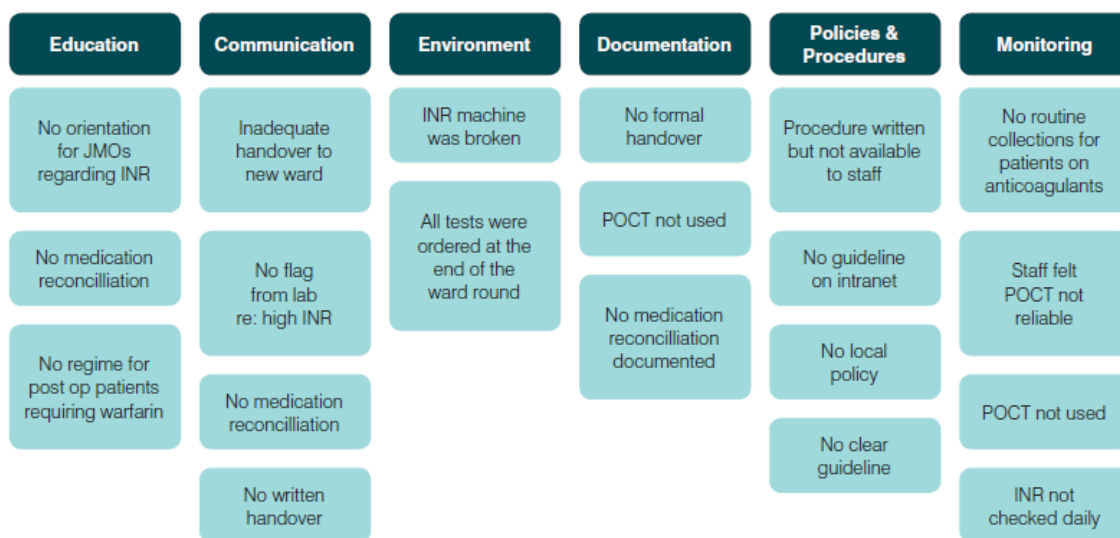24. Weighted Comparison

Tool Categories

The tools listed above fit into three basic categories: Visualizing Problem Structures, Displaying Data and Information, and Problem-Solving Techniques. The tools are sorted into these categories at the end of this paper. To access that page, click here. To return to this page, click on the title of the category page.

For Additional Information

There is wealth of information about these tools on the internet, easily accessible and, for the most part, free of charge. Simply Google the name of the tool about which you want more information.

Problem Solving Tools: What, When & How

Affinity Diagram

Education	Communication	Environment	Documentation	Policies & Procedures	Monitoring
No orientation for JMOs regarding INR	Inadequate handover to new ward	INR machine was broken	No formal handover	Procedure written but not available to staff	No routine collections for patients on anticoagulants
No medication reconcilliation	No flag from lab re: high INR	All tests were ordered at the end of the ward round	POCT not used	No guideline on intranet	Staff felt POCT not reliable
No regime for post op patients requiring warfarin	No medication reconcilliation		No medication reconcilliation documented	No local policy	POCT not used
	No written handover			No clear guideline	INR not checked daily

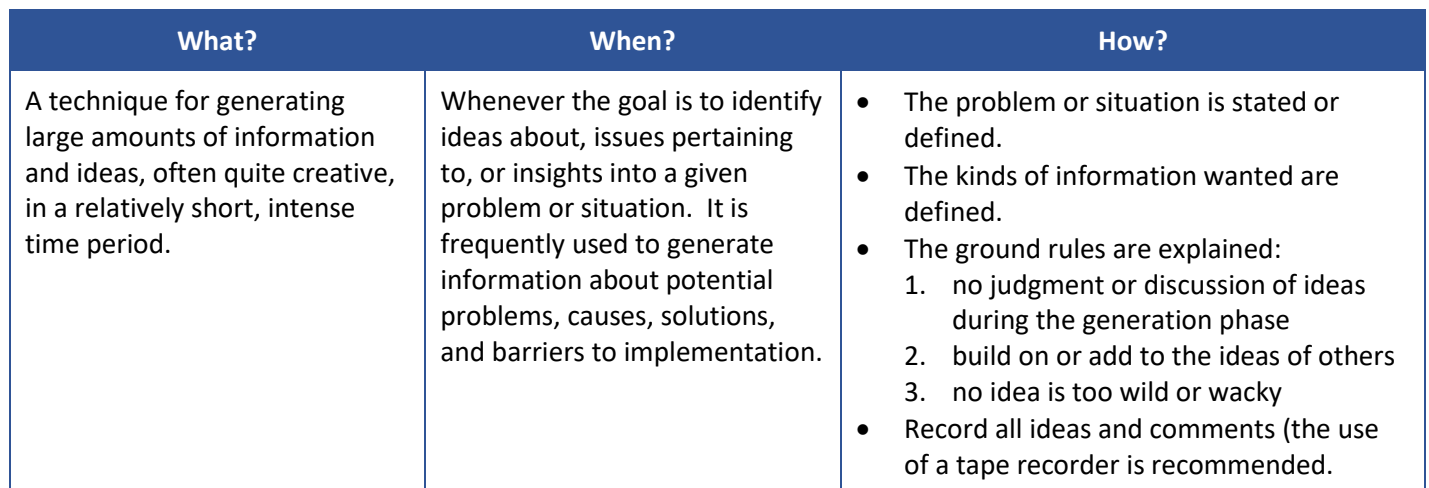| What?	When?	How?
A way of organizing, categorizing, and summarizing large amounts of information.	Any time large amounts of information have been generated, but particularly right after a brainstorming session.	• The issue or topic is stated • Ideas and/or issues are generated, usually as a result of brainstorming • These are then recorded on 3x5 or yellow stickies and distributed to the group or to sub-groups • The cards/stickies are then clustered into categories based on common characteristics • The clusters are discussed, and individual items moved from cluster to cluster as necessary • The final clustering is captured in a list of cluster headings and items in each cluster.

