Techniques for Managing Quality

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Summary

The science of quality management is an eclectic collection of concepts and methods primarily borrowed from other fields. Techniques roughly fall into three categories involving quality improvement, planning, and measurement. Improvement techniques include models to guide team-based efforts, tools for process description, and tools for data analysis. These methods are the most visible artifacts of CQI efforts in health care organizations today. Less widely known, but equally powerful, are the techniques of quality planning. There are models to guide both process design and strategic planning, methods for identifying customer needs, and tools to support these efforts. Finally, while measurement is a traditionally well-developed area in health care, industrial quality management science broadens our outlook about what is important to measure. It also provides the technique of benchmarking, which suggests that we look beyond our own organization when we measure performance.

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The modern approach to the management of quality in health services borrows heavily from the quality management science in use for decades in general industry (Berwick 1989; Laffel and Blumenthal 1989; Blumenthal 1993; Berwick, Godfrey, and Roessner 1990; Gaucher and Coffey 1993). Industrial quality management science—a.k.a. CQI or TQM—is an eclectic collection of techniques. While some were developed specifically for use in quality management, most are borrowed from the fields of statistics, engineering, operations research, management science, market research, and psychology. In this article, I will review a basic collection of techniques using an outline proposed by Juran (1989), who asserts that quality management science can be understood as comprising techniques for improvement, planning, and measurement (or control).

While Juran's trilogy makes a convenient taxonomy for a review article such as this, the classification system proposed here should not be taken as rigid. Tools for improvement can also be used for planning; planning a process can be seen as an improvement; and measurement naturally overlaps with the other two areas. Figure 1 describes the elemental tool kit for quality management that will be covered in the article.

Techniques for Quality Improvement

Quality improvement techniques, specifically those associated with so-called quality improvement projects, have served as a natural point of introduction to modern quality management science in many health care organizations.

Quality Improvement Projects and Teams

A quality improvement *project* is a focused effort to address a specific improvement opportunity. For example, we might set a goal to improve waiting times in a clinic or reduce medication errors in a hospital. In undertaking such a project, senior leaders in an organization charter a quality improvement *team*, typically consisting of three to nine people who routinely work in the process under investigation. These teams are often multidisciplinary and multilevel in composition, achieving what Juran (1964) calls a "breakthrough in organization."

Models for Improvement

To guide the work of these improvement teams, many organizations adopt a quality improvement *model*. A model provides a high-level road map to remind the team to explore thoroughly the work process under study and to rely on the scientific method to guide decisions. In addition to guiding improvement efforts, these models also establish a common approach and

Figure 1
A Basic Tool Kit of Techniques for Managing Quality

Improvement Techniques
Quality improvement projects and teams
Models for improvement
Tools for process description
- Flowcharts (chronological description)
- Cause-effect diagrams (causal system description)

Tools for data collection
- Checksheets
- Data sheets
- Interviews
- Surveys

Tools for data analysis
- for categorical data
  - Pie charts
  - Bar charts
  - Pareto diagrams
- for continuous data
  - Average, median (center)
  - Range, standard deviation (spread)
  - Histograms (shape)
  - Line graphs (sequence)
- To study relationships between variables
  - Scatter diagrams
- To determine stability of a process
  - Control charts

Advanced tool: design of experiments (DOE)
Tools for collaborative work
- Brainstorming
- Boarding
- Multivoting
- Decision matrices
- Composite techniques (e.g., nominal group)

Planning Techniques
Management and planning tools
- Affinity diagram
- Relations diagram
- Tree diagram
- Process decision program chart (PDPC)
- Failure mode and effect analysis (FMEA)
- Activity network diagram

Models for process design
Critical paths, clinical guidelines, and algorithms
Models for strategic planning
- The annual quality plan
- Hoshin planning/strategic quality management
- Organization-as-a-system exercise

Customer needs analysis
- Dimensions of quality
- Focus groups and surveys
- Moments of truth method
- Critical incident technique

Advanced tool: quality function deployment (QFD)

Measurement Techniques
Traditional approaches in health care
Framework for a comprehensive measurement system
- Clinical outcomes
- Customer perceptions of quality
- Internal process performance
- Financial performance

Benchmarking
- Internal benchmarking
- Competitive benchmarking
- Functional (or group) benchmarking
- Generic benchmarking

vocabulary for improvement. This enhances both the efficiency of training and the transferability of results across an organization.

Figure 2 shows an example of such a model from the Virginia Mason Medical Center in Seattle. While there are literally dozens of such models in common use, all derive from a common set of principles (Plsek 1993b). Chief among these principles are a profound understanding of work processes, involvement of staff, and use of the scientific method. For example, the improvement model in Figure 2 reminds the team of these three principles when it suggests the team "learn and define the existing process," "charter a team that knows the process," and "collect data to confirm root causes."

Other models also reflect prominently the cycle of divergent and convergent thinking that is critical to effective improvement (Plsek 1993b). Divergent thinking—thinking broadly, exploring various options, and avoiding being locked in to traditional approaches—is reflected in improvement models through recommendations to "list opportunities," "form theories of cause," and "develop alternative solutions and controls." Convergent thinking —focusing our efforts, making choices, and getting down to business—is likewise reflected in suggestions to "form a team," "identify root causes," "implement solutions and controls," and "check performance."

Regardless of the specific model used, the work of improvement teams is also aided by a collection of simple engineering and statistical tools. These tools are described fully in a variety of references (Berwick, Godfrey, and Roessner 1990; Gaucher and Coffey 1993; Juran 1988b; Wadsworth, Stephens, and Godfrey 1986; Gitlow et al. 1989; Plsek, Onnias, and Early 1989; Ishikawa

Figure 2
The Virginia Mason Medical Center's Quality Improvement Model: Steps to VMQI

The Problem
- identify a problem
  - write mission statement to define problem
    - charter a team that knows the process

The Analysis
- learn and define the existing process
  - formulate theories of cause
    - collect data to determine root causes

The Improvements
- choose the solutions
  - design the implementation
    - address resistance to change

The Results
- evaluate results
  - monitor control system to hold gains

Source: Virginia Mason Medical Center, Seattle WA.

1985). For classification purposes, we can identify four groups: tools for process description, data collection, data analysis, and collaborative work. These tools are listed in Figure 1; some are also schematically displayed in Figure 3.

