

The Quality Manager Body of Knowledge (Part 2)

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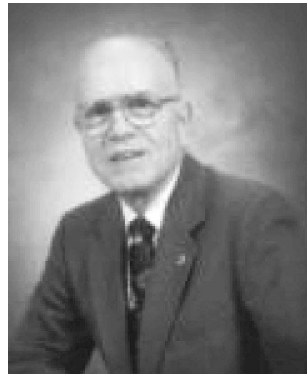
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Introduction to Part 2

The purpose of this paper is to provide a relatively brief overview of what today's quality manager is expected to know. Essentially this is the body of knowledge (BOK) which the American Society for Quality (ASQ) uses to develop its examination for Manager of Quality/Organizational Excellence (MOQ/OE) certification. This information should be of interest to anyone who is involved in any way with ensuring the quality of his or her company's goods and services. In fact, since good quality management is becoming more and more simply good management, the BOK should also provide good review of general management concepts and best practices. Also it should be of interest to those who teach quality management and provide a framework for such teaching. Finally it will provide those studying for the MOQ/OE certification examination a quick way to refresh their memory about the contents of the BOK.

Westcott (2006) is the basic reference for the body of knowledge and is the basis for this paper.¹⁾ Unless otherwise indicated, all page citations refer to Westcott (2006). To even briefly summarize the BOK (as spelled out in Westcott's voluminous handbook) in any meaningful way requires a lot of pages. Therefore, to keep this paper a reasonable size it was decided to break in into two parts. This is part 2; see Austenfeld (2007) for part 1. Part 1 covers the first 12 chapters in Westcott; part 2



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1) However, even this handbook by Westcott is considered to be only a guide and those preparing for the certification exam are "urged to seek more information from one or more of the resources lists" (and many are listed).

Papers of the Research Society of Commerce and Economics, Vol. XXXXVIII No. 2
chapters 13–19.

The BOK consists of seven major parts: I Leadership, II Strategic Plan Development and Deployment, III Management Elements and Methods, IV Quality Management Tools, V Customer-Focused Organizations, VI Supply Chain Management, and VII Training and Development. Under each part are from one to five chapters which are further divided. Appendix A shows this breakdown in detail. Due to the breath of this BOK it would be impossible to do any more than briefly summarize each chapter. This is done by first doing a bullet summary of the essential points of the chapter and then another bullet listing of certain other key points felt particularly noteworthy. Both of these lists are according to my understanding of the subject matter *and not necessarily authoritative*.

Part 1 of this paper (see Austenfeld, 2007) is organized as follows²⁾:

- Introduction to Part 1
- I Leadership (Chapters 1–4 in Westcott)
- II Strategic Plan Development and Deployment (Chapters 5–7 in Westcott)
- III Management Elements and Methods (Chapters 8–12 in Westcott)
- Summary and Conclusion to Part 1

Part 2 (this document) is organized as follows:

- Introduction to Part 2
- IV Quality Management Tools (Chapters 13–15 in Westcott)
- V Customer-Focused Organizations (Chapters 16 & 17 in Westcott)
- VI Supply Chain Management (Chapter 18 in Westcott)
- VII Training and Development (Chapter 19 in Westcott)
- Summary and Conclusion to Part 2

2) See Appendix A for a further breakdown.

IV Quality Management Tools

IV-A Problem-Solving Tools (Chapter 13 in Westcott)

Brief summary of chapter:

- Problem-solving tools provide a systematic means for both analyzing the problem and coming up with a solution in the most creative and efficient way.

IV-A-1 The Seven Classic Quality Tools

- The seven classic quality tools are:
 - Flowchart
 - Check sheet
 - Cause-and-effect diagram
 - Pareto chart
 - Control charts
 - Histograms
 - Scatter diagrams
- A *flowchart* allows all the steps in a process to be graphically displayed showing interrelationships and decision points (see also section IV-B-2 Process Analysis below).
- A *check sheet* is simply a way to tally the number of times something occurs. For example the different types of defects causing a particular part or product to be rejected.
- A *cause-and-effect diagram* (also known as an Ishikawa or fishbone diagram) lays out all the possible causes for a particular problem. The causes are usually grouped according to some system such as the four Ms³⁾ for a manufacturing processes or the four Ps⁴⁾ for service processes.

3) Manpower, machinery, methods, and materials.

4) People, policies, procedures, and plant.

- A *Pareto chart* takes data—e.g., types of defects or downtimes of machines—and groups it according to frequency of occurrence. When graphically displayed this way it is easy to see which defect or machine is contributing the most to the problem.
- A *control chart*, using periodically gathered sample data from a process, shows how far each sample deviates from the desired norm. By setting mathematically derived upper and lower control limits, unacceptable variation can be quickly spotted. Control charts help to both detect special (one-time) causes of variation and show how the process performs over the long-term. Figure 1 is an example of a control chart.

