CHAPTER 2

Multi-disciplinary Concepts: A Fundamental Foundation

This chapter introduces data collection topics, analytic techniques, and team dynamics tools. These essential tools and techniques are used to collect, aggregate, and analyze data. When used in various combinations, these techniques generate team discussions that lead to effective decision-making by team consensus. Examples of these techniques and concepts are:

- Brainstorming
- Flowcharting and “imagineering”
- Force field analysis
- Ishikawa (or cause and effect) diagramming
- Nominal group techniques (NGTs)
- Pareto analysis
- Run and control charting

The initial focus is on common tools used by process improvement teams, business process reengineering task forces, and IT professionals of all disciplines. All IT professionals must be proficient to effectively lead digital transformation initiatives in health care. As digital transformationalists, these multidisciplinary individuals lead process redesign and automation-driven projects using a variety of ITs.
FLOWCHART

A flowchart is a fundamental tool used to explain, communicate, and facilitate a collaborative understanding of a process, including logic and essential relationships among and between various process or system components. Flowcharts document how systems, applications, functions, and processes operate. This graphic tool is sometimes considered to be an “imagineering” tool that visualizes and facilitates analyses to identify problems, bottlenecks, delays, and opportunities for potential process improvements. Analysts can visualize each unique component, task, decision, and event in a process to understand their relationships to design, reengineer, or imagine an “ideal” process. Visual images are easier to understand and explain than painstaking descriptions of the same process documented in lengthy paragraphs or narrative pages.

Truly, a picture is worth a thousand words. Team members from different disciplines can quickly understand key functions, decisions, and relationships in a process. A flowchart has defined start and end points to establish boundaries and to frame each perspective for analysis. Typical events such as answering a telephone call, taking a patient’s vital signs, and printing orders are each functional components that constitute a process and as such are depicted in a process flowchart. Each event is represented by a symbol that has a distinct meaning and is connected by arrows indicating both direction and logic of process flow with a distinct end point. Process flowchart construction requires discussion and collaboration of knowledgeable team members who are stakeholders of each portion for the entire process and who are recognized as “subject matter experts” regarding each key process component.

Flowchart construction requires a team to

- Define start and end points and identify key workflow components, decisions points, and related flowchart steps
- Collaborate and document each process step and thereby enable all team members and executive sponsors to review and understand process beginning and ending points
- Define and document assumptions to avoid any potential confusion
- Sequence each process, task, or event
Assign a symbol, such as those in Figure 2.1

Validate this clearly and concisely developed process flow with personnel involved in the process and most knowledgeable about each relevant process component

Identify and correct any gaps to eliminate any misunderstandings

Process automation technologists and digital transformationalists use variations of these simple generic flowchart symbols to depict unique activities or actions. Many variations and additional symbols are used. Symbols are occasionally customized as necessary to show unique characteristics that are dependent on each process, or system, as well as to explain specialized activities.

Historically, systems analysts and computer programmers used flowcharts to graphically document logical and detailed steps encoded in computer programs. Operations analysts, management engineers, and process improvement, reengineering, and Six Sigma teams commonly use flowcharts to document current states and depict future states of processes or systems under study. This aspect of flowcharting and process documentation is vital to ensure that all team members understand complete processes or workflows, even though individual team members may have expert knowledge of only a limited portion of an entire process.

Figure 2.2 illustrates a simple process flowchart depicting outpatient clinic visit process activities from beginning to end. Figure 2.3 is an example of a "deployment"

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**FIGURE 2.1** Essential flowcharting or imagineering symbols.

- **Arrow:** Denotes Operations or Activity Flow
- **Circle:** Depicts Process Movement, Transport, Direction or To/From Page Connection
- **Diamond:** Highlights Decisions, Inspections or Evaluation
- **Oval:** Defines Process Start and Finish
- **Rectangle:** Concisely Describes Key Operations
FIGURE 2.2  Process flowchart documenting current state of outpatient clinic visit process.

FIGURE 2.3  Example of horizontal or deployment flowchart.
or “horizontal” flowchart showing process actions by different individuals or departments. This variation is frequently used to show complex process “hand-offs” from individual to individual or from department to department. These hand-off transactions are very often opportunities for process improvement. Many commercial, open source, and software programs include capabilities to quickly and accurately develop flowcharts of many types and to edit with corrections and changes over time.

PARETO CHARTING AND ANALYSIS

Pareto analyses facilitate data organization and presentation to isolate and show those “vital few causes” of a problem from the “trivial many.”

Pareto Principle: 80/20 Rule

Pareto developed the “80/20 rule”: 80% of problems are caused by 20% of personnel.