Tools for Process Description

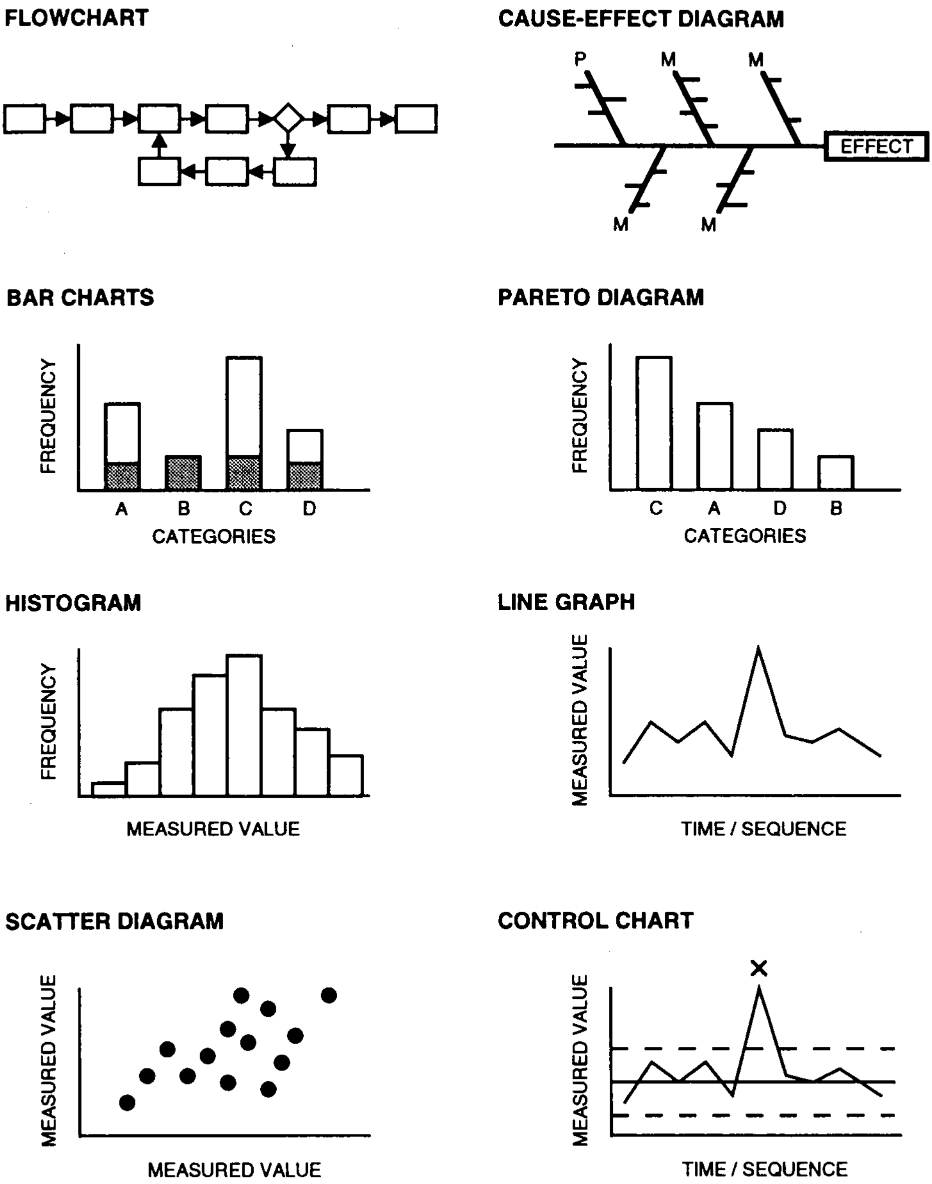
A *flowchart* graphically depicts the sequence of steps in a work process; it is a chronological description of a process. A flowchart consists of terse descriptions of activities written inside simple symbols—for example, "take history and physical" or "is information current?" These symbols are then connected with arrows to indicate the sequence of events. In health care, flowcharts can be used to describe the flow of patients (e.g., the process for admitting), information (e.g., the handling of lab orders and test results), materials (e.g., the flow of supplies from receiving to the exam rooms), or thought (e.g., the clinical algorithm for the treatment of low back pain).

The description of the process can be at any level of detail. Typically, we begin with a high-level conceptual view consisting of three to six major steps, and then get successively more detailed as we focus in on particularly important segments of the process. Sometimes, particularly in early process improvement efforts, the flowchart is the only tool we need. As teams document the sequence of activities, they often uncover redundant steps, wasted effort, and unnecessary complexity. In such cases, improvement can be a simple matter of common sense.

The *cause-effect diagram* is a description of the process at a causal level. Consider, for example, the problem of HMO members being seen by a specialist without their medical record. An improvement team might have a flowchart describing the sequence of events involved in transferring a record from the referring primary care clinic to the specialist, but they are still faced with the question, What causes missing medical records? While the natural instinct is to blame people for not doing their jobs properly, quality management theorists point out that work processes are complex causal systems consisting of people, machines, materials, methods, and measurements (the so-called "4Ms and a P") (Berwick 1989; Ishikawa 1985). The classic cause-effect diagram, depicted schematically in Figure 3, embodies this theory by reminding us to think divergently about potential causal factors in each of these categories. Hypothesized theories of cause are written on lines extending from the main categorical spines. When completed, a good diagram is balanced—that is, there are theories associated with each of the categories.

Such diagrams are referred to in the literature as "fishbone diagrams" (because they resemble the skeleton of a fish) or "Ishikawa diagrams" (in honor of their originator, the late Dr. Kaoru Ishikawa). Ishikawa (1985)

Figure 3
Schematic Depiction of the Graphical Tools Most Commonly Used in Quality Improvement Efforts



also describes several variants of this basic diagram, such as the process-type diagram where the theories of cause are shown on spines coming off a flowchart at the step in the process where they are most likely to occur.

These two tools of process description—flowcharts and cause-effect diagrams—support divergent thinking and lead naturally to the convergent thinking of the Pareto principle. The *Pareto principle* states that in any collection of factors that contribute to a common effect, a few of those factors will account for the majority of the effect (Juran 1964). In other words, while there may be many steps in the process and many theories about the causes of problems, a focus on the "vital few" steps or theories will yield the greatest improvement. Furthermore, while there may be various opinions about where to focus, the scientific method calls us to be objective in our thinking. Therefore, after using the tools for process description, improvement teams often turn to the tools for data collection in order to progress to what Juran (1964) calls a "breakthrough in knowledge."

Tools for Data Collection

Data collection begins with the formulation of a specific question for which we are seeking an answer (Plsek 1994). For example, a medical records flow improvement team might now want to know, What percentage of missing medical records are associated with patients who are referred for an appointment to a specialist later in the same day that they saw their primary care physician? and Does that percentage vary significantly according to which primary care clinic was involved? Note that such questions are much more specific than the vague, What causes missing records? This specificity will result in more effective data collection.

Having formed specific questions, the improvement team typically gathers data via one of four methods—checksheets, data sheets, interviews, and surveys. A *checksheet* is a form for gathering data that enables one to analyze the data directly from the form. In contrast, a *data sheet* is a form for recording data for which additional processing is required. Figure 4 compares a checksheet and a data sheet for the medical records flow team. The checksheet uses simple tick marks to construct a type of stratified bar chart that focuses our attention immediately on the processes associated with the South Street Clinic. But while analysis of this checksheet is easy, notice that with the simplicity, we have lost the ability to explore the situation further. The ubiquitous "X"s on the checksheet provide no follow-up information on items such as patient demographics, primary care physicians, or diagnostic tests associated with these missing medical records. In contrast, the data sheet in Figure 4 does provide the means to dig deeper. In the end, the choice between a checksheet and data sheet depends on the trade-off between desired ease of collection and ease of analysis. Teams often use checksheets early in their efforts to determine simply if there is an opportunity for improvement, then they switch to a data sheet for more detailed analysis and switch back to a checksheet to monitor performance after improvements are implemented.