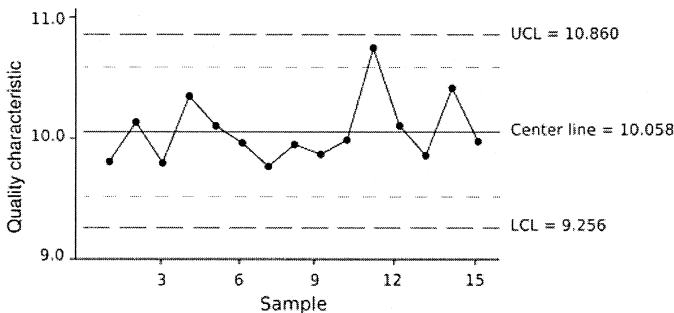


Figure 1. Example of a control chart (Wikipedia—http://en.wikipedia.org/wiki/Control_chart).

- A *histogram* is a frequency distribution diagram showing how often a certain nominal process value occurs over time. It can show if two or more distributions are actually present due to different inputs to the process.⁵⁾
- A *scatter diagram* plots the relationship (correlation) of two variables to each other; e.g., the curing temperature of glue joint and its shear strength.⁶⁾ Such a plot will also show if the relationship is positive or

5) For example the effect of the same raw material purchased from two different suppliers (Westcott, p. 336).

6) Example from Westcott, p. 336.

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negative and how strong it is. Because two variables are correlated does not mean there is a cause-and-effect relationship!

IV-A-2 Basic Management and Planning Tools

- The seven classic quality tools are used to analyze processes, the following seven tools are used more for planning and managing activities:
 - Activity network diagram
 - Affinity diagram
 - Interrelationship digraph
 - Matrix diagram
 - Priorities matrix
 - Process decision program chart
 - Tree diagram
- An *activity network diagram* is a way to lay out all the activities of a project to show how they relate to each other. It includes the critical path method (CPM) and program evaluation and review technique (PERT) tools previously mentioned in Part 1 (Austenfeld, 2007, pp. 81/2).
- An *affinity diagram* is used to group similar ideas—e.g., those generated in a brainstorming session—into meaningful clusters for further study. It can help the group come to a better common understanding of what the ideas mean.
- An *interrelationship digraph* shows cause-and-effect relationships between ideas. For example, suppose an affinity diagram has been used to group similar ideas about, say, things that impact team performance. The interrelationship digraph would then be used to see if there are any logical cause-and-effect relationships between idea clusters and, if so, the direction of the relationship (one-way or both directions).
- A *matrix diagram* is another way to show how two sets of data are related. One set of data is represented by the rows and the other set by the

columns. If a relationship exists between any of the any of the data elements it is indicated by some mark or symbol placed at the intersection of that row and column. A number or special symbol could be used to indicate the strength or significance of the relationship. Matrix diagrams are typically used to help develop an interrelationship digraph or to show the involvement of various parts of an organization in each task of a project.

- A *priorities matrix* is used to analyze several options one might have in choosing some product—say a new car—against a set of criteria. By appropriately weighting each significant attribute (e.g., handling, acceleration, etc.) in terms of importance, and then assigning an “objective” value to the attribute for each possible choice (each car), a final matrix can be derived showing, for each possible choice, a number that combines importance with the objective value of the attribute. Theoretically the possible choice (car) with the highest total for all the attributes is the best. Appendix B shows Westcott’s car example.
- A *process decision program chart* is used to show for each task of a project the things that could go wrong and, for each thing that could go wrong, one or more contingency plans. It is especially helpful for new projects for which there is little experience.
- A *tree diagram* breaks down an objective or problem into more and more detail much like a work breakdown structure.⁷⁾ A tree diagram is a way to analyze an objective to see what needs to be done or to analyze a problem to determine its cause(s).

IV-A-3 Process Improvement Tools

- In this section Westcott discusses the follow process improvement tools:
 - Root cause analysis

7) See p. 252 in Westcott for an example of a work breakdown structure.

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- The plan, do, check, act/plan do study, act (PDCA/PDSA) cycle
- Supplier-input-process-output-customer (SIPOC) analysis
- Six Sigma and the define-measure-analyze-improve-control (DMAIC) model
- Failure mode and effect analysis (FMEA)
- Statistical process control
- Pre-control
- Process improvement model
- There are two approaches to *root cause analysis*: (1) the seven-step problem-solving model and (2) the five whys. These are the seven steps of the problem-solving model:
 - Identify the problem
 - List possible causes
 - Search out the most likely root cause
 - Identify potential solutions
 - Select and implement a solution
 - Follow up to evaluate the effect
 - Standardize the process
- The *five whys* method is simply continuing to ask why about a problem's causes until the actual root cause is revealed. For example a leaking pipe is caused by poor maintenance, is caused by not enough maintenance personnel, is caused by poor management, etc. There could be multiple first-level causes for a problem and, for each of these causes, more than one cause at the second-level and so forth.
- The *PDCA/PDSA*⁸⁾ cycle is a very simple yet powerful way to view process improvement. First you plan what you want to do by designing a prod-

8) Stands for plan, do, check/study, act.

uct or service and setting up the process to provide it. Second you carry out the process. Third you check/study the results—usually in terms of acceptability to the intended customer. And finally, using what you’ve learned from the third step, you improve the product/service and/or process.

