Quality improvement and TQM (total quality management) processes use a variety of data collection and analysis tools for program improvement. The following examples are six of the most frequently used tools. The examples describe what the tool is useful for, and demonstrates how to use the tool and interpret the results. The examples we provide are grounded in STW practices, but these tools may easily be applied to other educational settings.

The quality improvement processes are also used as a tool for gathering, organizing, interpreting and synthesizing information. These processes are frequently used by teams to facilitate inclusion, consensus building, and prioritizing.
How to construct a flowchart.

Flowcharts provide a visual representation of a process (a sequence of events, actions, or decisions). To create a flowchart, team members break down a process into a series of steps, decision points (or alternatives), and a flow sequence. A flowchart helps simplify the analysis of a process by identifying the essential steps in a process and depicting how each step in relates to the next.

Flowcharts are used to:
- Show a sequence of events or instructions.
- Show stages in the development of a product (or service).
- Write instructions.
- Plan a course of action.
- Solve problems.
- Show consequences of a decision.
- Show cycles of an event.

Source: VICA Total Quality Curriculum (1993)

Flowcharts help team members identify: 1) how the process currently operates; 2) errors and gaps in the process; 3) positive and negative impacts of the process; and 4) ways to improve the process.

How to construct a flowchart.

Flowcharts are based on a common set of symbols:

- Ovals are used at the start and the stop points.
- Rectangles are used for action points.
- Diamonds are used for questions at decisions points.
- Arrows are used to show the flow of steps and events.

1. Select a process, event, plan, or cycle to analyze.
2. List the primary steps of the process. (Use 2x2 post-its.)
3. Place post-its on the wall in order of occurrence.
4. Determine:

   **Action points** - use □ symbols. Each step should be represented by a rectangle. Check to make sure each step represents only one part of the process and no steps in the actual process are missing.
**Decision points** - use ◊ symbols. Decision points occur at the end of each step and prior to the following step. Decision points can represent yes/no questions or alternative paths to the next step.

**Flow** - Review the steps to determine if they represent the actual sequence of events, or steps in the process. Use ⇒ symbols to show the flow of events and alternative paths at decision points.

5. Team reviews flowchart to identify:
   - Missing steps or gaps in the flow.
   - Missing alternatives or gaps in the flow.
   - Repeated or unnecessary steps.
   - Repeated or unnecessary loops.

6. Determine if the flow chart is valid—does it represent how the process actually occurs throughout the school? Teams may submit the flowchart for review by others to determine validity and accuracy. The flowchart may also be compared to flowcharts of other similar processes.

7. Review and analyze completed flowchart to determine what can be improved.

For an example of a flowchart please refer to the case study, page 1.
Next Steps: Deployment Charts

Deployment Charts help determine who is responsible for carrying out steps and making decisions in a process. To construct a deployment chart, first create a table where each step and decision point from the completed flowchart is in the left hand column in order of occurrence. Determine principal and secondary participants in the process; this includes who is responsible for individual actions and decisions, and those who actually conduct the actions. Complete the chart. A deployment chart is useful for identifying who does what and for determining weak links or missing roles in the process.

For an example of a deployment chart please refer to the case study, page 6.
What is a Check Sheet?

Check sheets are used to record a variety of data in a simple format. Check sheets use a standardized format in which data can be recorded in a uniform way (by checking boxes, tallying, or recording numbers) from one source or a variety of sources. Check sheets are typically used to list occurrences, items, or events; record number of participants; and to count use, errors, or defects. Checks, numbers, or tallies are totaled and displayed for an easy and efficient analysis of information.

How to Construct a Check Sheet.

1. Determine the problem or process to review and the data to be collected. First, decide what it is you want to know. Then decide what information and data will provide you with that knowledge.

   Data may include:
   - Counts of errors in a process
   - Number of participants
   - Number of times a service or product is used
   - Counts of occurrences or events
   - Other quantifiable characteristics

2. Construct a checklist. Decide how the check sheet design will facilitate data collection and if it will display the information in an accessible way. The check sheet may take a variety of forms:

   - Tables – identify headings, rows and totals
   - Logs – such as sign-in sheets, hours worked, etc
   - Criteria lists – check if criteria is met
   - Forms – use existing forms to collect data

   Identify each sheet by time, date, data collector, and location.

3. Field test the check sheet. Review the check sheet for ease of use, validity (Does the check sheet measure what you want it to measure?), and reliability (Does it measure accurately and consistently?). Revise the check sheet as needed.

4. Train the data collectors on how to use the check sheet. Describe the data collection process to be followed. Stress the necessity of collecting and entering accurate data.
4. Collect data. Decide how long data will be collected—for one day, two weeks, a semester.

5. Collect all check sheets. Note different data collectors, times, dates, and location. Aggregate check sheet subtotals and totals. Display the results in a simple format (as a graph, table, histogram, pareto chart, or scatter diagram.

For an example of a checklist refer to the case study, page 3.
**What is a Cause and Effect Diagram?**

Cause and Effect Diagrams are used to determine the variety of possible causes of a single effect. Teams can use cause and effect diagrams to determine the root causes of a problem and to organize and understand the causes or factors which affect a process. The completed diagram illustrates the relationship between cause and effect, and the process of completing the diagram benefits team members by providing a rational understanding of the major factors and relationships affecting a problem or process.