Pareto charts are the most widely and creatively used process improvement tools. Pareto analyses facilitate data organization and presentation to isolate and show those “vital few causes” of a problem from the “trivial many.” This technique is best used when problems must be identified to focus team members on a relevant issue and further isolate and eliminate others from consideration and analysis. Team efforts can then effectively focus on those problems, offering the most potential for substantial process or system improvement. A Pareto diagram displays the relative frequency or size in either an ascending or descending bar graph. Ideally suited to focus team attention on key problems, this tool is especially useful to identify opportunities of a highest value. Quality improvement, process reengineering, or a Six Sigma team can effectively allocate resources by using the Pareto technique to do the following:

- **Understand** relative importance of problems in a simple, quickly interpreted, visual format
- **Reduce** the probability of shifting a problem because a proposed solution removes some causes but worsens others (i.e., the result of unintended consequences; there is no net organizational benefit by simply moving a problem from one department to another)
- **Measure** progress using a visible and easy to understand format
As depicted in Figure 2.4, a Pareto diagram construction involves

- **Identifying** problems to be investigated
- **Collecting** appropriate data and using Pareto analysis techniques to analyze zero-based data types (e.g., a number of complaints with an expectation that an ideal situation will reduce complaints to zero)
- **Classifying** data by categories such as type of complaints, nursing units or departments, shifts, diagnosis-related groups (DRGs), and patients
- **Arranging** error categories by type, quantity, and percentage in either ascending or descending order
- **Stratifying** data as required (i.e., weekly data grouped into weekdays and weekends and then classified by day or by shift as subgroups based on unique characteristics or useful categories)
- **Creating** Pareto diagrams as specialized bar graphs (e.g., displaying types of patient complaints, their respective totals, percentage of overall total, cumulative totals, and cumulative percentages)
- **Drawing** a cumulative Pareto curve with cumulative percentages above interval (e.g., each complaint connected with a solid line)
- **Verifying** that each graph displays an obvious Pareto pattern (i.e., categories with similar percentages may require an alternative stratification of data so that distinct problem categories are isolated)

For example, as depicted in Figure 2.4, patient complaints should be categorized, with infrequent complaints included as an “all others” category. If an “all

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**FIGURE 2.4** Pareto analysis: patient perceptions of emergency staff attitudes.
others’ bar reflects more than 50% of the largest individual bar in the graph, the
“all others” category should be separated and then displayed individually.

Pareto analysis and interpretation focuses on the tallest bars first because those
categories usually represent major contributing causes to the problem under study.
Focusing on these problem categories first results in more expeditious problem-
solving and deploys scarce resources most effectively.

Pareto graph construction, display, and analysis must include perceptions of
patients, staff, and other key stakeholders in any process being studied. As with most
tools, there are a number of specialized variations. For example, variations of Pareto
diagrams include “cause” breakdowns as tallest bars are broken into sub-causes in
subsequently linked Pareto diagrams. This limited overview highlights the typical
presentation that is most useful in multidisciplinary team initiatives.

**ISHIKAWA (CAUSE AND EFFECT) DIAGRAMMING**

Ishikawa diagramming is a common technique used for initial problem identifica-
tion and dispersion analysis. A team’s learning curve through these incremental
steps is necessary to discover each critical problem in a process and to understand
each problem’s root cause(s).

An Ishikawa, or cause and effect, diagram enables a team to identify,
isolate, explore, and display each cause in increasing detail while
demonstrating an understanding of all possible causes related to a
problem or condition.

By using Ishikawa diagramming techniques, digital transformation teams focus
on problems, not on various symptoms or other distractions, differing interests, or
unique and sometimes important disciplinary bias. This analysis encourages all
team members to gain a consistent collective knowledge about a problem and to
develop team consensus and support for further analyses of potential solutions. A
classic Ishikawa diagram resembles a fish skeleton with causes presented as ver-
tebrae branching from a central spine that leads to an observable effect. As depicted
in Figure 2.5, initial versions of an Ishikawa diagram usually take a generic form
of a fish skeleton with branches (vertebrae) shown as core policies, personnel,
processes, and procedures or people, methods, material, instruments, and equip-
ment. Additional team consideration, discussion, and brainstorming yield increas-
ingly detailed breakdowns of these causes. Ultimately, a root cause or causes are
presented as vertebrae, frequently requiring further data collection and validation
using other tools.
Typically, an Ishikawa diagram is used after likely causes are identified by using other tools, such as flowcharting, brainstorming, NGT, or Pareto analysis. Actual construction of an Ishikawa diagram is the most elemental of its use. Analysis differentiates true causes from symptoms of a problem. Identified causes are then further analyzed with other techniques or tools to understand relationships among and between causes while exploring opportunities for process improvement. This tool is also used to document and track changes in patterns or observed deviations from previously anticipated norms or expected effects.