Figure 4
Comparison of a Checksheet and Data Sheet for Missing Medical Records

MISSING MEDICAL RECORDS STUDY

Instructions
- Mark an X at the top of this form for each patient seen.
- Ask: "Were you at the primary care clinic today?"
- If yes, mark the appropriate place in the bottom of this form.

Specialty: Cardiology **Date:** January 12

Total patients seen today XXXXXXXXXXXXXXXXXXXXXXXXXX

For "same day" appointment patients:

Edwards Rd. Clinic: record present	Edwards Rd. Clinic: no record	Edgewood Ave. Clinic: record present	Edgewood Ave. Clinic: no record	South St. Clinic: record present	South St. Clinic: no record
X					X
		X			X
		X			X
		X			X
X		X	X	X	X

Checksheet

MISSING MEDICAL RECORDS STUDY

Instructions
- Complete one line of this form for each patient seen.

Specialty: Cardiology **Date:** January 12

		"Were you at the primary care clinic earlier today?"			
member number	specialist	Y/N	primary care clinic	referring physician	tests already done

Data Sheet

Interviews and *surveys* are used when the question of interest involves perceptions. While interviews, either one-on-one or in focus groups of multiple participants, are time- and resource-consuming, they do allow us to ask open-ended or follow-up questions that will deepen our understanding. Surveys, on the other hand, allow us to solicit efficiently the perceptions of a large sample of people. But with surveys we must carefully select and phrase the questions since we will be unable to probe deeper on responses. Again, we see a trade-off. I recommend beginning with interviews involving a small number of people and then using this information to inform the design of a good survey for administration to a larger group.

Tools for Data Analysis

Data collection leads naturally to data analysis. But in the context of organizational quality improvement, it is important that the "breakthrough in knowledge" generated by the analysis be broad enough to lead to what Juran (1964) calls a "breakthrough in cultural patterns." In other words, the analysis must be simple enough for everyone in the work process to understand; if it is not, they might resist recommendations for changes. So, while quality management practitioners use analytical statistical techniques such as analysis of variance (ANOVA) and tests of hypothesis (e.g., *t*-tests) (Duncan 1974), they would also point out that simple graphical analysis methods can be understood by more people. This need to pay attention to the understandability of statistical analysis is especially acute in health care where some clinicians and administrators have statistical training, while the majority of staff do not. Experience in health care has shown that while the physicians, nurses, and housekeepers on a team might not be equally facile with an ANOVA table, all participants can learn to look for certain departures from the classic "bell-shaped curve" in a simple histogram.

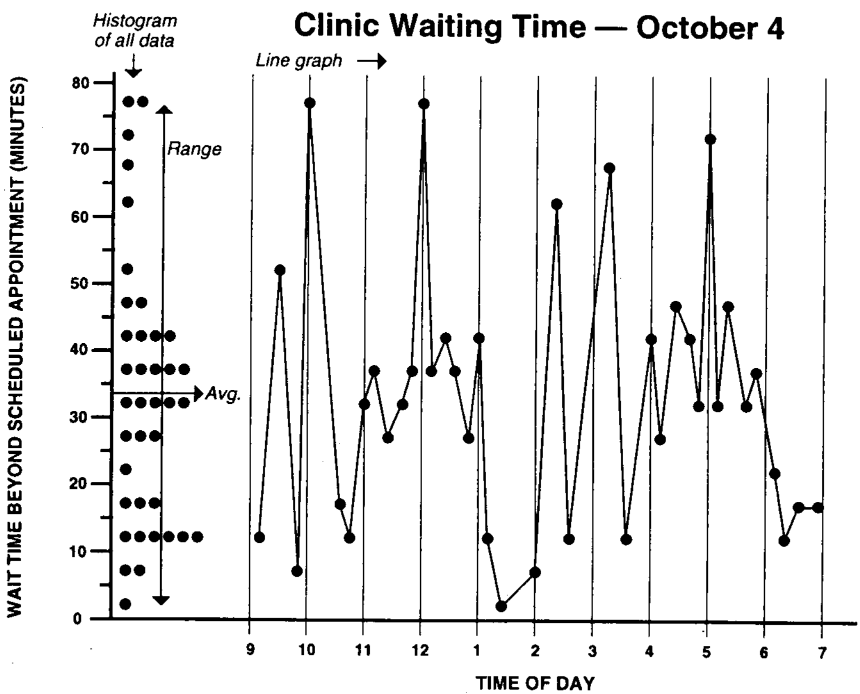
In some cases, our data fall into categories (e.g., number of Medicare bills rejected because of excess charge lines or a missing provider identification number). We can graphically display *categorical data* using a simple *pie chart, bar graph,* or a special type of bar graph called a *Pareto diagram* (see Figure 3). As the name implies, a Pareto diagram graphically illustrates the Pareto principle. Categories are arranged on the horizontal axis of the graph in the order of decreasing frequency of occurrence. Bars indicate the number of occurrences in each category as read on the vertical axis. A quick scan of the diagram indicates that the first few categories (the tallest bars) account for the majority of the occurrences (the "vital few"), while the remainder of the categories have only a little effect (the "useful many").

When the data are of a continuously variable nature (e.g., time, cost, productive output, or physiological data), other simple data analysis tools are valuable. *Continuous data* have at least four dimensions, each potentially holding information about the process from which the data come. The first dimension of the data is the center, which we commonly summarize as an *average.* For example, we might analyze some data and tell a clinic operations manager that, on average, HMO members waited 33.6 minutes beyond their scheduled appointment times before being seen by a clinician. While this might be useful information to the manager, we could be even more helpful by providing the spread of the values. This second dimension of the data could be reported as the range: the shortest wait was 2 minutes while the longest was 77 minutes.

As Figure 5 shows, the shape and sequence dimensions reveal even more information. To form the *histogram* (shape) of the data in Figure 5 we have simply tallied the frequency with which waiting times fell within various five-minute intervals. Note that the data fall into three groups: a first group that forms a bell-shaped curve centered at about 12 minutes, a second group with a broader bell-shaped distribution centered at around 35 minutes, and a third group of extremely long waits. The *line graph* (sequence) of the data indicates that the second group is associated with certain time intervals during the day (11 a.m.–1 p.m. and 4–6 p.m.), while the extremely long waits seem to occur sporadically throughout the day. This simple graphical analysis naturally leads the focus of the investigation to theories associated with (1) staffing and scheduling policies associated with certain times of the day and (2) how events that occur randomly, such as emergencies, are handled.