- *SIPOC analysis* is used to understand an existing process better so it can be improved. Once the five parts of the process—supplier, input, process, output, and customer—have been identified, such things as the adequacy of the evaluation and control measures can be determined for possible improvement actions.
- *Six Sigma’s* purpose is to produce a product that is essentially defect-free. It involves the follow five steps referred to as DMAIC:
 - Define the requirement
 - Measure what is critical to quality
 - Analyze the process to determine its capability
 - Improve the process
 - Control the resulting improved process
- *Failure mode and effects analysis (FMEA)* is used to identify the ways a product or process could fail, especially a new product or process for which there is little experience. It involves assessing the severity, likelihood of occurrence, and likelihood of detection so the potential failures (risks) can be prioritized and dealt with through preventive and corrective actions.
- *Statistical process control* is used to analyze and monitor the variation in a process over time. This is done by periodically sampling data related to the process; e.g., the number of defective units. The sample data is recorded on a control chart,⁹⁾ which also shows upper and lower control

9) See prior section IV-A-1 and Figure 1. Westcott describes several types of control charts on pp. 354/5.

limits. As long as the data meet certain criteria for randomness the process is considered to be under control. Should the variation begin to exceed the control limits and/or shows a trend, the presence of some underlying special cause of variation is indicated and the process is out of control and corrective action needs to be taken.

- Typically *pre-control* is useful with new processes where there is not enough data to determine statistically valid control limits. Instead the specification limits are set in terms of zones: green (good), yellow (may be a problem), and red (defect present).
- The *process improvement model* consists of these five steps: select process, review current performance, identify improvement opportunities, implement improvements, and evaluate progress.
- Regardless of the improvements being made, they should be based on certain principles such as senior management oversight, a strategic and customer focus, data-based decision-making, and prevention over corrective actions.

IV-A-4 Innovation and Creativity Tools

- Problem solving often requires not only analytic skills but also creativity to come up with new ideas. Tools to aid creativity include:
 - Brainstorming
 - Mind mapping
 - Analogies
 - Nominal group technique
 - Multivoting
 - Lateral thinking
 - Critical thinking
 - Design for manufacturing (DFMA) and design for Six Sigma (DFSS)
 - TRIZ

- SCAMPER
- Storyboard
- *Brainstorming* is used to get ideas for something such as solving a problem. A group is assembled and asked for ideas. Any idea, no matter how strange, is okay and accepted without comment by the others. When no more ideas are forthcoming, the list of ideas is then evaluated and reduced to a smaller set for final selection. The ideas can also be solicited anonymously.
- *Mind mapping* is used to help expose all the issues that might be relevant to an objective. The objective is written down and then each major related issue is identified and written down as a “spoke” off of the central objective. Then each major issue is treated the same with related sub-issues written down around that major issue.
- *Analogies* allow a group to see a problem from a wholly different perspective. Westcott uses the example of getting ideas for the design of a new gardening tool after randomly selecting the phrase “soaring like an eagle” for the analogy; Figure 2 is the result. If one analogy doesn’t seem to be working another one is selected and tried.

Eagle Description	Would Equate To
Sharp eyes	Seeing ways to reduce the time required to weed
Weightless	Wouldn't be tired after weeding
Automatic, air does the work	Very easy to use, doesn't require bending/stooping
Wide view	Can cover a lot of ground
Kills rodents	Gets weeds out by the roots so they don't come back

Figure 2. Example of using an analogy (Figure 13.22 in Westcott, p. 360).

- *Nominal group technique* is a good way to reduce the number of ideas a group has come up with (say from brainstorming). First any similar ideas are combined. Then each member of the group ranks the ideas—for

example, from 1 to 10 with 10 being the best. Finally the rankings are totaled up and the ideas receiving the highest rankings are selected.

- *Multivoting* is another way to reduce the number of ideas. Members are asked to pick those ideas they think are best—say about half of the total number of ideas. These ideas are then tallied and the ideas that were least preferred are dropped from the list and the process repeated until a small enough number is reached.
- *Lateral thinking* is a way to force the brain to think in a certain way; e.g., by the use of Dr. deBono’s six thinking hats.¹⁰⁾ Each “hat” is a different color representing a certain way of thinking. For example the when “wearing” the white hat you are to think objectively (“just the facts”), when wearing the yellow hat think optimistically with a “can do” spirit, etc.
- *Critical thinking* is a way to approach a problem by the use of good reasoning—both deductive and inductive—and from both an analytical and systems view of things. Typical of critical thinkers is inquisitiveness, truth-seeking, and open-mindedness.
- *Design for Manufacturing (DFMA)* is a methodology that attempts to make the design of a product as compatible with the production process as possible to minimize the need for subsequent design changes. It does this mainly through standardization and simplification.
- *Design for Six Sigma (DFSS)* brings statistical techniques to DFMA such as “analysis of tolerances, mapping processes, development of a product scorecard, design to unit production costs (DTUPC), and design of experiments (DOE)” (p. 363). As inferred by the name, the goal is to design a product that can be delivered with Six Sigma quality.