A dispersion analysis is developed as an Ishikawa diagram is constructed by placing individual causes within each “major” cause category and then asking about each individual cause with questions like, “Why does this cause (dispersion) happen?” These questions are repeated for each level of detail until potential causes are exhausted. Use of this simple “why” technique, is espoused by Labovitz et al.
This technique is most effective when sequentially exploring through at least three response levels and then displaying responses as more detailed branches off each major cause. Further interpretation is necessary to discover underlying issues and to develop a credible consensus that identifies a root cause for each problem (a fundamental underlying cause). Causes that appear repeatedly may require more data to determine relative frequencies of each cause and ultimately to discover a root cause. When this root cause is eliminated or effectively modified, a “future state” solution is presented. This graphic presentation is very effective when describing a before and after picture of problem resolution.

**RUN CHARTS**

Run charts show trends as observations over time. They are used to visualize process characteristics such as errors and increased or decreased activity that changes over time. Meaningful trends can be identified as a team monitors unusual events in a process that affects average process performance. This basic tool enables team members to visualize individual data points and to monitor a process to see if a “trend” is developing or changing.

Run charts highlight process changes and variations as a team plots and studies observations. Data points are plotted in sequence when available.

Run charts are simple to construct and easy to use and interpret. As with other charting techniques, team members should focus only on critical changes, being cautious not to consider every variation as significant. Teams use run charts to monitor performance and identify meaningful trends or shifts in average process performances.

In clinical laboratories, known control specimens are included in each “run” of glucose analyses to ensure that all reagents and instrument components are performing within expected specifications. Figure 2.6 is a run chart showing control values for a month. Because control chart construction begins with an overlay of a run chart with statistical control protocols, this data set is also used in control chart examples:

- **Track** useful information.
- **Predict** potential variation as data are collected and plotted.
- **Focus** attention on vital changes to detect meaningful trends.
If favorable, a change should be evaluated and considered a potential process improvement. If unfavorable, team members must consider countermeasures that reduce unfavorable process variation.

**CONTROL CHARTS**

Control charts are graphs that display process characteristics and compare process performance with statistically derived control limits that measure process variation. Understanding and mastering run chart concepts, construction, and use to identify process variation is necessary before moving on with this natural transition to even more fundamental statistical process principles. These concepts and traditional industrial engineering principles have evolved from their manufacturing origins. Deming developed these principles to understand and measure process variation over time. By constructing and using control charts with control limits, IT professionals can incorporate IT to monitor and manage any healthcare delivery process. Deming concluded that quality is best achieved by simply controlling and managing process variation. Similarly, radical improvement of care delivery processes
is more effectively attained by applying robust IT applications to drive digital transformation of mission critical processes.

All processes exhibit some inherent variation because variation is simply unavoidable. For example, an expected proportion of laboratory analytic or billing errors varies from one day to another. By recognizing this information as fundamental fact, a conscientious effort is made to control and reduce variation. Common cause variations are due to variations that are inherent in a process. Special cause variations are not inherent in a process but are controllable by management:

- Poor workplace lighting or other aspects of a worker’s environment
- Ill-equipped tools, excessive background noise, and poor ventilation
- Instrumentation or other equipment malfunction
- Poorly designed technical tools, software interfaces, or information systems
- Management failure to provide feedback to each worker

All variation is due to either common or special causes.

Although complex statistical and comprehensive quantitative analyses are sometimes difficult to understand and master, they are fundamental concepts and metrics commonly used to manage healthcare delivery process performance by decreasing process variance from average performance:

- A control limit is a line (or lines) on a control chart used to assess process variation significance.
- Variation is the difference of output values of a process from the process mean.
- Variation reflects both common causes and special causes. Variation beyond a control limit reflects special causes affecting a process.
- Graphic problem-solving techniques (e.g., control charts) display these variations as important “current state” problems to be solved and show whether “future state” interventions have been effective enough to demonstrate a sustainable and controlled process.
- Statistical process control uses statistical tools and techniques (e.g., control charts) to analyze process capability, outputs, or outcomes. Appropriate management action or other necessary countermeasures are required to achieve and sustain improved process capability.
- Data universe is a population under study from which a sample is drawn.
- Prevention is a future-oriented strategy that improves quality by directing analysis and action to correct processes, not ad-hoc problems. Prevention
reflects a philosophy of continuous improvement demonstrated by less process variation over time.