Two other graphical tools—the scatter diagram and the control chart—can be used to conduct further analyses. A *scatter diagram* is used to study the relationship between two variables (see Figure 3). Using the waiting time example, we might want to examine the relationship between waiting time and number of appointments scheduled. Figure 6 shows a scatter diagram for this relationship. Each point on the graph represents paired data for an individual patient. For example, there were a total of 11 individuals who were in the situation of having four other appointments scheduled within 15 minutes of their appointment (each such individual is represented by a "dot" above the "4" on the horizontal axis). The waiting times for these individuals

Figure 5
Graphical Display of Four Dimensions of Continuous Data

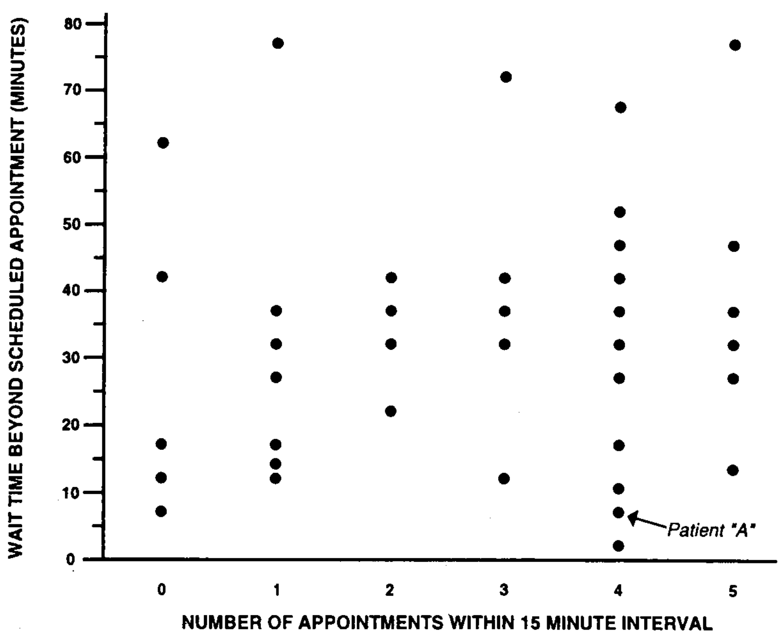


can be read on the vertical axis; it varied from a low of 2 minutes to a high of 68 minutes. Specifically, four other appointments were scheduled within 15 minutes of Patient A's appointment, and Patient A waited 8 minutes beyond the scheduled appointment time.

The value of the scatter diagram is that it allows us to examine the data as a whole, rather than to look at each piece of data individually. While there are certainly some cases of long waits when there are many simultaneous appointments scheduled in the clinic, the overall pattern in the data indicates that waiting time is not strongly influenced by the number of concurrent appointments. In other words, even when the number of concurrent appointments is high (say four), the waiting time appears equally likely to be short or long (in this case, to range from 2 to 68 minutes).

After the improvement team succeeds in acting on the most influential factors, it can monitor the ongoing stability of the process with a *control chart* (Wadsworth, Stephens, and Godfrey 1986; Gitlow et al. 1989; Shewhart 1931; Deming 1986; Plsek 1992). A control chart is simply a line graph of the data with superimposed horizontal lines indicating statistically derived upper and lower control limits (see Figure 3). These upper and lower limits indicate the range of variability that we would expect if the variation is subject only

Figure 6
Scatter Diagram on the Effect of Scheduling on Wait Time



to small, randomly occurring factors that are inherent in the process (so-called "common cause variation"). If the measured data points fall randomly within the control limits, we say that the process is stable. Stable processes are predictable; performance will continue to fall within the limits as long as the process remains as it is. Furthermore, if the process is stable, we can also assert that further improvements in performance can only come about through fundamental changes in the process itself. Reacting to individual ups and downs in the data within the control limits (e.g., "Waiting time was higher today than it was yesterday, so I'll speak to the staff and admonish them to do better") is called "tampering" and is likely to be counterproductive (Deming 1986).

When data values fall outside the control limits, or exhibit certain unnatural patterns within the control limits, there is statistical evidence of a so-called "special cause"—that is, the evidence suggests that the variation is not random. We should, therefore, be able to isolate the source of this unnatural variation and remove it from the process.

Although these basic tools for data analysis are being widely deployed in health care (Laffel and Blumenthal 1989; Berwick, Godfrey, and Roessner 1990; Gaucher and Coffey 1993), they are not the only statistical and engineering tools that can be used for improvement. For example, modern industrial improvement teams commonly employ somewhat more sophisticated techniques for efficient design of experiments (DOE) (Box, Hunter, and Hunter 1978). Moore (1994) has recently documented an early application of DOE in health care that resulted in improvements in patient satisfaction in the emergency room of the Anderson Area Medical Center in Anderson, South Carolina. I anticipate that the next 10 years will see continued adaptation of analytical improvement techniques into health care from industrial quality management science.

Tools for Collaborative Work

Wide-scale staff involvement in decision making and unprecedented cooperation across traditional departmental boundaries are key principles in the modern approach to quality management. Ferguson, Batalden, and Howell (1993) further assert that collaborative work is critical to organizational success because health care is a system of interdependent resources, the functioning of which depends largely on how well we communicate with one another. To support this collaborative work, quality management practitioners have borrowed tools from the work of psychologists and organizational development specialists (Scholtes 1988; Mosel and Shamp 1993).

The four most commonly used tools for collaborative work are brainstorming, boarding, multivoting, and decision matrices. *Brainstorming* involves unrestricted, free-wheeling, divergent thinking where group members list options and ideas without detailed discussion or fear of judgment (Scholtes 1988; Osborn 1953). *Boarding* is simply the visual display of information on easel sheets or other media that all group members can see. Brainstorming and boarding aid collaboration and consensus-building by showing that everyone's ideas are valued.

Multivoting and decision matrices, in contrast, support collaborative convergent thinking. In *multivoting,* group members review a long list of options, problems, theories, or suggestions and privately select the one-third they feel are most significant. When the votes are tallied, a Pareto distribution typically results. In other words, some items from the divergent thinking list appear on all or nearly all of the group members' lists, while other items receive few votes. The feedback to the group of the results of this voting process will either quickly expose an already existing consensus or pinpoint options that require further discussion in order to build a consensus. While multivoting is useful when the criteria for making a choice are simple, *decision matrices* can be helpful in situations where the criteria are multidimensional (Scholtes 1988; Grandzol and Gershon 1994). For example, a group might construct a two-dimensional matrix with options listed as row titles down the side and specific criteria listed as column headings across the top. The intersections of the rows and columns are used to capture the group's opinion about how each option rates on the specific criteria. So, in considering optional process changes, the group might agree that option 1 has high desirability in terms of cost, low desirability in terms of potential effectiveness, and medium potential acceptability to the people in the process. A similar analysis of the other options might demonstrate that while no option is perfect, some are better than others. This realization, and the time spent in group discussion, aids consensus-building and cross-departmental collaboration.

These four techniques—brainstorming, boarding, multivoting, and decision matrices—are the building blocks for other collaborative methods. For example, the nominal group technique (Delbecq, Van De Ven, and Gustafson 1975) consists of a sequence of boarding the question of interest, silent brainstorming of ideas, boarding those ideas, discussing as a group, multivoting to prioritize the list, and discussing again to confirm a final decision. Similarly, many other popular group consensus techniques can be decomposed as a sequence of these four elemental techniques.