Problem Solving Tools: What, When & How

Benchmarking

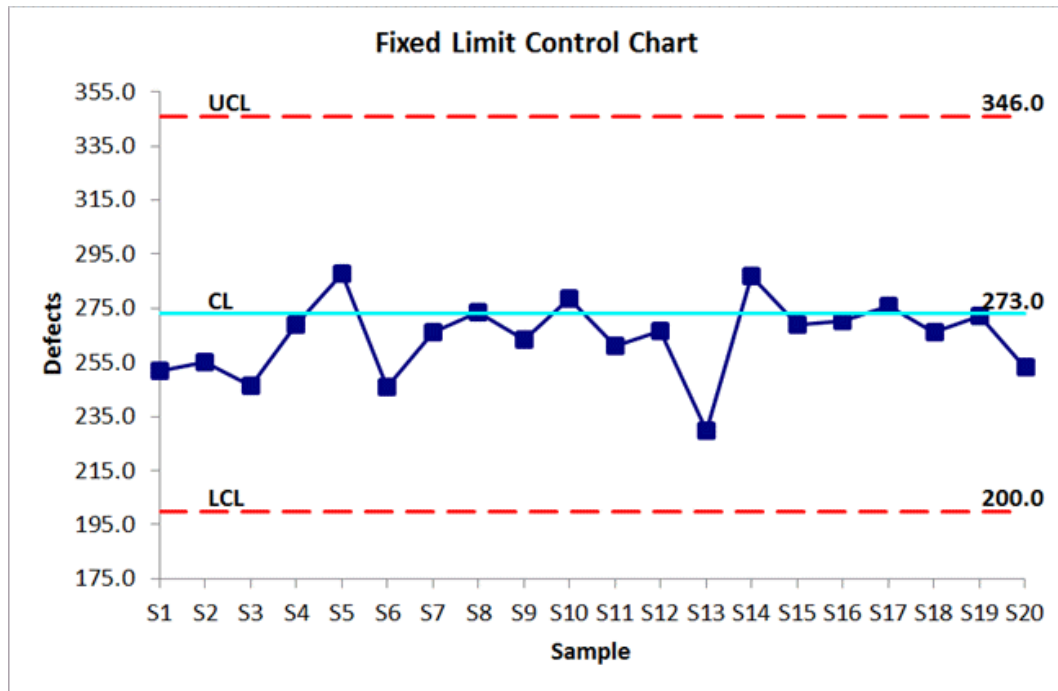| What?	When?	How?
A technique for identifying best-in-class performance for some aspect of organization (e.g., customer satisfaction, product quality, cycle times, unit costs, and so on).	To set standards or targets for an improvement effort, and to determine comparative performance of one's own organization.	• Determine what to benchmark and why • Form and train a benchmarking team • Identify and obtain participation from benchmark partners (exemplars) • Collect and analyze performance data • Produce a benchmark study setting forth conclusions and recommendations

Problem Solving Tools: What, When & How

Brainstorming

What?	When?	How?
A technique for generating large amounts of information and ideas, often quite creative, in a relatively short, intense time period.	Whenever the goal is to identify ideas about, issues pertaining to, or insights into a given problem or situation. It is frequently used to generate information about potential problems, causes, solutions, and barriers to implementation.	• The problem or situation is stated or defined. • The kinds of information wanted are defined. • The ground rules are explained: 1. no judgment or discussion of ideas during the generation phase 2. build on or add to the ideas of others 3. no idea is too wild or wacky • Record all ideas and comments (the use of a tape recorder is recommended.

Problem Solving Tools: What, When & How

Check Sheet/Tally Sheet

Category	Saturday	Sunday	Monday	Tuesday	Wednesday	Thursday	Total
Open stitch	II	IIIIII					8
Un even top stitch	I	IIII					5
Loop slanted	IIIIIIII	IIIII					13
Un cut thread	III	IIII					7
Over stitch	II	IIIIII					8
Down stitch	I	IIIII					6
Skip stitch	II	III					5
Uneven lob	III	IIII					7
Broken stitch	II	IIII					6
short stitch	I	III					4
Puckering	III	II					5
label displace	II	IIIIII					8
Raw edge out	I	IIII					5
Up-Down position	II	IIIIII					8
Rejected	II	IIIII					7
	35	67					102

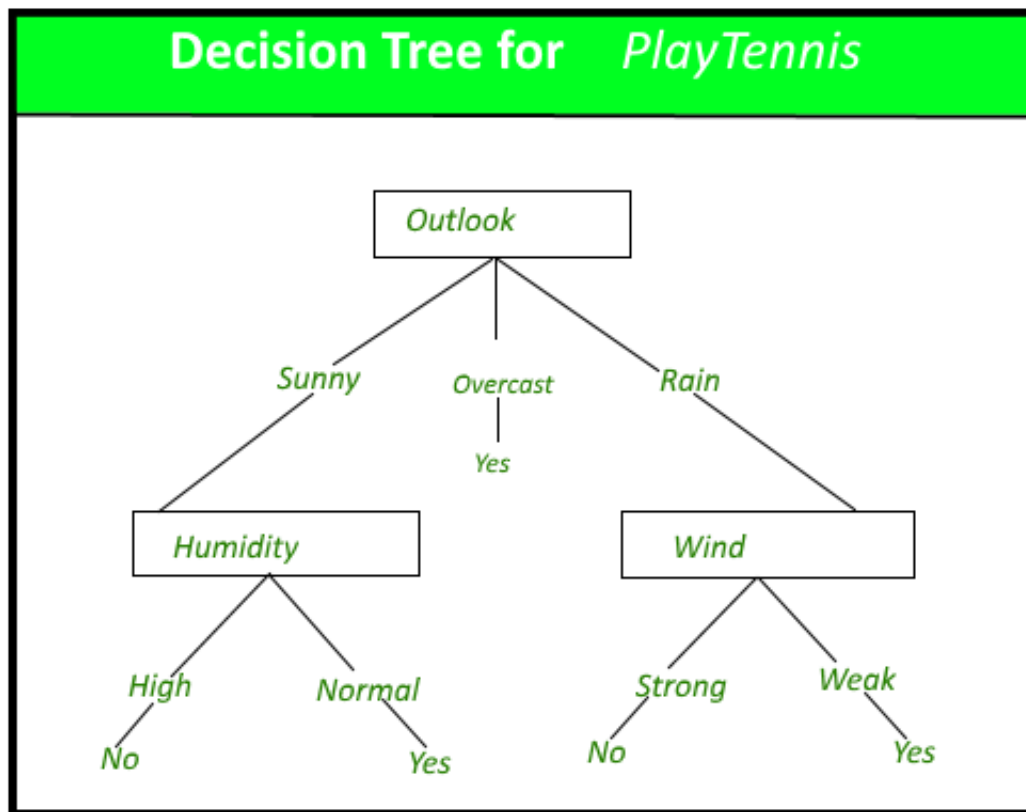| What?	When?	How?
A list or a diagram for recording the frequency with which events occur or their location. In essence, a checksheet is a tally sheet.	When frequency of occurrence or location is not known.	A simple form or diagram is made up and, as events occur, their frequency and location are marked on the form.

Problem Solving Tools: What, When & How

Control Chart/Shewhart Chart

Fixed Limit Control Chart

What?	When?	How?
Control charts are used to determine the range of variation in the performance of a process or system.	To identify the baseline performance of a system or process, and to monitor that performance over time. It is especially useful in distinguishing between systemic and special causes.	• Performance data are collected on a sampling basis • The mean and standard deviations are calculated and used to determine upper and lower control limits • Performance within the control limits signifies a process under control • Ordinarily, the use of control charts requires a minimum amount of statistical training.