- **Value distribution** around a process’s mean performance patterns is consistent with concepts implying that anything measured repeatedly will produce different results.

- **Observations** of process outputs and outcomes occur in statistically predictable patterns and have been associated with the “Hawthorne effect” by some experts.

A normal distribution of these data points results in a classic bell-shaped curve with most observations near the process mean, with fewer and fewer observations falling evenly on either side of this process average. Figure 2.7 and Figure 2.8 show this conceptual construct and depict classic bell curves being transformed into a control chart. This transformation shows the mean and each standard deviation of a bell curve becoming control limits on a control chart. This fundamental process improvement tool and technique were derived from a traditional “central tendency theorem” and related statistical control theory to discover, understand, and quantify the variability of a process’s current state.

QM, continuous process improvement, process reengineering, and Six Sigma teams use control charts to analyze problem causes. After reviewing this information the team can develop the comprehensive understanding necessary to formulate consensus, present an effective solution, and execute their solution using a corrective countermeasure or action plan. After implementation the team continues to monitor process performance using control charts to sustain improved statistical process control over time.

As introduced earlier, a control chart is a run chart with a statistically derived upper control limit (UCL) and lower control limit (LCL). These control limits are

**FIGURE 2.7** Bell curve with 1, 2, and 3 standard deviations.
Control Charts

FIGURE 2.8 Normal bell curve transformation.

displayed as horizontal lines on either side of a process’s arithmetic average on the chart’s x-axis. Data points are individual values of process performance criteria used to determine whether a process is “under statistical process control.” Usually, a sample size of 20 to 30 variables is drawn from a dynamic database and collected during a predetermined time frame. Variability of these values is used to statistically calculate UCLs and LCLs. Control limits reflect process capability compared with predetermined specifications and should not be confused with a patient’s wants, needs, requirements, or expectations.

A process may be in control but not capable of producing outputs or outcomes that meet required specifications. “In control” does not imply that process outputs or outcomes meet system needs or patient expectations. This technique is a metric used to express process consistency (i.e., either consistently acceptable or consistently unacceptable).

Variation beyond control limit represents special causes affecting a process. Graphic problem-solving techniques (e.g., control charts) display these variations as important problems to be solved and show that interventions have been effective enough to produce a controlled process. Some variation is random or otherwise due to unique characteristics of a process that is in statistical control.
UCLs and LCLs at 1, 2, and 3 standard deviations are determined and displayed above and below the arithmetic mean of a process control chart. Figure 2.9 shows special cause variation as shaded data points above the UCL. Fluctuations within control limits represent variation that is inherent to a process. Common causes within a process or system (e.g., inadequate design, equipment limitations, outdated policy or historical protocols, incorrect operating procedures, inadequate preventive maintenance) are affected by a system or process change. Values outside of control limits represent special causes (e.g., personnel error(s), unplanned events, unusual accidents or occurrences, unintended circumstances) that are not characteristic of a typical process in operation. Special causes must be addressed by management to be corrected, modified, or eliminated before a control chart will accurately depict that a process is “in control” when operating and monitored on an ongoing basis. After a process has demonstrated that consistently in control outputs or outcomes are produced and ongoing monitoring confirms that no fundamental change has occurred, then and only then can a process be considered as “in statistical control.”

Senior management must actively support opportunities to control and reduce variation in key organizational processes and systems. Such initiative support is needed during development and execution, requiring necessary intervention, and then again after an intervention, demonstrating an effectively transformed process by requiring necessary monitoring to ensure sustainable change.

During this process team members and executive sponsors should encourage questions to gain an understanding from both a process behavior and a statistical process control perspective:

FIGURE 2.9  Control chart with a special cause.
• Are there differences in measuring instrument accuracy used?
• Are there differences in methods used by different staff members?
• Is process affected by varying environmental or organizational factors (e.g., temperature, humidity, budgetary constraints, staffing, scheduling)?
• Has there been a significant environmental or organizational change?
• Were any untrained staff members, students, or interns involved?
• Have supply sources changed?
• Could staff fatigue affect this process?
• Has there been a change in maintenance procedures?
• How are instruments changed or adjusted?
• Did errors occur with different instruments or equipment, shifts, or operators?
• Are staff members reluctant to report “bad news”?

Staff should not be held responsible for problems that are due to common variations. Management must accept responsibility to resolve common causes of variation.