10) Not real hats, of course, but a way to help a person stay focused on that particular mode of thinking.

- *TRIZ* is a Russian acronym standing for “the theory of the solution of inventive problems.” It is a set of tools and principles for letting the average person engage in out-of-the-box thinking characterized by the way inventors think.
- *SCAMPER* is a way to stimulate creative thinking using these seven questions:

S	What can be used as a Substitute?
C	What can be Combined with _____ ?
A	How can _____ be Adapted?
M	How can _____ be Modified?
P	How can _____ be Put to other uses?
E	How can _____ be Eliminated?
R	What if _____ were Reversed or Rearranged?

- *Storyboard* is a way for a team to display all the ideas it has generated (e.g., through brainstorming) pertinent to solving the problem it is working on. Typically the ideas are represented in words and/or pictures and are posted on a storyboard in a way that logically shows how they relate to each other and the problem to be solved. The storyboard gradually evolves as more ideas are developed and existing ideas modified until the team is finally satisfied with the arrangement.

IV-A-5 Cost of Quality (COQ)

- The final problem-solving tool in this chapter of Westcott (Chapter 13) is cost of quality (COQ). COQ might better be termed a way to identify and prioritize improvement opportunities to which other problem-solving tools can be applied. A COQ program seeks to identify all the costs associated with poor quality. Four categories of costs are tracked:
 - *Internal failure costs*: The costs incurred before the product is delivered to the customer; e.g., the costs of nonsalvageable bad product,

rework, etc.

- *External failure costs*: The costs incurred after the product is delivered to the customer; e.g., the costs of handling customer complaints, replacements, lost good will, etc.
- *Appraisal costs*: The costs of ensuring the product meets established standards and performance requirements; e.g., various inspections and tests, calibration of testing equipment, etc.
- *Preventions costs*: The costs incurred to minimize the appraisal and failure costs; e.g., the costs of maintaining a good quality management system, costs for quality education and training, etc.
- Once these costs are methodically and as accurately as possible tracked, those areas showing the largest costs become candidates for quality improvement initiatives.

Some other key points for further consideration (Problem-Solving Tools):

- No matter how well an organization is performing, there is always room for improvement.
- What is at first thought to be the cause of a problem may turn out to be only a symptom of a deeper cause.
- Problems can often have multiple causes.
- Pareto analysis should also be done according to costs associated with each problem since the financial impact of different problems is not the same.
- A priorities matrix¹¹⁾ brings objectivity to the decision-making process by establishing agreed upon criteria.
- It is important to always follow up a problem that has been “solved” to be sure the remedial action is working. In fact, whatever changes have been made need to be institutionalized by ensuring such things as updat-

11) See Appendix B for an example.

ing procedures and training employees occurs.

- The PDCA/PDSA cycle (see above under IV-A-3 Process Improvement Tools) should be considered not only a way to improve some product or process but a means of organizational learning.
- The PDCA/PDSA cycle “captures the core philosophy of continual improvement” (p. 247).
- Six sigma may be used to measure things other than manufacturing defects, for example it “may be used to measure material, forms, a time frame, distance, computer program coding, and so on” (p. 348).
- One of the most valuable inputs to a failure mode and effect analysis (FMEA) is people’s experiences that are somehow related to the new product. For example, those employees who have been involved in the development process or who are also customers and have used a similar product.
- Control charts can be used for both controlling a process and to analyze one for improvement purposes.
- When improving a process it is important that decisions about what to change and the implementation of those changes be made by those who will actually carry out the process to take advantage of their knowledge and ensure a feeling of ownership on their part.
- One way to view the team creativity process is: generate, percolate, illuminate, and substantiate:
 - Generate ideas.
 - Percolate by allowing time for the team to think about the ideas for a while, which will often generate new ones.
 - Illuminate the ideas by discussing what has been learned during the “percolate” phase.
 - Substantiate the feasibility of the best ideas.

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- The best thing about the COQ is it measures quality (or the lack of it) in terms of dollars, something management can understand. This also helps to decide which quality improvement projects are likely to have the biggest payoff.
- To increase the accuracy of the quality costs associated with a particular product, it is a good idea to use activity-based costing in conjunction with COQ.

IV-B Process Management (Chapter 14 in Westcott)

Brief summary of chapter:

- A process is a set of related actions that transform an input into a desired output. The input could be a concept, request, or order (or anticipated order).
- In general a process differs from a system in that a system has “its own self-serving objectives” (e.g., an accounting system) while a process “aims at transforming inputs into outputs to achieve (ultimately) the strategic objectives of the organization” (pp. 372/3).
- Process management includes setting goals, establishing controls, and measuring and improving performance.