Problem Solving Tools: What, When & How

Decision Tree

What?	When?	How?
Decision trees are a form of tree diagrams used to analyze complex decisions having quantitative aspects.	Whenever the consequences of complex alternatives need to be examined in the course of making financial or other decisions that are readily quantifiable.	• Work from left to right. • Start with the decision that needs to be made at the far left in a square. • Draw branching line out from the decision box that represent possible solutions. • Use squares to represent additional decisions that must be made, and circles to represent uncertain outcomes of the solutions. • Repeat the branching effort for additional decisions identified. • Calculate the values of the branches to identify relative cost-benefits of each solution.

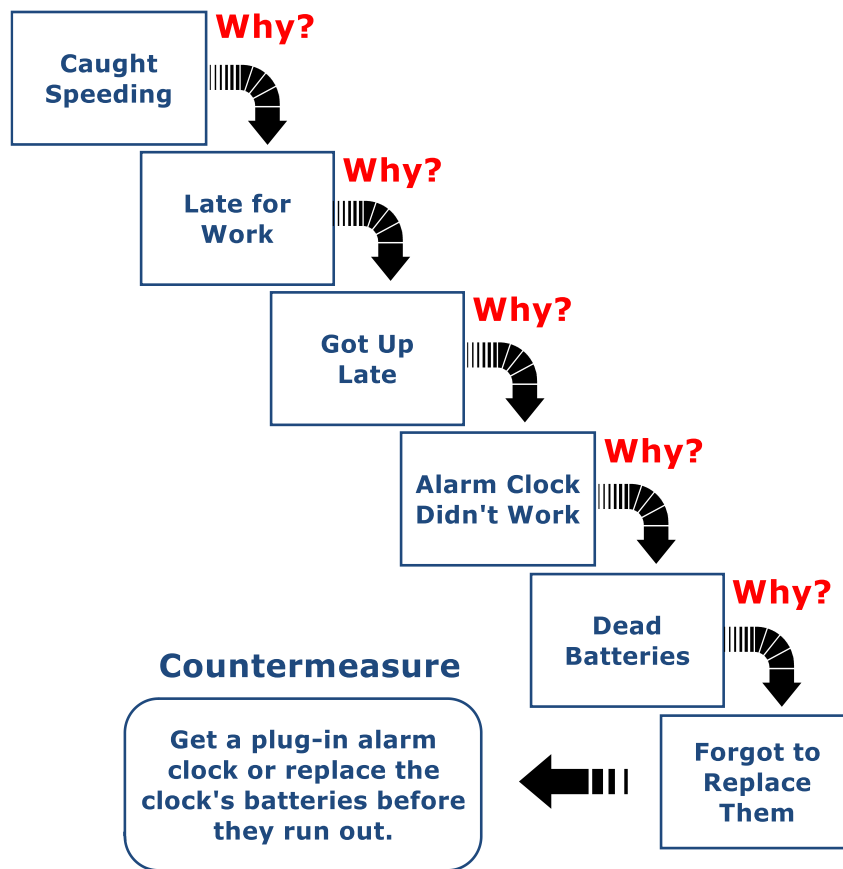# Problem Solving Tools: What, When & How

Fishbone/Ishikawa Diagram

Fishbone Diagram
Factors Reducing Competitiveness

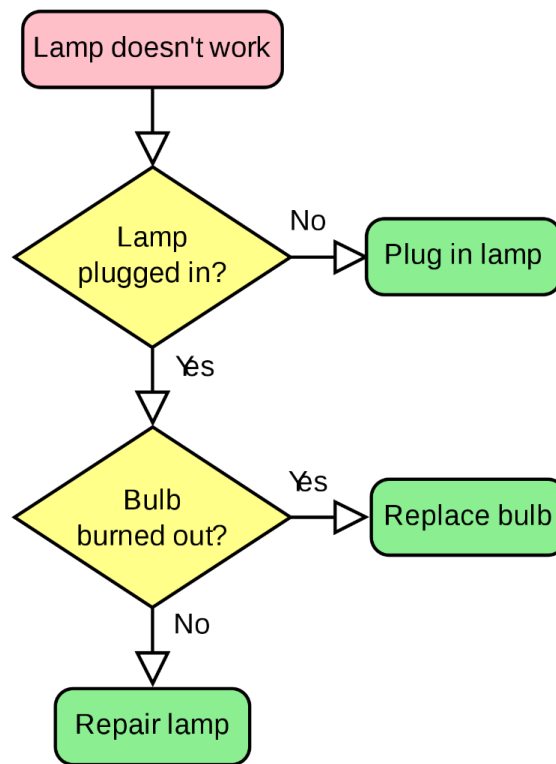| What?	When?	How?
A visual display of the elements making up the structure of a problem situation. It consists of diagonal lines off a horizontal center line, making it look somewhat like the skeleton of a fish, hence its name. The effect is shown at the right-hand end of the horizontal line, and the causes are shown on the diagonal lines.	After information about a problem or unwanted effect has been collected and needs to be organized into some kind of cause-and-effect relationship.	• Identify the problem or effect to be examined. • Write the effect in a box at the right-hand side of a piece of paper and draw a long horizontal line from it across the paper. • Select the major categories of causes (standard categories are people, materials, machinery, methods). • Draw diagonal lines away from the horizontal line and place boxes at the end of each diagonal; print the cause categories in the boxes. • Brainstorm for possible causes; write these along the diagonal lines. • Evaluate and analyze the causes generated.

Problem Solving Tools: What, When & How

Five Whys

Caught Speeding → **Why?**

Late for Work → **Why?**

Got Up Late → **Why?**

Alarm Clock Didn't Work → **Why?**

Dead Batteries → **Why?**

Forgot to Replace Them

Countermeasure

Get a plug-in alarm clock or replace the clock's batteries before they run out.

What?	When?	How?
The Five Whys offer one way of identifying the root cause of a problem. As the name implies, it's essentially a matter of asking Why? – five times in succession.	The technique is used whenever you want to delve deeper into the causes of a problem.	• First, state the problem. • Then ask, "Why?" (or "Why is this happening?") • Ask the same question four more times.