Special cause variations are typically avoidable and cannot be overlooked (e.g., cases caused by not following certain prescribed standards or improper application of standards). Special causes are frequently associated with differences among workers, methods, or instruments. Both common and special cause variations should be identified and managed. When variations are due to special causes, a presence of certain meaningful factors is implied and should be investigated.

Another control chart should be prepared after process improvement or after corrective countermeasures have been implemented. This control chart displays a “future state” as experienced, indicating whether or not these interventions were adequate enough to bring this process under control. For mission critical processes, even processes under control may still be so broken that continuous process improvement or business process reengineering projects will not produce acceptable outcomes. These situations are best addressed in conjunction with Six Sigma initiatives, as described in Chapter 12.

Figure 2.10 reflects a process brought under control as demonstrated by control charts. Control charts are developed from run charts and are routinely used in a clinical laboratory to monitor patient glucose analyses. A “before” control chart identified unacceptable special cause variation (Figure 2.10, Out of Control...
Process, top). This graph reflects an out of control analysis because not all plotted points are within control limits. After investigation the laboratory manager determined that the cause of a variation was in fact special, and steps were immediately taken to permanently eliminate the cause. Revised policies and procedures were developed and staff were retrained to prevent a recurrence.

The control chart shown at the bottom of Figure 2.10 (In Control Process) shows this process after special causes of variation have been eliminated. After investigation and procedure changes were made to eliminate these special causes, no "out-of-control" values were experienced. Several such iterations may be needed to stabilize a process and bring it under control as determined to meet management requirements.

Table 2.1 summarizes the most common technical types of control charts used in healthcare process reengineering and digital transformation initiatives. Each type of control chart is listed in decreasing order of common use, including a typ
Process Capability Analysis

A process capability analysis is used to determine whether a process is capable of meeting an established specification as "controlled" by current natural variation. Being in control is not enough. An "in control" process can produce a bad product. True process improvement results from balancing repeatability and consistency with the capability of meeting patient or customer requirements. This approach objectively measures the degree to which a process is or is not capable of meeting those requirements. Capability indices graphically portray this situation by showing a distribution of process results or outcomes in relation to patient or customer specifications. Statistical control limits reflect current state process. A control chart is developed from a run chart modified to show average performance with process variation. Variance is expressed in standard deviations (i.e., square root of variance above and below mean performance over time).

A square root of variation is a standard deviation (\( \sigma \)) and is calculated as the cumulative distance of values from a process's arithmetic mean, not its geometric mean.

TABLE 2.1 Control Chart Types

<table>
<thead>
<tr>
<th>Type</th>
<th>Description and Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-Bar R</td>
<td>Two-part chart monitoring process accuracy and precision, e.g., patient waiting time and food temperature</td>
</tr>
<tr>
<td>p</td>
<td>Chart tracking acceptable or unacceptable process results as a percentage, e.g., percentage medication errors</td>
</tr>
<tr>
<td>N p</td>
<td>Unique p chart tracking acceptable or unacceptable process results, e.g., number of medication errors</td>
</tr>
<tr>
<td>c</td>
<td>Chart depicting an area of opportunity with occurrence held constant, e.g., number of reported accidents per day</td>
</tr>
<tr>
<td>u</td>
<td>Chart depicting an area of opportunity without holding each occurrence, e.g., number of misdiagnoses per DRG</td>
</tr>
</tbody>
</table>
SCATTER DIAGRAMS

This tool is used to examine relationships between two variables plotted as data pairs. A scattergram is used to test for possible cause and effect relationships by displaying patterns or possible relationships among data.

Although not proving that one variable causes another, a scattergram and an associated correlation coefficient demonstrate that a relationship exists and express the relationship’s relative strength. When used in conjunction with a correlation coefficient, a scattergram describes and quantifies relationship strength between variables without expressing or demonstrating proof of any causal relationship (a scattergram is not a tool to be used to demonstrate a definitive cause and effect association). This technique is correctly used for continuous variables rather than discrete data.

Scattergrams are plotted for each data pair. Figure 2.11 is an example of a classic scatter diagram showing the number of billing errors compared with the number of overtime hours worked.

Each plotted point reflects a data pair of variables in a clustered pattern, with the “direction and tightness” of the cluster pattern expressing a type and relative strength of the relationship between each variable in each pair. As in this example,

![FIGURE 2.11 Scatter diagram (scattergram).](image-url)
A straight line means that every time one variable changes the other would change by the same amount in the same direction, showing a stronger correlation between these variables.