IV-B-1 Process Goals

- Process goals are connected to the organization’s strategic plan and each goal is supported by one or more process objectives.
- Each process objective should be specific and measurable; e.g., reduce the number of defects in a certain product by 50% in the next six months. Note: This objective might be supporting a more general goal of improving customer satisfaction. The previously mentioned S.M.A.R.T. W.A.Y.¹²⁾

12) See Part 1 of this paper section 1-C Teams and Team Processes (Austenfeld, 2007, pp. 60/1) or p. 98 in Westcott.

is a good guide for developing process objectives.

- Some generic areas that process goals would typically address include exceeding customer requirements, being sure the process contributes to the organization's profits, being sure a product/service is safe and does not harm the environment, and the continual improvement of the process.
- Once the more specific process objective has been established, it will then have its supporting procedures/process to meet the objective.
- The key to successful process objective achievement is the setting and systematic monitoring of clear metrics.

IV-B-2 Process Analysis

- Reasons for analyzing a process include identification of non-value-added steps or simply to better understand the process.
- The primary method for analyzing a process is the flowchart/process map.¹³⁾
- In general these are the steps to be followed for a mapping a process:
 - Decide on what process to map.
 - Define reasons for mapping.
 - Decide on the type of map (style); e.g., grid or nongrid.¹⁴⁾
 - Define the process by determining such things as inputs, outputs (e.g., customer requirements), departments involved, titles of those involved, constraints, etc.
 - Map the process; first without exceptions and then with decision points¹⁵⁾ and alternative paths.
 - Review map with knowledgeable persons and revise as needed. The

13) There is little distinction between a flowchart and a process map except the latter is usually more detailed. See Appendix C for an example of a flowchart.

14) A grid process map overlays the process on a representation of the departments involved making it easier to visualize responsibilities.

15) For example "yes/no" diamond symbols.

review(s) can be off-site and/or at the site of the process.

- Initially the mapper will probably work with simple pencil and paper notes, eventually moving to a more formal depiction using pen and ink or some software application.
- Process maps are but one part of the organization's total documentation which will also include such things as procedures, work instructions,¹⁶⁾ and records.
- Ideally the organization's quality/business plan will reference the key, top-level procedures that, in turn, will reference associated work instructions and records to be kept.
- Other organizational documentation includes control plans, which address quality characteristics for a specific product/service, and industry-specific documentation such as that called for from automotive suppliers by ISO/TS16949.

IV-B-3 Lean Tools

- One of the best ways to improve processes is the use of lean tools. Lean tools can be generally classified as follows:
 - Cycle-time reduction
 - Value stream mapping
 - Five S
 - Visual management
 - Waste reduction
 - Mistake-proofing
 - Setup/changeover time reduction
 - Total productive maintenance
 - Kaizen blitz/event
 - Just-in-time
 - Takt time
 - Line balancing
 - Standardized work
 - Single-piece flow
 - Cellular operations
 - Concurrent engineering
 - Outsourcing
 - Business process reengineering

16) A procedure/work instruction might well incorporate a process map or vice versa the process map might call out a procedure/work instruction as part of the process.

- Kanban
- *Cycle-time reduction* attempts to minimize the total time to complete a process. There are many ways to reduce cycle time but the basic idea behind them is to eliminate non-value-adding activities, usually by employing one or more of the following lean tools.
- *Value-stream mapping* charts “the sequence of movements of information, materials, and production activities in the value stream (all activities involving the designing, ordering, producing, and delivering of products and services to the organization’s customers)” (p. 390). By seeing this overall picture communications among those involved along the value stream is improved plus areas of non-value-adding activity become apparent and targets for elimination. Figure 3 from Westcott is an example of a partial value-stream map at the plant level.

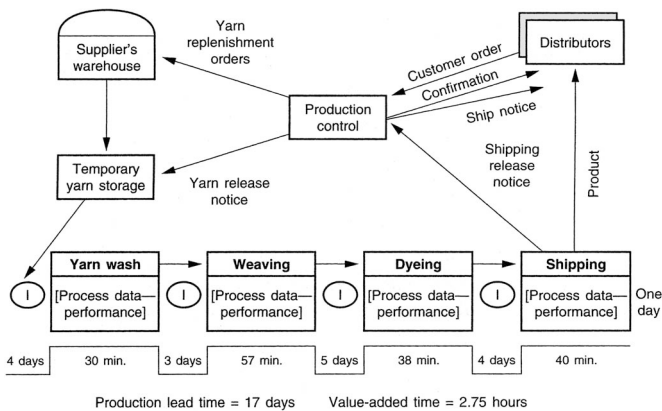


Figure 3. Example of a value-stream map (Figure 14.10 in Westcott, p. 391).