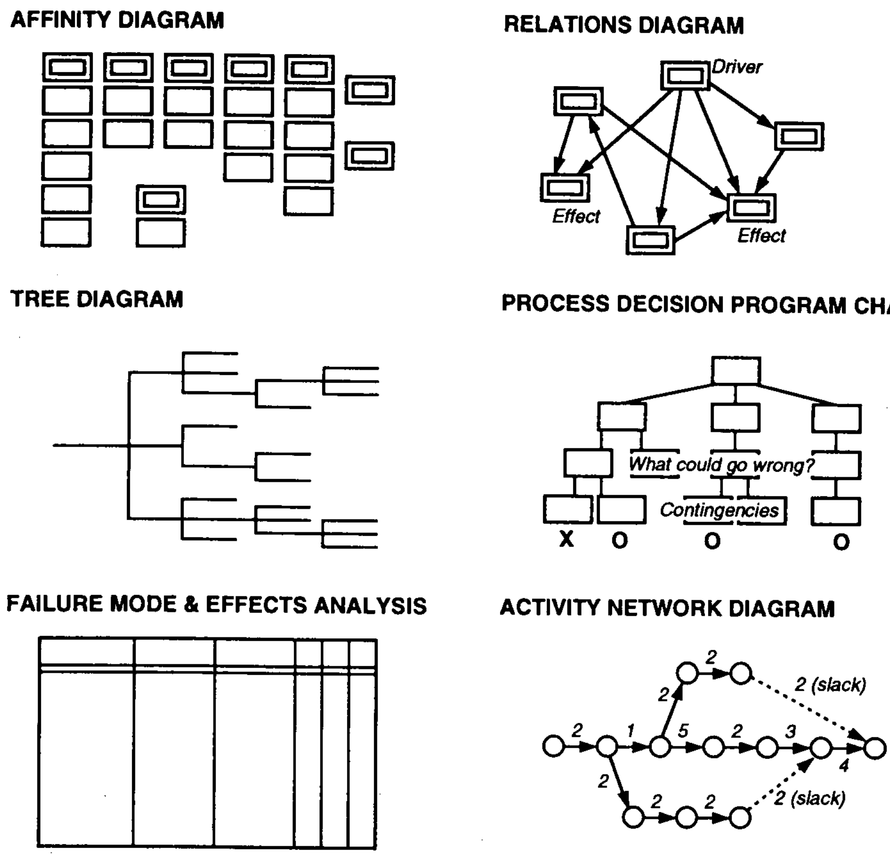
Tools for Quality Planning

While the graphical and team tools cited are most often used to improve existing processes, quality management science also includes techniques for planning of new processes and services. There is a set of basic planning tools that have been borrowed from various disciplines, models to guide both new process design and strategic planning, and techniques borrowed from the field of market research for determining customer needs.

The Management and Planning Tools

The management and planning tools in the quality management literature aid groups in generating and organizing verbal information (e.g., ideas, concepts, intuitions, attributes, and descriptions of tasks). These tools were adapted from other fields and imported into quality management science by the Japanese in the 1960s and 1970s. These tools are fully described in a variety of references that also provide a host of application examples (Mizuno 1988; Brassard 1989; Plsek 1993a). Some of the most commonly used tools will be described briefly. Figure 7 provides a schematic depiction.

Figure 7
Schematic Depiction of the Common Management and Planning Tools



The *affinity diagram* (also known as the K-J Method in honor of its developer, Japanese anthropologist Kawakita Jiro) (Brassard 1989) is a group brainstorming and organizing technique. Team members begin by brainstorming freely on a defined topic (e.g., What are the features of an ideal primary care clinic?). Ideas are written on individual cards or adhesive note papers and arrayed on a surface for everyone to see. After a period of brainstorming, the team then shifts its attention to grouping the ideas into sensible categories. In silence, each team member searches for two cards that he or she feels are related in some way. These cards are then placed together and the process is repeated continuously, with team members finding two new cards that are related or adding additional cards to existing groups. In this process, cards are said to have an "affinity," or attraction, for one another because the individual ideas on them seem related in some way. The silent grouping continues until all cards have been placed into six to ten groups. At this point, the team switches from silent work to discussion mode, examining each group to identify the central theme that ties them all together. This theme is written on a header card, with the individual items arranged under it, to complete the diagram. The brainstorming allows everyone to participate freely, while the silent grouping allows new patterns of information to emerge by postponing the critical thinking that tends to push information into the mold of preconceived patterns. Finally, the process of naming the group establishes a common understanding among team members as to the central themes reflected in the collection of ideas.

A *relations diagram* (also known as interrelationship diagraph or I.D.) documents complex cause-effect relationships among items (see Figure 7). Again, the construction of the diagram is participatory and verbal. Items are written on individual cards and displayed on a wall or easel sheet. These items might be the themes (header cards) from an earlier affinity diagram. Considering one card at a time, the leader asks the team, Which other items are driven by or influenced by the factor written on this card? Based on the discussion, the leader draws arrows from the factor of interest to every other item it influences. This process is repeated for each card in turn until all possible causal relationships have been documented.

The completed diagram gives us a greater appreciation of the system as a whole. Items with many outgoing arrows are key causal factors ("drivers") that, if properly addressed, influence a large number of other items. Identifying these drivers gives the team a sense of priorities, or starting points, in an otherwise overwhelmingly complex situation. Similarly, items with many incoming arrows are key effects. If the team properly addresses the many other driving (causal) factors on the diagram, it should see changes in these key effects as a result. The team might want to track these few itemsas a way of assessing the ultimate success of the effort, rather than trying to measure each of the causal factors directly.

The *tree diagram* (also known as the systematic diagram) starts with an end result to be attained and then describes in increasing detail the full range of tasks or contributors to that result (see Figure 7). Graphically, it resembles an organization chart or family tree. To illustrate, suppose that a planning committee in a home health agency has constructed a relations diagram and identified "availability of appropriate staff" as one of the key drivers in the causal system for patient satisfaction. This driver is written on a card and represents the first level of the tree—the problem, objective, or goal statement. In the second level of the tree, the group might break "availability of appropriate staff" into four categories of activity—external recruiting, internal transfers, training programs, and retention of existing staff. Note the comprehensive nature of these second-level categories; the team strives to be both complete and increasingly detailed as it moves down the levels of the tree. In the third level, the team takes each second-level item and dissects it further into its component parts or necessary tasks. This dissecting process continues until the team reaches the point where tasks are defined well enough that they can be assigned to someone (typically, this occurs at the third to fifth level of the diagram). The group effort needed to construct the tree diagram ensures that there are no major gaps in our thinking about what needs to be done, and that, in the end, the people working on individual tasks will be able to see how what they are doing fits into a bigger picture.