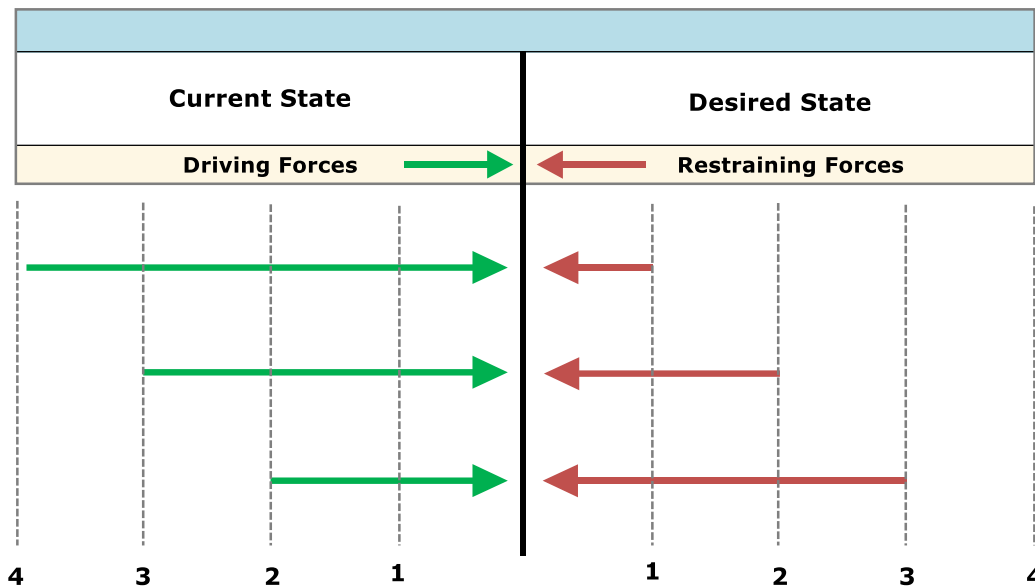# Problem Solving Tools: What, When & How

Flowchart

```
        ┌─────────────────┐
        │ Lamp doesn't work│
        └─────────────────┘
                 │
                 ▽
              ╱────────╲            No      ┌──────────────┐
             ╱   Lamp    ╲ ─────────────────▷│  Plug in lamp │
             ╲ plugged in?╱                  └──────────────┘
              ╲────────╱
                 │ Yes
                 ▽
              ╱────────╲            Yes     ┌──────────────┐
             ╱   Bulb    ╲ ─────────────────▷│ Replace bulb │
             ╲ burned out?╱                  └──────────────┘
              ╲────────╱
                 │ No
                 ▽
        ┌─────────────────┐
        │   Repair lamp    │
        └─────────────────┘
```

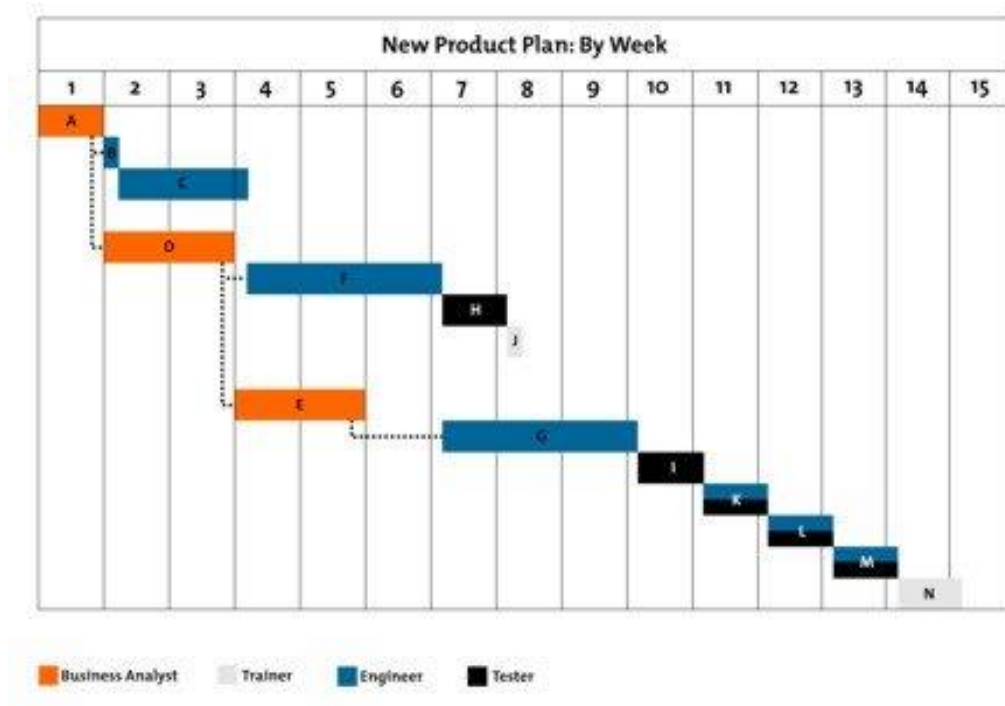| What?	When?	How?
A visual means of displaying the sequence of activities and decisions that occur in a system or process over time. Note: There are several different types of flowcharts, all using different symbols and coding conventions; however, all seek to show the flow of activities over time.	Whenever one wishes to understand or document the operation of a process or unit; most often as part of an effort to improve system, process, or unit performance.	• The process may be "walked," "talked," or both. • Walking the process is frequently the best way to identify processes involving the production or manufacture of physical goods. • Talking the process (i.e., interviewing people) is frequently the only way to identify information-based processes. • Preliminary diagrams are prepared and then reviewed and revised by knowledgeable people. • The final diagram constitutes a model that can be used to explain or analyze the system, process, or function.

Problem Solving Tools: What, When & How

Force Field Analysis

	Current State		Desired State	
	Driving Forces →	←	Restraining Forces	

```
   4      3      2      1        1      2      3      4
```

What?	When?	How?

Force-field analysis is a means of examining the forces in a situation that keep it as it is. This is often defined as dynamic stability or tension and is the result of driving and restraining forces that are in balance.	When one wishes to understand, and usually to change, the balance of forces in a given situation.	• Using a regular letter size piece of paper, the current state is listed at the top left.
		• The desired state is listed at the top right.
		• A vertical line is drawn from the center of the page to the bottom of the page.
		• Horizontal lines to the left of, with arrows pointing to the vertical line are used to indicate forces driving toward the desired state.
		• Horizontal lines to the right of, with arrows pointing to the vertical line are used to indicate restraining forces.
		• Driving and restraining forces are usually generated as the result of a brainstorming session.
		• Perceived strength of a force is indicated by the length of the arrow on a four-point scale
		    1 = Negligible
		    2 = Weak
		    3 = Strong
		    4 = Very Strong
		• Strategies are then developed to increase the driving forces and undercut the restraining forces.

Problem Solving Tools: What, When & How

Gantt Chart

New Product Plan: By Week

What?	When?	How?
A Gantt chart or harmonogram is essentially a bar chart. It was invented in the early 1900s by Henry Gantt and is named for him. It is used to illustrate project schedules and to show task dependencies (e.g., tasks that can't be started until other tasks are complete).	With respect to problem-solving efforts, a Gantt chart is most useful when planning and scheduling the implementation of large-scale or complex solutions, typically involving several people and tasks. That said, a Gantt chart can also be useful for much smaller, less complex undertakings.	Most people use spreadsheet software such as Excel and the software being used will determine how it is used. • Identify essential tasks • Identify task relationships • Input activities into software or template • Monitor progress and update chart as necessary

Problem Solving Tools: What, When & How

Goals Grid

No   Do You Have it?   Yes

| Achieve | Preserve |
| Avoid | Eliminate |

Yes   Do You Want it?   No

No   Do You Have it?   Yes

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What?	When?	How?