**How to construct a Cause and Effect Diagram**

1. Determine the problem or process to review. Teams may select to review a specific problem. If teams select to review a process, it is often easier to analyze each step of a process (such as the steps identified in a flowchart) individually. The selected problem or step is the “effect”—the focus statement to be analyzed and improved. The effect is the main stem of the diagram and is labeled on the right.

2. Each branch of the diagram represents a major cause category (or class of causes). Teams members can determine the major causes or themes by using a brainstorming or affinity process. Use generic headings to label the major branches. The complexity of the diagram is determined at this step—a few general headings will result in a fairly simple diagram, whereas many specific headings will generate a more complex diagram.

The affinity process (described on page 15) allows teams to generate individual, detailed causes. These causes are then grouped into similar themes or major causes. The advantage of using the affinity process is that it addresses both the major and offshoot branches of the diagram.

3. The offshoots of the major branches represent more detailed causes. Team members can generate these causes through brainstorming, an affinity process, or by asking probe questions to get at the lowest level of causes by asking “why does this happen?”. Be careful to list causes, not symptoms.

4. Teams may choose to prioritize specific causes to focus on for improvement. Priorities may be set by determining which causes are most urgent or most prevalent. Teams may also choose to prioritize causes for which they currently have the resources and ability to improve or affect.
Interpolation:

This cause and effect diagram depicts major and minor causes for an observed problem. The problem shown in this diagram is the lack of parent knowledge of work-based learning options. This team used an affinity process to determine four major themes and their root causes. The four major branches represent problems in communication, marketing, understanding, and contact. Offshoots from each of these branches represent the individual responses team members developed using the affinity process. (The affinity process is described on page 15.)
Histogram

What is a Histogram?

Histograms are bar graphs which display the distribution, frequency, changes, and variation of data. The histogram provides a graphical picture of data for analysis and problem solving. Histograms typically represent sets or groups (represented on the horizontal or X-axis) of data which are compared to frequencies, counts, observations (represented by numbers on the vertical or Y-axis). For example, data on tests scores of students could be displayed as a histogram. On the X-axis, grades (A-F) are represented by five bars. On the Y-axis, the number of students achieving each grade are represented.

The information on a histogram can show variation in data, between groups, across time, or across locations.

How to construct a Histogram.

1. Collect data which address the problems or areas to improve in a process. Each “observation” or “count” represents one unique piece of data collected from a process.

2. Total data collected. Determine the range of data by subtracting the smallest value from the largest value.

3. Group data in appropriate sets, groups or cells—each set will be a bar on the histogram chart. The sets should be similar in size, and make sense for interpretation. For example, grades (A-F), age ranges (11-12, 13-14, 15-16, 17-18, 19-20), or times in the day (8-10am, 10-12noon, 12-2pm, 2-4pm, 4-6pm, 6-8pm) are all examples of the kinds of sets you may choose.

4. Determine the scale to use on the vertical axis. The scale should begin with 0 or the least number of occurrences and cover the range of occurrences including the highest number of occurrences.

5. Total the counts or occurrences which fall into each group or set.

6. Construct the graph, with values on the X-axis running from minimum on the left to maximum on the right. Label groups or sets on the horizontal axis. Label counts or occurrences numerically on the Y-axis, with minimum values at the bottom and maximum values at the top.

7. For each group, fill in a bar as tall as the number of occurrences recorded for that group.
8. Analyze the histogram.
   - Look for variation or the dispersion of the bars. Determine how much variation is to be expected. Differences in variation form the expected results may indicate either strength or problem areas.
   - Note any center or average. Determine how close the average is to the target, goal, or results expected.
   - Note typical “shapes”. There may be a distinct group which stands out, with significantly lower (or higher) occurrences. This would be a “skewed” histogram. Another common shape is a bell curve, where the distribution of occurrences peaks in the middle, and falls off at each end. This is sometimes referred to as a normal distribution. Other shapes may include a flat shape or a shape with two centers. Interpret these shapes with caution; each process has its own “normal” distribution, for some processes a skewed shape may be “normal”.

Example:

Survey Question: How familiar are you with the concepts of School-to-Work?

Interpolation:

This histogram represents the responses from one survey question obtained from a faculty survey conducted by the team. The graph illustrates faculty’s average level of familiarity with STW in each years-of-service category. The x-axis represents the years of faculty service grouped into 5 year increments from 0 to 20 years of service. The y-axis represents the level of familiarity with STW measured with this one question. The number of faculty responding in each category is shown at the top of each bar. This histogram shows that faculty with 0-5 years of experience were more familiar with STW. The level of familiarity drops off as years of service increases.
What is a Pareto Diagram?

Pareto diagrams are used to identify factors which have the greatest (or least) effect on a process. By grouping the frequencies of occurrences in descending order, the essential factors can be easily analyzed. These charts can be used to determine which factors are more prevalent or problematic in a process. Analysis of Pareto diagrams can also help a team to prioritize which factor may need the most attention.