The *process decision program chart* (PDPC), another of the management and planning tools, maps out conceivable, but undesirable, events in a plan and indicates appropriate contingencies (see Figure 7). Planning teams typically construct PDPCs near the end of their planning efforts, utilizing the collective knowledge of the team to perform a final check of an implementation plan. The team begins as with a tree diagram by defining a goal (level 1) and the high-level steps that contribute to that goal (level 2). Then, instead of breaking each of the second-level items down into more detailed categories or tasks, the team leader takes each second-level item and asks, What could go wrong with this? The various failure scenarios—based on data, past experience, or simple hunches—are written on individual cards to form the third level of the tree. Next, the fourth level of the diagram is used to describe various contingencies (countermeasures or preventive actions) that the team could utilize to minimize the impact of each failure scenario. In the fifth and final level of the chart, the team evaluates these contingencies. The symbol X is typically used to mark those that are impractical, while the symbol O is used to mark those that should be implemented (unmarked items are simply held for future consideration).

A *failure mode and effects analysis* (FMEA) is a slightly more sophisticated version of contingency planning (Juran and Gryna 1980). In FMEA, steps, failure scenarios, and contingency plans are typically described in more detail and the resulting information is displayed in tabular form (see Figure 7). The key refinement is that each failure mode is then rated based on likelihood of occurrence and severity. These rating scores follow a Pareto distribution and direct the planning group's attention toward the most likely and most severe potential failures.

A final tool in the basic set of management and planning tools is the *activity network diagram* (also known as the arrow diagram). The diagram shows the sequence of tasks required to accomplish some objective, along with time estimates for each task (see Figure 7). By compiling the time estimates, a team can: (1) define start and completion dates, (2) identify the critical path of activities that dictate the minimum total time required to accomplish the objective, (3) manage the slack time in parallel tasks, and (4) monitor progress toward the objective. It is one of the last planning tools that a team might use.

In concluding the discussion on management and planning tools, let me emphasize three key points from the quality management literature about these tools. First, it is easy to get carried away with endless detail; we must use common sense and know when to stop. Prudent teams will question whether a suggested tool will contribute to the team's goal and decide up front what they hope to accomplish by using it. They can then stop at regular intervals (e.g., 15 minutes) and ask, Is this helpful? Are we accomplishing anything with this? Should we stop and move on to something else or continue doing this? Second, the successful use of the tools depends heavily on team members' commitment and attention to group process skills. Team members must value each other's expertise, be open to active participation by all, and practice good listening. The need for good team skills is so critical that teams should consider the use of trained facilitators or formal team-building exercises. The organization's human resources department might help in these areas. At a minimum, teams should establish written group groundrules and conduct frequent self-evaluations relative to these. For example, the team leader might ask, What drives you crazy when you have to participate in meetings or work together in teams? This question typically generates both a light-hearted discussion and many nods of agreement. After listing these "pet peeves" on an easel sheet, the leader can then ask, What groundrules should we establish for ourselves to avoid doing those things that drive us all crazy when we have to work together in groups? This list of groundrules can then be used to remind the team members of the behavioral norms that they have established for themselves. Finally, it is important to understand that while the management and planning tools provide a way to make use of verbal information and intuition, they should not be taken as license to ignore the need for data and facts. Planning teams should use the traditional data analysis tools of quality management to confirm the subjective relationships documented in the various management and planning tools.

Models for Process Design

Just as there are models to guide teams seeking incremental improvements in existing processes, various authors have proposed high-level road maps to guide the design (or redesign) of new processes (Plsek 1993b; Ackoff 1978; Juran 1988a; Hammer and Champy 1993). While these models differ in their details, common threads run through them all.

The first step typically involves defining the scope and aim of the new process in a way that reflects the needs of the various customers that the process serves. This statement of aim might be derived from an affinity or relations diagram, based on the results of customer focus groups. The various models for process design also stress the importance of involving workers and caregivers directly in design; processes should not be designed by staffers or managers who will never work in the processes themselves. The models typically direct these multidisciplinary design teams to begin by constructing flowcharts of an ideal process to meet customers' needs. These flowcharts lead naturally to focused work on the internal hand-offs between individuals and departments that are often the sources of process breakdowns. Next, the design team reviews the ideal process step-by-step and plans for realistic contingencies; the PDPC or FMEA tools described above might be useful here. Finally, the models suggest that the design team plan for the measurements and controls that are needed to assure quality. It is much easier to design control and feedback systems before the new process is implemented than it is to retrofit them in the climate of defensiveness that may be present after the process is in place and problems have appeared.

Specific Process Planning Methods in Health Care

The importance of process design has led to the development of specific adaptations for health care. *Critical paths* (a.k.a. care paths or clinical paths) are multidisciplinary, high-level process design efforts that specify key milestones in the care process for patients in a given diagnostic category (Shoemaker 1974; Mosher et al. 1992; Coffey et al. 1992; Falconer et al. 1993). These explicit milestones aid coordination of care, help reduce length of stay, improve quality of care, increase patient and family involvement, and enhance cross-departmental cooperation. Similarly, *clinical guidelines* and *algorithms* outline the process of clinical decision making and thereby help focus discussion on potentially unnecessary variation in clinical practice (Murrey, Gottlieb, and Schoenbaum 1992; Green and Katz 1992). Both care paths and guidelines are used widely in health care, with good initial results (Coffey et al. 1992; Falconer et al. 1993; Murrey, Gottlieb, and Schoenbaum 1992).

Techniques and Models for Strategic Planning

The late W. Edwards Deming (1982), a highly influential thinker in the field of quality management science, stressed the importance of long-term planning in the first of his famous 14 points, "establish constancy of purpose." As a result of this emphasis, quality management practitioners have adapted various techniques from the field of strategic planning.

In the early 1970s, Juran and Gryna (1980) and others recommended that quality goals be given the same prominence in organizations as financial goals. Juran's approach to strategic planning for quality was, therefore, to set up a quality goal-setting system that paralleled the organization's financial budgeting system. The result was an *annual quality plan,* as formal as the annual budget. A health care organization following Juran's advice (circa 1970–1985) might ask each department or service to set specific improvement goals, which would then be categorized and summarized to form organizationwide goals such as "reduce patient waits by 30 percent," "improve physician satisfaction by 50 percent," or "perform mammography screening on 90 percent of at-risk females."

While introducing specific quality goals was a step forward for industrial companies during the 1970s (and would be a step forward for some health care organizations today), practitioners questioned whether such goals were truly strategic in nature and worried that the separateness of the annual quality plan might mean that quality management would never be seen as integrated with day-to-day organizational management. During the decades of the 1970s and 1980s, the Japanese developed a strategic planning system that places quality (in terms of meeting customer needs) firmly at the center of all organizational plans. This method, called *hoshin planning,* rests on two critical assertions: (1) that the central goal of any organization must be to meet the needs of its customers and (2) to be successful, the organization must achieve alignment between its strategic goals and the personal goals of each of its members (King 1989; Akao 1990). In hoshin planning, all organizational goals—such as customer satisfaction, efficiency, or financial performance—emanate from the needs of customers. Senior leaders commission substantial customer research and use this information to develop tentative strategic goals. Then, in order to achieve alignment between organizational and personal goals, these senior leaders personally engage in sharing the tentative strategic plans with subordinates. This process, called "catchball," is a true negotiation that provides subordinates with a real opportunity to influence the organization's strategic choices. The catchball process continues down the entire organizational hierarchy, with the goals becoming increasingly more detailed at the lower levels. In the end, all departments and workers have clear goals for improvement that are linked to the overall strategic, customer-based goals of the organization.