A Goals Grid is a tool for making sure you have attended to all your goals and objectives, especially when defining the solved state or "what should be." Its four cells are the result of arraying Yes and No answers to two questions:
1. Do we have it?
2. Do we want it?
	Whenever you are contemplating the ends you seek, whether as part of a problem-solving effort or some other effort aimed at realizing certain results.	• Ask yourself the questions in the Goals Grid:
		  1. What do I want to achieve?
		  2. What do I want to preserve?
		  3. What do I want to avoid?
		  4. What do I want to eliminate?
		• Fill out the Grid as you answer the questions.
		• Review it to ensure you have all your goals in mind.

Problem Solving Tools: What, When & How

Histogram

Histogram of arrivals

What?	When?	How?
Histograms are a form of bar chart. The shape of a histogram says a lot about the performance of a process or system.	Histograms are ordinarily used to display statistical data regarding a process or aspects of it (e.g., mean, median, mode, standard deviation, etc.). Their basic use is as a baseline to be used as a gauge against which to measure improvement.	The general process for constructing a histogram is as follows: • Determine the range of the data • Record the measurement unit used • Determine the number of classes (6 to 15) • Determine class width (divide range by number of classes) • Establish class midpoints and limits • Determine the X-Y axes for the diagram (frequency on Y axis and measurement scale on X axis) • Draw the graph • Title the histogram

Problem Solving Tools: What, When & How

Mindmap

What?	When?	How?
A Mindmap is a visual means of depicting a central idea and its many branches.	Mindmaps are used to organize thoughts about a central issue and can be used to capture the ideas generated in a brainstorming session. Other uses include: • organizing and planning tasks • developing concepts and ideas • preparing for presentations • note taking for later write-up	• The central idea is recorded in a box or circle at the center of a sheet of paper • Related thoughts are then reflected on lines branching out from the center • These initial branches are themselves the basis for further branching • Thoughts and ideas are recorded via key words on the lines used to lay out the branches • Color is used to distinguish various categories or clusters of ideas • Use images wherever possible

Problem Solver's Tool Kit

Problem Solving Tools: What, When & How

Nominal Group Technique

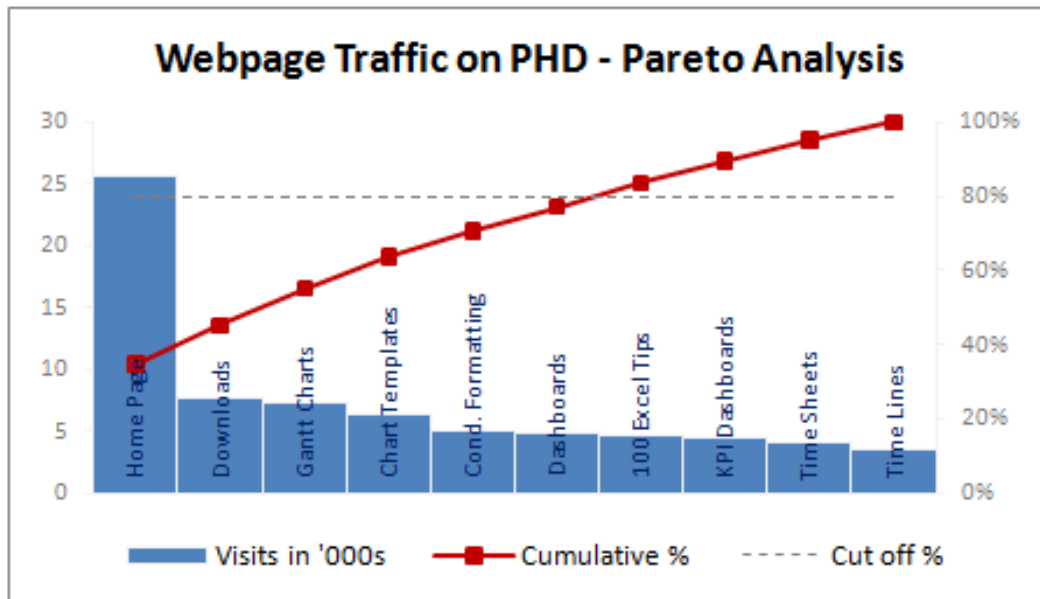| What?	When?	How?
Nominal Group Technique (NGT) is a structured group activity similar to brainstorming.	NGT is used to generate and evaluate or rank a series of actions or solutions. It is often used after a brainstorming session to organize and evaluate the products of the brainstorming session.	• The problem or decision is stated by the facilitator • Ideas are generated or imported from a previous brainstorming session • The group then discusses the ideas and clusters them into related groupings • Evaluation criteria are developed • Each team member selects and rank orders five to eight of the ideas generated • The facilitator consolidates the individual rankings • The highest-ranking items are discussed, and consensus developed • The end product is a consensual decision or chosen course of action (i.e., a solution)

Problem Solving Tools: What, When & How

Paired Comparisons

	A	B	C	D	E	F	G	H	I
A: Appreciation		A	A	A	A	A	A	A	A
B: Achievement			C	B	B	B	G	B	B
C: Work condition				C	C	C	G	C	C
D: Power					D	D	G	D	I
E: Creativity						F	G	E	I
F: Interest							G	F	I
G: Financial benefits								G	G
H: Relationship									I
I: Self development									
Count	8	5	6	3	1	2	7	0	4
Rank	1	4	3	6	8	7	2	9	5