After collecting 50 to 100 paired samples of paired data, horizontal and vertical axes can be drawn using commercial spreadsheet software to support development. A scattergram and associated correlation coefficient can be displayed and analyzed. A variable suspected as a possible “cause” is drawn horizontally and a possible “effect” variable is usually vertical. The resulting patterns and analysis are summarized as a graphic of all plotted pairs.

Figure 2.11 is an example of a scattergram produced from data pairs with a positive correlation of 0.72, implying that a possibly strong relationship exists between patient representative overtime hours (x-axis) and billing errors (y-axis). The degree to which an increase in x corresponds with a comparable increase in y is expressed as the correlation coefficient. A correlation coefficient indexed at exactly 1.00 is relatively rare.

Other possible types of correlation include the following:

- A negative correlation depends on the degree to which an increase in x corresponds with a decrease in y. A negative relationship is as important as a positive relationship.
- There is no correlation when the correlation approaches zero.
- A straight line correlation, as in Figure 2.11, is very common but is the only relationship that may be encountered. Nonlinear correlations require the use of additional statistical tools that are beyond the scope of this book.

**HISTOGRAMS**

This tool is used to analyze data by summarizing and presenting data as a frequency distribution in tabular form and graphically as a bar graph. Graphic formats of this type display either raw or aggregate data that are otherwise difficult to interpret in tabular form.

Histograms are “intermediate tools” to assess data distribution (e.g., centering, spread, and shape).

- Show relative frequency of occurrence for a specified time period (e.g., hour, shift day, week, etc.)
Use historical data to find patterns or to use a baseline measure of past performance

Reveal centering, skewing variations, and the shape of underlying data distributions

Provide useful information to assess current or predict future process capability and performance

Commercially available spreadsheet software includes functions to facilitate data collection, aggregation and analysis as a tabular frequency distribution, and display in a classic histogram format. Initial histogram interpretation includes analysis of data distribution centering or skewing and variation or spread. This analysis answers questions about the data, for example,

- Is the data distribution normal (bell shaped), bimodal (twin peaks), or multimodal (three or more peaks)?
- Is the process center running too high or too low relative to patient expectations, analytical specifications, or outcomes?
- Is the process too variable (i.e., within requirements)?
- Does the process demonstrate consistent performance?

Figure 2.12 is an example of a classic histogram as a specialized bar graph presentation of the same data set shown in Figure 2.11 as a scattergram.

TEAM DYNAMICS FACILITATION TECHNIQUES

Remaining tools and techniques in this chapter are less quantitative and more qualitative in nature. Each tool capitalizes on and uses these facilitation techniques to create ideas by harnessing the power of team dynamics and dialogue. This facilitation focuses team members on problem identification, analysis, and solution development.

These tools are used during and after initial brainstorming sessions or other group dynamics techniques from previous analyses (e.g., NGTs, cause and effect analysis, force field analyses, etc.). Some experts consider these techniques alternative or specialized forms of structured brainstorming.

Figure 2.13 shows a conceptual application of these group dynamics using a real-world example drawn from the design and development of the National Health Information Network (NHIN). This set of problem identification and solution development techniques is especially useful as each team member gains an understanding of potential issues that identify driving forces, priorities, and desired outcomes. These tools and techniques facilitate systematic identification, analyses, and classification and prioritization of potential influential cause and effect
FIGURE 2.12  Histogram distribution of patient representative billing errors by overtime hours.

FIGURE 2.13  Using group dynamics tools to design an NHIN.
relationships that exist among and between critical issues. These key drivers or outcomes must then be incorporated as core components of a credible solution.

These tools

- **Encourage** team members to think in multiple dimensions rather than only linear directions.
- **Enable** participants to explore cause and effect relationships among and between issues that may be controversial.
- **Require** a deeper exploration of key issues to naturally emerge rather than just superficial discussions of issues, potentially forced by dominant or powerful team members.
- **Identify** basic assumptions and underlying reasons for systematic disagreement among team members. This is an important process to ensure that a final solution inclusively incorporates key aspects from varying perspectives of each team member.
- **Facilitate** team identification of root cause(s), agreement, and focus on problem articulation and analysis even if credible empirical data do not yet exist.

These tools encourage additional discussion as may be required to ensure that input is valid and clearly understood by all team members. Groups use these tools to gain a comprehensive knowledge of subjects under discussion by considering whether resulting cause, priority, sequencing, and effect patterns ensure that their proposed solutions are more likely or less likely to be credible.

**BRAINSTORMING**

Brainstorming is used to initiate creative thinking by team members, operations analysts, systems analysts, and management engineers. Brainstorming sessions begin as both a team leader and a recorder are selected and the brainstorming topic is clearly and precisely stated.