How to construct a Pareto Diagram.

1. Use the data you collected for the Histogram Chart, or any other similar data.

2. Find the total frequency of the data. Find the cumulative frequency for each category of the data. Example: The total frequency is responses to a survey question is 100%. If 30 out of 90 teachers reply in one category, there is a 33.3% response rate for this category \([30/90 \times 100 = 33.3\%]\).

3. Arrange each category of data from largest to smallest.

4. Label the Y-axis with the frequency of the observations. Label each category of data on the X-axis.

Example:

Survey Question: What is the primary barrier to integrating career information into your curriculum?

Faculty Survey Responses

Categories of STW Programming
Interpolation:

This diagram takes similar data as was used in the previous histogram and recasts it in a different format. Rather than comparing the level of familiarity with years of service, the pareto chart rank orders the percentage of respondents indicating that they were unfamiliar with a particular program in descending order. A team could use these results to prioritize which program or activity to emphasize in an in-service for the faculty. The diagram illustrates the highest level of unfamiliarity was with youth apprenticeship while the lowest level of unfamiliarity was with cooperative education.
What is a Scatter Diagram?

Scatter diagrams show correlation or relationships between two variables. The diagram can be used to see if there is a potential cause and effect relationship between two variables. A scatter diagram creates a pattern of data points which shows if two variables are related, and if so, whether it is a positive correlation (as one variable increases, so does the other variable) or negative correlation (as one variable increases the other decreases). The diagram will also indicate the strength of the relationship.

How to construct a Scatter Diagram.

1. Collect data for the scatter diagram. Data should be “paired”; for example, the relationship between level of education and annual income could be illustrated in a scatter diagram.

2. Create the diagram by placing one variable on the horizontal axis (the X-axis) and one variable on the vertical axis (the Y-axis). The scales for each axis should increase from left to right and from bottom to top.

3. Plot the data on the graph by placing a dot at the point where the two variables for each set of paired data intersect.

4. Interpret the results of the scatter diagram. There are three common results: a) positive correlation; b) negative correlation; and c) no correlation (refer to the examples below). The closer the dots are to each other, the “stronger” the relationship. If the dots are scattered loosely across the graph, this indicates that the relationship is not strong, or that there is no relationship. If the dots form a close line across the graph, this indicates that as one variable changes the other changes by a similar amount. This correlation can be either positive (as one variable increases so does the other) or negative (as one variable increase the other decreases).

5. The scatter diagram will indicate general relationships and correlation between two variables. However, keep in mind that the diagrams do not prove causality—they do not prove that one variable is causing the effect in the other variable.
Example:

Survey Question: How useful were your career plans in selecting postsecondary education?

![Student Survey Responses](image)

Interpolation:

Can you spell heteroskedastic? That’s statistical mumbo-jumbo for a plot not uniformly grouped around a best-fit-line. Note the spread of dots gets wider as the GPA goes up. The scatter plot shows career plans are seen as increasingly useful at relatively low GPAs. Past the 2.0 GPA, however, the level of usefulness is much more difficult to predict. For example, many students with high GPAs may only consider college as a viable postsecondary option and find career plans less useful.
Affinity grouping is a way of structuring large amounts of information in order to look for underlying patterns. This process is frequently used by teams or in focus group sessions as a means to allow input from all members. The value of this tool lies in the arranging and rearranging of information to pull out common themes, synthesize diverse perspectives, and form new ideas and ways of thinking.

Instructions:

1. **State the issue/question** to be discussed.

2. Team members **brainstorm ideas** either individually or as a group. Write each idea on a separate post-it note.

3. **Gather the post-it notes together** and randomly spread them out in a large space.

4. Individually, or as a team, **group similar post-it notes**. To begin, find two post-it notes containing similar ideas and place them together. Repeat for all of the post-it notes, either adding them to existing groups or forming new groups of similar ideas, until the team reaches consensus. Arrangement and order are not important and groups containing one post-it note are all right.

5. **Create a title** for each group of post-it notes. Titles should summarize the content of all of the ideas in a group in a concise, meaningful way. Write titles on post-it notes and place each with its appropriate group.

6. **To summarize**, write these titles on a piece of paper. Underneath each title, list each of the ideas in that group. Order is not important.

Adapted from the VICA Total Quality Curriculum (1993)
The nominal group process is a way of organizing and prioritizing brainstormed ideas that considers input from each person on the team. The nominal group process results in a rank-order list of those ideas the group feels are most important.

Instructions:

1. **State the issue/question** to be discussed.

2. Team members **brainstorm ideas** either individually or as a group.

3. **Gather the ideas together** in a master list. Combine or delete repeated items.

4. **Assign a letter** of the alphabet to each idea (in no particular order).

5. **Each team member ranks his/her five most important ideas**, with Number 1 being least important (effective, useful, etc.) and Number 5 being most important (effective, useful, etc.).

6. **Tally the ranks** assigned to each idea. The idea with the highest score is the most important (effective, useful, etc.) to the entire group.

Adapted from the VICA Total Quality Curriculum (1993)

References