- *Five S* is a simple program for making the workplace much more efficient. It consists of five steps originally described by five Japanese words that can be translated as follows:
 - *Seiri* (sort): Sort the stuff you actually use from that you don't use

and get rid of the latter.

- *Seiton* (set in order): Arrange things for their most efficient use; e.g., tools on a shadow board, dies in a designated and convenient place, etc.
- *Seiso* (shine [clean]): Keep everything spic and span.
- *Seiketsu* (Standardize): Set up procedures to keep everything orderly and clean.
- *Shitsuke* (Sustain): Ensure the procedures continue to be followed.
- *Visual management* is the use of any sort of visual aid to enhance efficiency and safety or to prevent errors. Examples include a shadow board that keeps tools where they can always be found or an electronic status board to show when there is a problem on the assembly line.
- *Waste reduction*. Westcott lists seven type of waste
 - *Overproduction*: Incorporating more into the product than the customer actually requires or wants.
 - *Waiting*: Where one part of a production process is being held up by another part—indicates poor process design.
 - *Transportation*: The inefficient transport of materials and/or work-in-process likely due to a poor plant layout.
 - *Processing*: Basically a poorly designed and therefore inefficient process with too much non-value-added activity.
 - *Excess inventory*: Having more inventory than really needed. This may be due to a “batch and queue” mentality or overproducing some part/subassembly to compensate for an unreliable machine.
 - *Wasted motion*: Unnecessary motion such as bending, reaching, walking, etc. due to poor workplace layout.
 - *Defective parts*: Such parts cause waste by having to be reworked, scrapped, sold at a discount, etc.

Westcott also groups waste according to visible and invisible:

- Examples of *visible waste* are: rework, scrap, and downtime.
- Examples of *invisible waste* are: wait time due to an assembly time not being properly balanced, overproduction, and unnecessary reports.
- *Mistake-proofing* is known as *poka-yoke* in Japanese and is anything done to prevent an error. For example, if two parts go together, mistake-proofing will cause them to be designed so that there is only one (and correct) way they can be assembled.
- *Setup/changeover time reduction* is also called “single-minute exchange of die” or SMED¹⁷⁾ since an obvious application of this “tool” is to minimize downtime between die changes on a production machine. Westcott provides an extensive list of steps for improving setup/changeover times based on the PDCA¹⁸⁾ cycle (pp. 398/9).
- *Total productive maintenance* means doing everything reasonable possible to keep the production equipment and facilities in top operating condition. Besides a good preventive maintenance schedule, it involves training the operators to do some of the maintenance and to know what to look for if something needs maintenance personnel attention.
- *Kaizen blitz/event* is an intensive short-term effort to radically improve some part of the organization’s production/service process. A typical kaizen blitz lasts five days (Monday–Friday). Once the target improvement is identified, a carefully selected team, mostly those involved with the process, is selected and given appropriate training. Then the team collects data, plans the improvement, and carries it out. Ideally the event

17) SMED is the brainchild of Shigeo Shingo, one of the important players in the development of Toyota’s highly efficient production system.

18) Stands for plan, do, check, act.

will serve as a learning vehicle for those involved so that what was accomplished is sustained and even continually improved. Examples might be to improve the layout of a workplace to reduce wasted motion or to make a workplace clean and orderly and thus more efficient.

- *Kanban*¹⁹⁾ is part of the just-in-time inventory system (see next) and involves the use of a signal of some sort to let the upstream supplier know additional supplies are needed at some production point. For example a parts bin, once empty, is sent back to the upstream supplier signaling the need to be refilled and returned. There is usually a card associated with the replenishment action detailing what is required and, indeed, kanban means signboard (card) in Japanese.
- *Just-in-time* is closely related to kanban and means material is made available to the production system just when it is needed. It requires a lot of coordination with external suppliers including ideally using suppliers whose quality is so good incoming inspections are not required.
- *Takt time* “is the total work time available (per day or per shift) divided by the demand requirements (per day or per shift) of customers” and “establishes the production pace relative to the demand” (p. 401). Its obvious benefit is matching supply and demand to minimize the chance of either producing more than needed or not being able to satisfy customer demand.
- *Line balancing* is “proportionately distributing workloads within the value stream to meet takt time” (p. 402). The idea, as implied by the name, is to be sure each part of the production process is working at full capacity versus some parts being overworked and other parts under

19) This is also known as a “pull system” since production material is *pulled* into the system only as needed as opposed to a batch and queue operation where large work-in-process inventories are sitting around.

worked or even often waiting for work.

- *Standardized work* means developing and continually improving the best way to carryout each part of the manufacturing (or service) process. Toyota is famous for its use of this tool.
- *Single-piece flow* is the opposite of batch and queue where individual parts are made in large batches and then placed in wasteful inventories until used. With single-piece flow the product/subassembly is made one unit at a time. This method has many advantages such as reducing work in process inventories, eliminating wait times, and allowing quality problems to be detected quickly and early on.
- The *cellular operations* “tool” is closely related to single-piece flow by designing a work cell for completion of a single unit of a product or major subassembly. Figure 4 from Westcott shows a typical U-shaped²⁰⁾ work cell. Such a layout is also designed to minimize waste such as that from wasted motion, wasted transport, waiting time, etc.