The objective of a brainstorming session is to generate as many ideas as quickly as possible without any consideration of each idea's quality, value, or merit.

Brainstorming is either structured or unstructured:

- Structured brainstorming requires every team member to contribute an idea in rotation or pass until the next round. This technique encourages even shy team members to participate but enables all present to contribute.
Unstructured brainstorming permits contribution of spontaneous ideas as expressed by team members in any sequence. This technique creates a more relaxed atmosphere but risks domination by more vocal members.

The following guidelines are useful to maximize a brainstorming session:

- As ideas are generated, the recorder documents each idea so it is visible to all members. A common form of recording ideas is to print them on flip charts in large handwriting and then display multiple sheets taped to walls of meeting room.
- As everyone agrees on an issue or idea, it is recorded on the flip chart in words of each speaker without interpretation.

Brainstorming occurs in distinct phases: creation, refinement, and assessment. The creation phase is started by the team leader’s review of appropriate rules, for example, individual ideas are posted in sequence, one at a time, without discussion or criticism. This phase continues until all ideas are exhausted. Team members may pass without expression of a new idea. Individual ideas frequently build on others, with this phase continuing until all ideas are exhausted. During refinement and assessment phases ideas are reviewed by all team members to ensure that everyone understands each idea without further discussion or criticism. This tentative idea list is reviewed during assessment discussion. This final phase eliminates duplication or issues that are not on topic. A structured series of votes should reduce the team’s consensus list of ideas as much as possible.

CONTINGENCY DIAGRAMMING

This tool is used to refocus team analysis when members are grid-locked, when some or all present are hostile, or when a very controversial issue is being confronted for further analysis. Contingency diagramming contributes “group dynamics” to quickly find and resolve persistent problems with practical solutions. At times, individuals and groups may focus first on negative aspects of an issue, especially when confronted with a difficult problem or analytic resistance.

A contingency diagram uses reverse logic to generate promising solutions. This approach builds on brainstorming to identify as many ways as possible that a problem could get worse or persist. As a team works through this process, it gains systematic insight to solve the problem. An action plan is then quickly and easily prepared to prevent this problem from recurring.

Figure 2.14 illustrates an example of how this technique could be used to plan more effective team meetings. A flip chart is created in advance of a team meeting. This tool should be sketched as in Figure 2.14 with only the problem to be
addressed in the oval. Using this technique a team’s leader should initiate a structured brainstorming session to identify causes that would make this situation worse.

Effective use of a contingency diagram includes these key steps:

- Ask each group member to offer actions, permitting passing if a member does not express an idea.
- Document actions on “arrows” left of the oval.
- Do not tolerate any criticism, question, or praise of others’ ideas during a brainstorming session. All present should refrain from comment, listen carefully, and courteously build on each other’s ideas. Any input is acceptable, even silly, strange, or similar ideas. Great solutions frequently evolve as variations of other ideas.
- Continue until ideas are exhausted, recognizing that quantity of ideas rather than quality is the objective.
- Clarify ideas by team discussion while identifying actions that could prevent the problem from continuing by working through each opposite action.
- Develop an action plan to document corrective actions.
WHY TECHNIQUE

This simple tool is an effective approach to problem-solving that drills down through multiple but less obvious or unacknowledged cause levels. The why technique is used to identify a potential and preventable root cause of a recurring problem by simply asking why a problem occurs. The question of why the problem occurred is persistently continued until a root cause is targeted for further analysis and resolution. This technique is especially effective in potentially “confrontational” group settings.

Execution is simply repeatedly exploring cause levels through as many iterations as are required:

- Focus on a problem.
- Ask “Why did this problem occur?” to uncover a first-level cause.
- Repeat asking “Why did this problem occur?” for each cause to uncover a next layer of cause(s).
- Strive to uncover multiple causes at each level as each cause level is explored as a likely chain of events.
- Continue to repeatedly ask “Why?” until a root cause is identified for further analysis and resolution. If cause levels are exhausted without identifying a root cause, another technique is recommended for additional analytical focus.

The why technique is useful for both problem identification and analysis, as is the more graphic fishbone diagram.

NOMINAL GROUP TECHNIQUE

This group dynamics tool is frequently used to make decisions. A working definition of consensus is introduced and acknowledged by all present as “a solution that everyone can live with and no one is prepared to die for.”

Nominal group techniques are useful when a team must develop a consensus to identify priorities or to define a sequence of actions in rank order.