This approach to planning is so compelling that Juran (1989) has incorporated many of its aspects into what he now calls "strategic quality management." Hoshin planning and strategic quality management are now used by many leading U.S. companies and some health care organizations such as the SSM Health Care System (headquartered in St. Louis, Missouri). Implementation of hoshin planning in health care is hindered by confusion over multiple customers, lack of information about the true needs and expectations of these customers, and the tradition of not involving staff in strategic planning. However, there are encouraging trends that suggest that these barriers will be reduced with hard work and good leadership over time.

An approach to strategic planning in health care that reflects the centrality of the customers and also incorporates elements of systems thinking (Deming 1986; Senge 1990) is the *organization-as-a-system exercise* developed by the quality resources group at the Hospital Corporation of America (Batalden and Nolan 1993). Though not strictly designed for this purpose, health care organizations such as the SSM Health Care System have adapted it as an analysis tool for strategic planning. The exercise, which can be used by a health care system, a stand-alone entity, or a department within an entity, poses a series of questions to be answered by senior leaders based on knowledge of customer and community needs. The first question, What do we make? forces leaders to step out of the traditional definitions of hospitals, HMOs, and clinics and define their purpose in broad terms. For example, a hospital leadership team might decide that it makes (among other things) "opportunities for improvement of health." This opens up avenues of strategic thinking that go beyond acute care beds and into such areas as community outreach and preventive primary care. The analysis continues with such questions as, Who are our customers? How do they define quality and why? What are the needs of the community? How do we make what we make? What is our vision for the future? What are our general themes for improvement? and What specific processes should we improve, design, or redesign? The end result is a better appreciation of an organization's role in the community and a clearer picture of its strategic vision for the future.

A final word of caution is appropriate in regard to the use of these strategic planning tools. Mintzberg (1994) points out that effective strategies can never come solely from analysis: "Strategic thinking," he notes, "is about synthesis; it involves intuition and creativity." The various tools of strategic planning can inform that synthetic thinking process, but they are not a substitute for it.

Customer Needs Analysis

Another major group of quality planning techniques are those borrowed from market research for identifying customer perceptions (Juran 1988a; Plsek 1987; Aday 1989; Gerteis et al. 1993; Gustafson et al. 1992). A key insight on which many of these techniques are based is the notion that quality is multidimensional. While Garvin (1988) first articulated the concept of *dimensions of quality* in general industry, the Joint Commission on the Accreditation of Healthcare Organizations (JCAHO) (1993) has recently brought this concept into health care by noting that quality involves appropriateness, availability, continuity, effectiveness, efficacy, efficiency, respect and caring, safety, and timeliness.

But any such list of quality dimensions is too general to guide specific, customer-focused planning. An organization needs to define these dimensions further for each of its services and customers. For example, "accessibility" for walk-in patients to an ER might mean being seen by a clinician within 15 minutes, while "accessibility" for an HMO member might mean being able to schedule a routine appointment within one week. We should develop such specific, measurable definitions for each dimension in conjunction with our customers through *focus groups* and *surveys*. Batalden and Nolan (1993) have further noted the importance of digging deeper and understanding what drives our customers to define quality in these ways; for example, Why is being seen in 15 minutes or less so important in an ER? Probing these customer needs might lead us to understand that anxiety is the real driver. This insight, in turn, leads us to understand that improvements in ER waiting time must be done in conjunction with efforts to reduce patient anxiety during the wait. If we fail to do this, we might expend resources reducing waiting time but fail to achieve desired improvements in patient satisfaction.

Other techniques that are helpful in customer needs analysis are the *moments of truth method* (Carlzon 1987) or the related *critical incident technique* (Gustafson et al. 1992; Flanagan 1954). The theory behind each of these techniques is that quality is a composite of impressions that customers get at various points of contact with our organization. For example, moments of truth for a clinic visit might include entering the parking lot, walking into the building, approaching the receptionist, entering the waiting room, or being called back by the nurse. At each of these moments of truth, our HMO members develop an impression about our level of service, attention to customer needs, and ability to provide service. Again, we can use focus groups and surveys to deepen our understanding about what is really important to customers at each of these moments. With this information, we can direct truly strategically focused improvements in areas that customers will really notice, thereby enhancing customer satisfaction and loyalty.

In concluding the discussion of customer needs analysis, let me call attention to three key points made repeatedly in the quality management literature on this topic. First, it is important to think of the "customer" in very broad terms—patients, members, families, employees, professional staff, payers, stockholders, boards, regulators, community groups, and others might all be customers. Successful organizations seek to understand and meet the needs of all these customer groups. Second, customers can be internal to the organization as well as external. When you write a memo and hand it to an assistant to type, the assistant is your customer in the transaction. While you are the ultimate customer of the typing, the process will have higher quality in terms of efficiency, accuracy, and ultimate satisfaction if you begin by understanding the needs of your assistant and making that initial hand-off as smooth as possible. In this sense, quality management science asserts that every work process is a series of supplier-customer relationships where understanding and meeting needs at every step will assure higher-quality outcomes (Ishikawa 1985; Juran 1988a). Finally, we should understand that analytical market research can never fully identify all customer needs. Noriaki Kano (Akao 1991) speaks of "surprising quality"—giving customers something they had not thought of before, but which delights them when they do experience it. Focus groups and surveys will never uncover such ideas directly; innovative thinking and experimentation is the only way. Gustafson and colleagues (1992) have recently documented an approach for uncovering such otherwise unexpressed customer needs in the context of treatment for breast cancer; their work led to the development of a computer-based bulletin board service that women in one study accessed over 1,600 times for answers to sensitive questions.

Advanced Planning Techniques

Progressive industrial firms and some leading-edge health care organizations are pushing customer-based planning a step further by the use of the technique of *quality function deployment* (QFD). QFD utilizes a series of progressively more detailed matrices to trace specific work process steps and detailed measures back to customer needs (Gaucher and Coffey 1993; Akao 1991; Hauser and Clausing 1988; Sullivan 1988). (One of the key matrices resembles the silhouette of a house; hence, the technique is also referred to as "the house of quality.") A comprehensive QFD analysis ensures that we have addressed all customer needs, that everyone who works in the process understands what is important to the customer, and that everyone understands why each performance measure is tracked. An early adopter of this technique in health care is the Bethesda Hospital System in Cincinnati, Ohio (JCAHO 1992).

Techniques for Measurement

Completing Juran's trilogy, the third set of techniques from quality management science are those for measurement. In this final section, I will discuss a framework for a comprehensive measurement system and explain the technique of benchmarking.