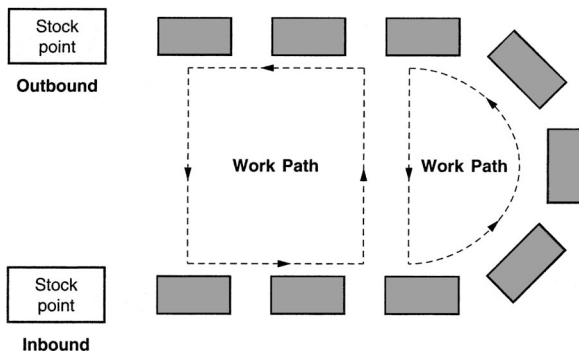


Figure 4. Example of a U-shaped cell layout (Figure 14.12 in Westcott, p. 403).

20) As Westcott points out, L, S, and V shapes have also been used (p. 403).

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- *Concurrent engineering* is a way to enhance the product and production process design effort such that the number of problems occurring later will be minimized. All “stakeholders”—e.g., marketing, design, and production—are involved.
- *Outsourcing* should be considered if what is to be outsourced could be better done by another organization. It will often let the outsourcing organization concentrate more fully on its core business.
- As Westcott puts it “*business process reengineering* may be viewed as cycle-time reduction on a grand scale (macro level)” (p. 404). In other words it involves a start-from-scratch redoing of individual processes or even those of the entire organization. As such it must be carefully considered and executed due to the potentially deleterious affect it could have on morale.

IV-B-4 Theory of Constraints (TOC)

- The theory of constraints (TOC)²¹⁾ is a way to look at an entire organization as a system. It is the brainchild of Eliyahu Goldratt whose popular and highly readable book, *The Goal* (2004), is largely responsible for making the TOC well known.
- Some of the basic principles underlying the TOC are:
 - Treat the whole organization as a system.
 - The system can be likened to a chain, which is only as strong as its weakest link. This weakest link is the system’s constraint.
 - Until the system’s constraint is addressed, there can be little improvement to the system.
 - It is important to follow the flow of money.²²⁾

21) See Austenfeld, 1999 for an overview and more details on the TOC.

22) The TOC does this using explicitly defined “throughput,” “inventory,” and “operating expenses.”

- The basic steps for improving the system are:
 - (1) Identify the weakest link (constraint) and determine if it is due to a physical or policy cause.
 - (2) Try to get more capability from the constraint without making expensive changes.
 - (3) Unless (2) eliminated the constraint, adjust the system to let the constraint operate at its maximum efficiency.
 - (4) If (2) and (3) are still not sufficient, carry out whatever major changes are needed to eliminate the constraint.
 - (5) Once the constraint is eliminated, move on to the next constraint (weakest link) and repeat the steps. (Note: This is a never-ending process.)

Some other key points for further consideration (Process Management):

- A good way to think about process goals and objectives is: goals support the organization's strategic plan and objectives support their respective goals. Therefore if each goal's objectives are met, the organization's strategic plan will be accomplished—at least in theory.
- Due to their critical importance, the effective and timely measurement of objectives is key to strategic plan accomplishment.
- Think of process mapping as usually requiring “a number of PDCA-type cycles.”
- When mapping a process start at a relatively high level, gradually filling in more detail as you go along.
- Simply the act of mapping a process will often uncover existing problems spotlighting areas for possible improvement initiatives.
- Procedures/work instructions may be presented in a variety of ways such as hard copy, a workstation computer screen, a video, etc. (see p. 385 in Westcott for more examples).

- Cycle time reduction can (and should) be applied to all activities, not just manufacturing.
- When trying to improve cycle time, think in terms of the system's/process' critical path, the set of activities which, if any are shortened, will cause the entire system/process time to be shorter.
- The essence of lean production is “only what is needed should be produced, and it should only be produced when it is actually needed” (p. 390).
- One key to achieving a waste-free production process is good design, not only of the production process but also of the product so it is “manufacturing-friendly.”
- One of the greatest sources of waste is large inventories caused by batch and queue operations.
- A good place to look for waste is unneeded reporting due to either the requirement no longer existing or duplication of reports.
- Since they often add no value, meetings should be kept at a minimum, last no longer than necessary, and involve only those truly needed.
- Mistake-proofing can (and should) be applied to any process, not just manufacturing.
- Although it is not possible to completely eliminate “mistakes,” continual efforts should be made towards that goal.
- Due to the scope of a major business process reengineering effort, the organization must be prepared to deal with a potentially major culture change and all that entails.
- When working a cycle time reduction initiative, it is important to be sure whatever action is taken doesn't create new problems such as a bottle neck somewhere else or the quality of the product/service. Using the TOC way of thinking will help avoid such problems.
- Regarding the TOC, Westcott notes: “Physical constraints are the easiest

to identify and eliminate. Policy constraints are more difficult, but their elimination usually means a higher degree of system improvement” (p. 413).