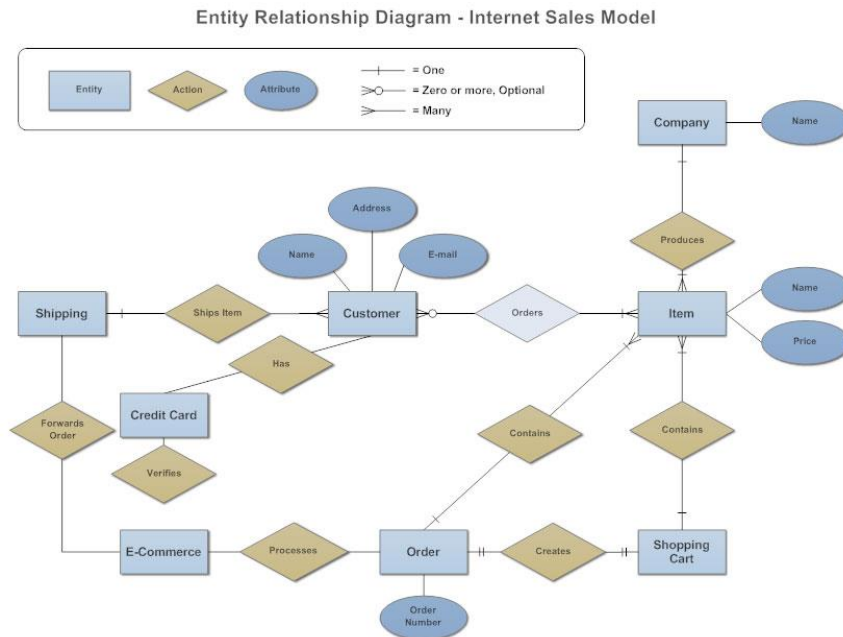| What?	When?	How?
Paired comparisons is a forced-choice method of determining the preferences for or priorities among several competing options (e.g., proposed solutions).	This method is used to make choices among options having similar or equal merit.	• Create a matrix with the same number of rows and columns as there are options to be considered • List and number the competing options in some order along one side of the matrix and in the reverse sequence along the other side • Make certain each option has the same number on both sides of the matrix • Blank out the cells where the options are compared against themselves (these will represent a diagonal line) • Blank out all the cells on one side of the diagonal line just blanked out • Using the remaining cells compare each option against each of the others • Note the number of the preferred option in the cell where the comparison is performed. • When finished the option with the greatest number of entries in the matrix is the preferred choice • If two options have the same number of entries in the matrix, the preferred choice is the choice made when the two were compared with one another

Problem Solving Tools: What, When & How

Pareto Chart

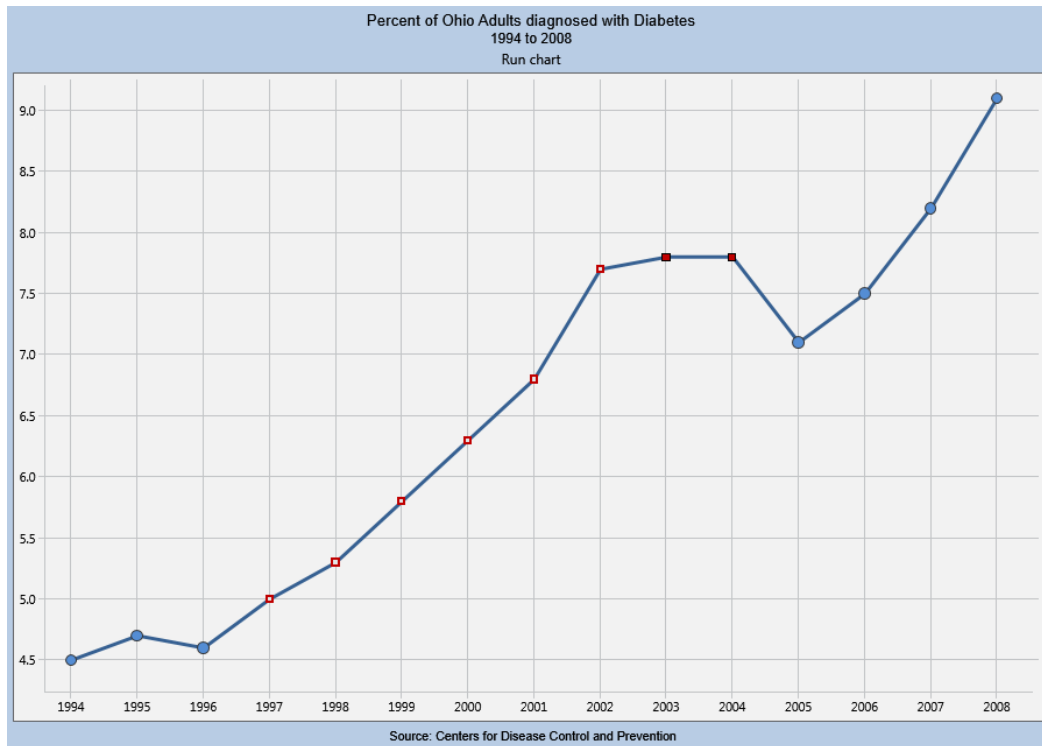| What?	When?	How?
Pareto Charts are a combination of bar graph and line graph.	Pareto charts are used to depict the distribution or frequency of an occurrence (e.g., defects, an error message, the amount of a sale, etc.). When used in relation to possible or probable causes, a Pareto chart separates the "vital few" from the "trivial many."	• Collect the data to be analyzed • Add up the totals for each item • List the items from left to right in descending order of magnitude • Calculate the total for all items • Calculate the percentage each item represents of the total • Determine the cumulative percentages starting with the leftmost item • Create a bar graph using the item totals • Draw a line graph using cumulative item percentages • Identify the vital few (usually at the 80% cumulative percentage mark)

Problem Solving Tools: What, When & How

Relationship Diagram

Entity Relationship Diagram - Internet Sales Model

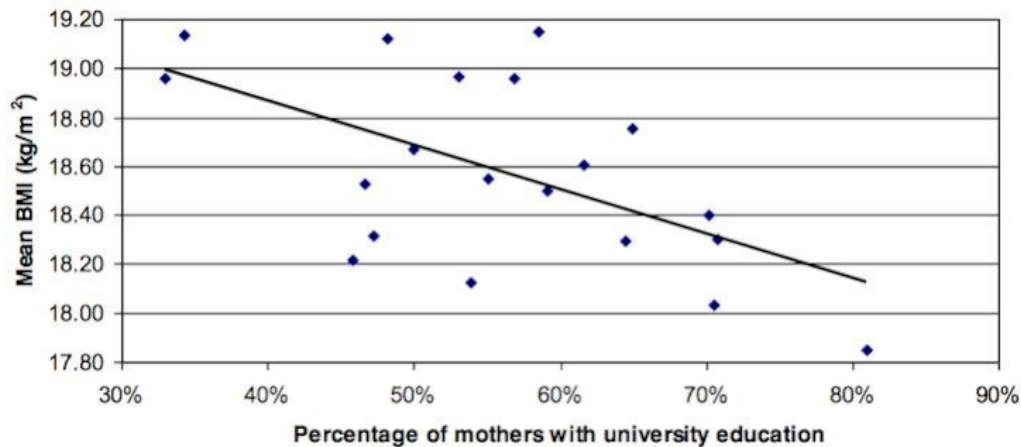| What?	When?	How?
Relation diagrams consist of labeled boxes (or circles) with lines drawn between and among them to reflect causal relationships.	Relationship diagrams are typically used when the cause-and-effect relationships in a situation are complex and unclear. They are often used in the course of: • responding to market/customer complaints • promoting quality in purchased/ordered items • improving process controls • reforming administrative/business units	• The problem or situation is stated by the team leader or facilitator • Issues and ideas regarding their resolution are generated and recorded on 3x5 cards or yellow stickies • The 3x5 cards or yellow stickies are then taped to a whiteboard/easel sheet in a circle • Each item is then examined in relation to every other item • If a connection exists, a line is drawn connecting the two; a line into an item means it is the effect; a line out of an item means it is the cause • Items with the most arrows pointing in are the primary effects of interest • Items with the most lines going out of them are the main or chief drivers of the problem • The relationships are then examined with an eye toward identifying possible solutions