NGT fixes sequential relationships or priorities among and between topics, actions, or items. NGT is a common complement of previous brainstorming sessions. This “ranking approach” enables decision-makers to quickly come to a consensus on the relative importance of issues, problems, or solutions. This technique builds team commitment to a decision using equal participation and an agreed on
process that aggregates individual rankings into a team’s priorities. Each team member ranks issues without pressure by others.

By using this approach all team members are on an equal footing to clarify team consensus or lack thereof. This process complements brainstorming, especially with decisions involving sensitive topics. Causes of disagreement can be identified and addressed during this process and between multiple iterations of ranking.

Application of an NGT technique includes these elements:

- Topics or issues to be ranked or sequenced are written on a flip chart as the team eliminates duplicates and/or clarifies meanings.
- With the team’s permission and guidance a final list of topics is identified with letters, not numbers, so that team members do not get confused by the numerical ranking process that follows.
- Each team member records these corresponding letters on a piece of paper and rank orders each topic with a numeric value, which may include zero if no value is associated with a topic. Conceptually, each member has one vote per item, but any member may choose to assign all their votes to a single or a limited number of items to be ranked.
- All team member rankings are then combined for each item to reflect each item’s team ranking.
- Multiple ranking cycles may be necessary, especially when only a few choices must be selected or ranked from a large number of items.
- A consensus selection or rank is achieved when the team choice is clear.

FORCE FIELD ANALYSIS

When used after brainstorming, contingency diagrams, the why technique, or NGTs this approach clearly identifies barriers to process improvement recommendations. Force field analysis requires a team to acknowledge driving and restraining forces and then support the development of effective countermeasures. Force field analysis enables a team to develop a deeper understanding of organizational politics and existing culture. These considerations are critical when implementation strategies are being developed.

“Driving forces” are likely to support a proposed situation requiring behavior change, whereas “restraining forces” are likely to impede and present barriers to desired change. Without a desire for change, opposing or restraining forces may appear to be too strong and are likely to hinder any implementation initiative. By using this tool, dynamic team dialogue can creatively build on existing driving forces to counter negative perceptions that threaten the status quo. Figure 2.15 is an example of using force field analysis to build a justification for substantial capital investment for IT infrastructure and systems implementation.
Desired change requires that driving forces be stronger than restraining forces. Otherwise, change will not happen until countermeasures are tactically incorporated into implementation strategy. Desired change will only occur when driving forces are more powerful than restraining barriers to change. Effective development of this desired disequilibrium requires force field analysis to

- **Encourage** team members to think cohesively about all aspects of a desired change
- **Stimulate** creative thinking and collaboration on relative priorities of driving and restraining forces
- **Expedite** consensus building when used with other tools (e.g., NGTs, contingency diagramming, and why techniques)
- **Provide** a starting point for action

**FIGURE 2.15** Information system investment justification.
Encouraging effective change requires strengthening driving forces or reducing restraining forces. Resistance rather than desired improvement occurs when unintended consequences reinforce negative forces. Effective strategies and operational tactics must be developed and introduced to diminish or eliminate restraining forces. Teams are more likely to be successful when they identify and understand potential negative impacts before implementation. Having done so by using force field analysis enables teams to be deliberate and proactively plan actions and countermeasures rather than be forced to react if not anticipated.

SUMMARY

This chapter introduced data collection topics, analytic techniques, and team dynamics tools. When used in various combinations, these techniques generate active team collaboration that leads to effective decision-making by team consensus.

Fundamental concepts and content included:
- Brainstorming
- Flowcharting and imagineering
- Force field analysis
- Ishikawa diagramming
- NGTs
- Pareto analysis
- Run and control charts

CHAPTER QUESTIONS

These questions reinforce student understanding, learning, and retention while stimulating class discussion:

1. Identify key symbols used for imagineering, and explain differences between process, horizontal and deployment flowcharts.
2. Define Pareto Analysis and discuss why this tool is both a problem identification and an analytic tool.
3. Explain the differences between a cause and effect, Ishikawa and fish bone diagram with examples.
4. In the context of statistical process control, how are common and special causes different?
5. What is process variation?
6. How is process variation related to process capability and customer expectations?
7. Explain how a traditional bell curve, a run chart, a control chart, and 1, 2 and 3 standard deviations are related.

8. What is meant by the terms “in-control” process and “out-of-control” process? Describe how they are different.

9. How is a scatter diagram constructed and what is its relationship to a positive and negative correlation coefficient?

10. Identify three common group dynamics tools and explain how each technique is used.

11. Describe a situation when a team leader may use a contingency diagram.

Additional Resources

These references are recommended for additional reading and more comprehensive content beyond the scope of this book.