Traditional Approaches in Health Care

Let me begin by acknowledging the long tradition of measurement in health care. The work of Donabedian (1980, 1982, 1985) and the health care quality assurance (QA) practitioners who followed him led to sets of measures for structure (e.g., number of board-certified physicians), process (e.g., frequency of use of urinary catheters more than 48 hours following surgery), and outcome (e.g., mortality rate). Today, measurements such as these, along with QA committees and chart reviews, are standard practice in nearly every health care organization. In addition to Donabedian's pioneering work, over the years many contributors have added to our selection of ways to measure the outcomes of health care processes—both technical performance and customer satisfaction (Bernstein and Hilborne 1993; Spiker et al. 1990; Ware and Hays 1988). Recently, various organizations have proposed standardized indicators and data sets to measure performance in health care settings: for example, HEDIS 2.0 (Corrigan and Nielsen 1993), the Maryland Indicator Project (Kazandjian et al. 1993), and the JCAHO's IMSystem (Nadzam et al. 1993). The introduction of quality management science in health care organizations should therefore be seen as building on, not tossing out, these past approaches to measurement.

While quality management science builds on the tradition of measurement in health care, it also encourages us to seek three new objectives. First, quality management science encourages us to expand the scope of our thinking about what is important to measure by prominently featuring the perceptions of customers as valid indicators of quality, in addition to technical and professionally based views of performance. Second, quality management science focuses on cross-functional processes and suggests that we view measurements as integrated systems that must be managed by cross-functional teams rather than having one set of measures tracked by medical staff, another set by nursing, and still another by administration. Third, quality management science calls into question the traditional use of measurement as a way of allocating rewards and punishments to individuals. Berwick's (1989) seminal article on this topic, in which he described the "search for bad apples" that seems to characterize our traditional approach to measurement, is widely cited as the trigger that initiated the introduction of industrial quality management science into health care.

A Framework for a Comprehensive Measurement System

A system for health care measurement should include measures of *clinical outcomes, customer perceptions of quality, internal process performance,* and *financial performance* (Bader 1993). Nelson and Batalden (1992) further suggest that such systems of measurement be arrayed in a hierarchical fashion, from broad to detailed. At the top of the hierarchy, there should be a few, broad summary measures in each category that provide senior leaders with an indication of the overall performance of the organization. These measures are analogous to the meters and warning lights in the cockpit of an airplane or dashboard of an automobile. For example, your car's oil pressure light provides gross performance feedback on your automobile's lubrication system. When the light is off, you can be generally assured that everything is fine, even though you do not have the detailed data to confirm this. In analogous fashion, Group Health Cooperative of Puget Sound's CEO, Henry Berman, M.D., describes 13 "dashboard" measurements used by his senior leadership team (Bader 1993). These high-level indicators (e.g., member retention, hospital days per 1,000 members, cesarean-section rate, and appointment waiting time) provide senior leaders with a general overview of organizational performance in the four areas of customer satisfaction, financial performance, clinical outcomes, and internal process performance. Each "dashboard" measurement is backed up by a set of more detailed measurements, tracked by teams of managers and clinicians throughout the organization, that can be used to quickly pinpoint process difficulties should the dashboard indicators show a problem. The value of this hierarchical approach to measurement is that it avoids the problem of information overload that characterizes many measurement systems. Instead of tracking 40–50 indicators as if they were all equally important, senior leaders can focus on about a dozen key measures and trust that other managers are monitoring the details.

Benchmarking

Benchmarking is the process of comparing your institution's performance to that of the best (Tucker, Zivan, and Camp 1987; Camp 1989; Balm 1992; Bader 1992; Flower 1993; Patrick and Alba 1994). It is not solely a measurement technique, but it is often thought of as such. In a benchmarking study, we begin with measurement, but then go deeper by making site visits to other organizations in order to understand why there are performance differences between seemingly similar processes. Knowing why something is better is the key to improving our own processes.

Balm (1992) suggests that there are four types of benchmarking. *Internal benchmarking* compares similar processes and services within the organization. For example, we might benchmark (compare) documentation practices on several nursing units in a hospital. While this is a good way to reduce unnecessary variation, we may not uncover substantially better practices simply by looking within our own organization. *Competitive benchmarking* compares ourselves with our direct competitors. For example, we might gather information by calling to schedule a routine appointment in our competitors' clinics. Such studies produce strategically important measurement data, but it is often difficult to go the next step and learn how a competitor achieves better performance.

Functional (or group) benchmarking compares performance against those who are the best in the industry, but not our direct competitors. The absence of direct competition opens up a better channel for detailed sharing across organizations. Group benchmarking is becoming common in health care. For example, 32 hospitals in the Healthcare Forum's Quality Improvement Network are sharing information in an effort to streamline their admissions processes (Bader 1992). Similarly, SunHealth Alliance, an affiliation of 260 hospitals and other providers, regularly sponsors groups of 5–15 organizations to identify and share "best practices" in specific areas (Patrick and Alba 1994). Health care organizations are also finding that the group benchmarking concept can be applied to clinical issues as well as administrative processes. The key to success in group benchmarking is identifying the "best" organizations to form the group. Sponsoring organizations typically accomplish this by surveying specific performance measurements in a number of candidate organizations, and then using that data to identify a smaller number as the "best in class."

Balm's (1992) fourth type of benchmarking is *generic benchmarking.* Here, we make a conscious effort to go outside our industry to find others who excel in a process similar to ours, or a dimension of performance that is key to our customers. For example, a hospital admissions department might examine the process of customer intake in an excellent hotel, a home health agency might visit a taxi company to gain insight into the efficient management of mobile resources, or clinic managers might review billing procedures in an excellent company like American Express. In generic benchmarking, quantitative measurement is less important because customer needs and measurement methods necessarily differ across industries. Rather, the keys to success here are open-mindedness, observation skill, and the creativity to adapt ideas for use in our industry. Generic benchmarking is a powerful way to stimulate innovative thinking. There is considerable anecdotal evidence of its use by focused quality improvement project teams in health care, but the traditional feeling that health care is a unique industry has been a barrier to its widespread adoption.

Regardless of the type of benchmarking one employs, it is important to understand that such studies require deep effort to be successful. Garvin (1993) notes that "benchmarking is not 'industrial tourism'. . . rather, it is a disciplined process that begins with a thorough search to identify best-practice organizations, continues with careful study of one's own practices and performance, progresses through systematic site visits and interviews, and concludes with analysis of results, development of recommendations, and implementation." Camp (1989) underscores these points and goes on to stress the importance of organizationwide communication and top management support. It is this emphasis on applying knowledge and making real changes that takes benchmarking beyond being a simple measurement effort. When properly practiced, benchmarking is an improvement process in the Juranian (1964) sense, where breakthroughs in cultural patterns and results (improvement) must follow breakthroughs in knowledge (measurement).

Conclusion

This article has surveyed a basic collection of tools and methods from the quality management sciences that can be applied in health care. Health care organizations that thoroughly understand and appropriately use the methods outlined in Figure 1 are on the leading edge of the modern approach to quality. The pace of adoption of these methods, which have been successfully applied in other industries, into health care over the last 10 years is encouraging. However, the field of quality management science is broad, and leading practitioners are continuously developing new tools and applications. The next decade of the evolution of quality management in health care promises to be as exciting as the last.

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