Problem Solving Tools: What, When & How

Run Chart

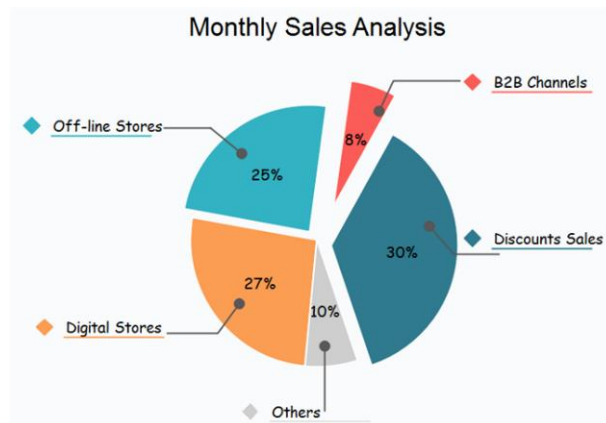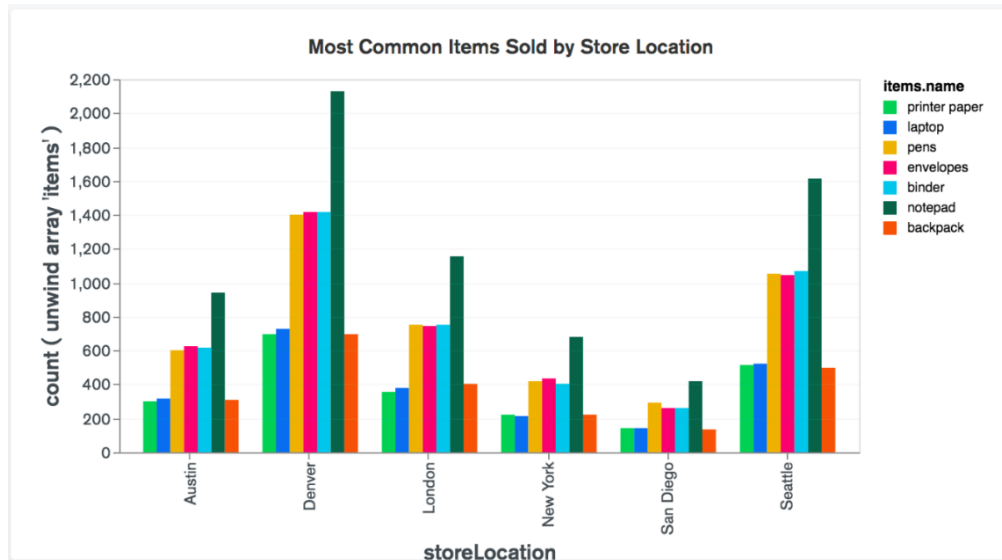| What?	When?	How?
Run charts are a form of line graph.	Run charts are used to graph data over time. You could, for example, use a run chart to record and graph the time it takes you to get to work during a given time period or using a certain route. The main purpose for using run charts is to detect patterns and trends.	• Gather data • Organize data • Chart data • Interpret data

Problem Solving Tools: What, When & How

Scatter Diagram/Scatter Plot

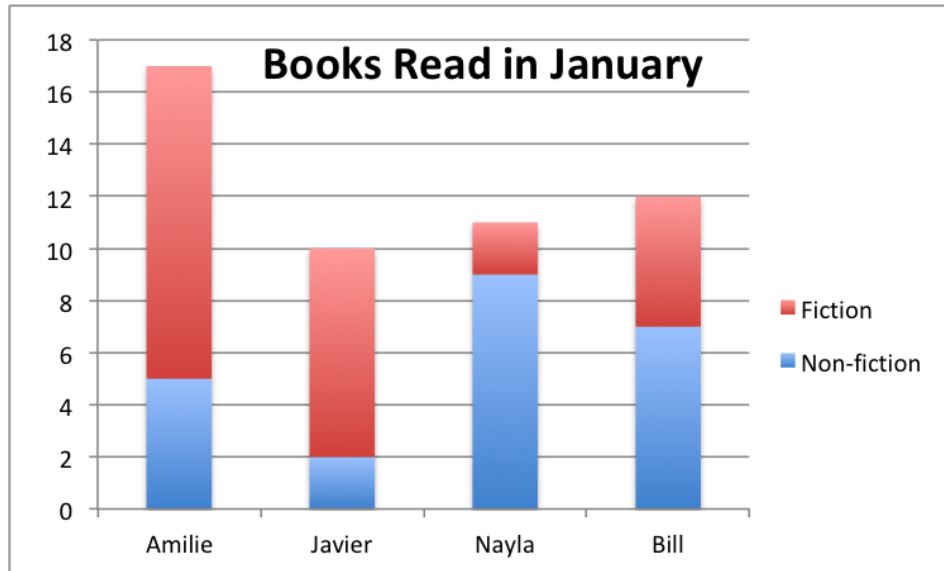| What?	When?	How?
Scatter diagrams or plots depict the relationship between two variables.	Scatter plots and diagrams are used primarily to determine what, if any, relationship exists between two variables. The most common patterns revealed by way of scatter plot analysis are: 1. definite positive correlation 2. possible positive correlation 3. no correlation 4. possible negative correlation 5. definite negative correlation One common scatter plot consists of the dollar amount of outstanding invoices plotted against the time it is outstanding or owed.	• Collect paired data regarding variables thought to be related • Construct a three-column data sheet listing each item, its data for variable 1, and its data for variable 2 • Construct the axes of the data plot • Place the dependent variable on the X axis • Place the independent variable on the Y axis • Plot the data • Interpret the data plot

Problem Solving Tools: What, When & How

Standard Data Displays

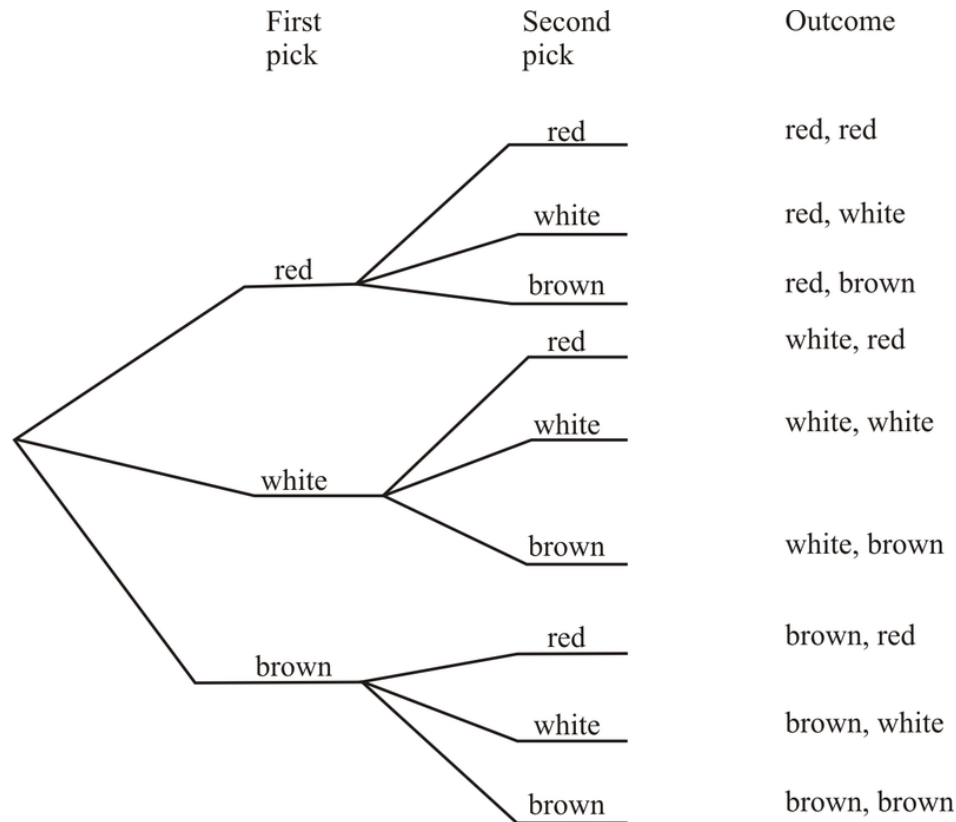| What?	When?	How?
These consist of bar and line graphs, and pie charts.	Generally speaking, standard data displays are used to show distributions, proportions, and so forth. Their basic use is to convert numerical data to visual form.	All spreadsheet software programs such as Lotus or Excel, and most word processing software programs such as Word and WordPerfect, contain standard data display provisions. They are hardly ever drawn by hand anymore.

Problem Solving Tools: What, When & How

Stratification

What?	When?	How?
This is a method of dividing and displaying data. It often takes the form of a stacked bar chart.	Stratification is used to get at finer-grained causal variables that can be hidden in high-level data displays. Hence, the need to divide the data. One could, for example, depict the absentee hours for various divisions within an organization in a bar chart with one bar for each division. Each bar could then be stratified to indicate the reason for absenteeism (e.g., sick, vacation, traveling, etc.).	• Collect high level data • Analyze for lower level data • Construct data display • Analyze data display for patterns • Identify possible problems, causes, and solutions

Problem Solving Tools: What, When & How

Tree Chart

	First pick	Second pick	Outcome
red		red	red, red
		white	red, white
		brown	red, brown
white		red	white, red
		white	white, white
		brown	white, brown
brown		red	brown, red
		white	brown, white
		brown	brown, brown

What?	When?	How?
Tree diagrams are most recognizable in one of their vertical forms -- the organization chart. Tree diagrams can also be structured to be read from left to right or right to left.	Tree diagrams are used to depict the structure of the variables in the situation. One common use is to depict a hierarchy of goals and objectives. A second common use is to indicate many layers of cause-and-effect relationships. Tree diagrams are also useful in decomposing many financial and operational measures of performance (e.g., ROI can be depicted in tree chart form).	1. State the problem, issue, or goal 2. Place it at the left, right, or top of the page 3. Identify the factors that affect or contribute to the main issue 4. Place these below or to the right or left of the main issue or goal 5. Repeat steps 3 and 4 until the tree-like structure of the situation has been fully elaborated

Problem Solving Tools: What, When & How

Weighted Comparison

Criteria	Weight	SPEM	OPF / OML	SOCCA	BPDM
Ease of Use	4	4	4	2	3
Industry Support	4	5	4	0	1
Tailoring	5	3	3	0	2
Mapping	3	4	1	0	2
Improvement Over Current Practice	5	5	5	3	4
Measurement Data	2	1	1	1	1
CMMI Support	5	5	5	3	5
Related Elements	3	3	3	3	3
Tool support	5	5	2	2	2
Weighted Total		149	121	59	98

What?	When?	How?
Weighted comparison is a method for comparing different options against a given set of criteria that have been weighted.	Weighted comparisons are ordinarily performed as a way of examining the relative merits of a set of options.	• List the options to be considered • List the criteria to be used in evaluating the options • Assign weights to the criteria • Construct a matrix with the options across the top and the criteria down the left side, along with a totals row running across the bottom of the matrix; indicate the weighting factor next to each criterion • Draw a diagonal line in each cell of the matrix • Develop a rating scale (1 to 5, or 1 to 10) for rating the options • Rate each option for each criterion, writing the rating in the cell for that option • Sum the weighted products for each option and enter in the weighted total column at the bottom of the matrix • The option with the highest total weighted score is the preferred option

Problem Solving Tools: What, When & How

Categories of Problem-Solving Tools

Diagrams for Visualizing Problem Structures	Tools for Capturing and Displaying Data and Information	Problem-Solving Techniques

• Affinity Diagrams
• Fishbone or Ishikawa Diagrams
• Flowcharts
• Mindmaps
• Relationship Diagrams
• Tree Diagrams
	• Check Sheet/Tally Sheet
	• Control Charts
	• Gantt Chart
	• Goals Grid
	• Histograms
	• Pareto Charts
	• Run Charts
	• Scatterplots
	• Standard Data Displays
	  - bar graphs
	
	  - line graphs
	
	  - pie charts
	
	• Stratification
		• Benchmarking
		• Brainstorming
		• Decision Trees
		• Five Whys
		• Force-Field Analysis
		• Nominal Group Technique (NGT)
		• Paired Comparisons
		• Weighted Selection

About the Author

Fred Nickols is an organizational generalist, a writer, consultant and former executive who spent 20 years in the U.S. Navy, retiring as a decorated Chief Petty Officer. In the private sector, he worked as a consultant and then held executive positions with two former clients. Currently, Fred is the Managing Partner at Distance Consulting LLC. His web site is home to the award-winning Knowledge Workers' Tool Room and more than 200 free articles, book chapters and papers. Fred writes the "Knowledge Workers" column for ISPI's *PerformanceXpress*. A complete listing of all columns is available here.