IV-C Measurement: Assessment and Metrics (Chapter 15 in Westcott)

Brief summary of chapter:

- To be effective, an organization needs feedback on its performance. For example, how well are its processes working and are its products/services meeting customer expectations?
- In general, statistics is the tool for understanding performance data. As Westcott succinctly puts it: “Statistics is the science of turning data into information” (p. 417).
- In general the keys to an effective measurement system are (1) knowing the exact purpose of the data and (2) ensuring the data source will continually provide reliable data. For example, what decision(s) will be made based on the data, are the measurement methods good, and are any devices involved properly calibrated?
- Although most data is quantitative, qualitative data is often also important for measuring organizational performance.

IV-C-1 Basic Statistical Use

- When developing a process performance measure it is good to use a checklist such as presented by Westcott on pp. 417/8. For example, is the measure easy to understand and use, verifiable and repeatable, and does it really measure what it is suppose to measure?
- A technique known as goal-question-metric (GQM) may be a useful approach to develop a measurement system.²³⁾

23) Discussed on p. 418 of Westcott. However I found the explanation rather nebulous; an example would probably help.

- It is important to understand the independent variables that drive organizational performance measures of interest. For example, if customer retention²⁴⁾ is one of the key performance measures, it would probably depend on among other things the timeliness and correctness of the service; and these, in turn, on the independent variables of the amount of training given service personnel and the scheduling system.
- To establish a good process measurement system the organization needs to (1) identify those things that are critical to customer satisfaction, (2) map the process to determine which functions are involved, (3) identify the resources and competencies key to meeting the things identified in (1), and (4) set up measures to track and manage those key resources/competencies.
- With regard to project management there are at least two things that need to be monitored with appropriate measures: (1) the project planning and management process and (2) the project deliverables.
- How metrics are used within an organization can have either a positive or negative affect on those involved. For example using them as a way for controlling people versus identifying areas for continual improvement would have a negative affect.
- Ideally the measurement system will allow the organization's workers to be in self-control by making clear what they are to do, letting them know how well they're doing, and giving them the ability to influence things if they're not meeting organizational expectations.

IV-C-2 Sampling

- Sampling may not always be required; for example if the number of items involved is small or self-inspection by trained workers is sufficient.
- Factors that need to be taken into account depending on the purpose of

24) This is a summary of an example on p. 419.

the sampling include: random sampling of the whole populations versus stratified sampling, the sample size (depends on confidence desired), and rational subgrouping (to reduce variability).

- Acceptance sampling is applied to a batch of material to see if a given level of nonconformance is exceeded or not. It is used to see if it is OK to pass the material to the next process or for accepting material from a supplier.
- A fundamental sampling concept is the amount of risk that is acceptable for both the producer and the consumer. Producer risk is the chance that good product will be rejected based on the sampling results and consumer risk is the chance that bad product will be accepted. A sampling plan will be based on specified risk levels for a certain sample size.²⁵⁾

IV-C-3 Statistical Analysis

- There are two basic things that are usually of interest when analyzing sample data: what is the data's central tendency (e.g., average) and what is the data's variability (i.e., its spread)?
- Common measures of central tendency are the data's average (mean), median, and mode. Common measures of variability are the data's range and standard deviation.
- For comparing these measures tests exists such as the t-test for comparing means and the F-test for comparing standard deviations.
- Meaningful statistical analysis of sample data depends on knowledge of how the population data is distributed. For this various probability distributions are used "depending on the type of data (for example, discrete versus continuous data) and characteristics of the process that produces

25) Westcott discusses various sample plans (pp. 425/6) but not in enough detail for me to really understand. This topic is more in the realm of the body of knowledge for the certified quality engineer.

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the data” (p. 428). The most common distribution is the normal (bell-shaped) distribution; others include: exponential, Weibull, Poisson, binomial, and hypergeometric.

- Some advanced statistical methods for analyzing sample data are: design of experiments (DOE), linear regression, analysis of variance (ANOVA), and response surface.²⁶⁾

IV-C-4 Trend and Pattern Analysis

- Trend analysis is simply examining data over time to see what can be learned from it. As for all data collection, a clear purpose for the analysis should exist such as tracking defects or customer complaints.
- Some of the tools that help organize data for trend analysis are: Pareto charts, check sheets, histograms, control charts, and run charts.
- Long-term trend analysis focuses on performance of the organization as a whole and provides information for planning and checking on how well strategic goals are being met.
- Short-term trend analysis focuses on work processes. Depending on the scope of the process, instructions for when to do the analysis, what constitutes acceptable performance, and what to do about unacceptable performance can be contained in organizational policy or in work instructions. At the work-instruction level the process operator would normally be expected to eliminate any special causes²⁷⁾ of variation.
- Besides the usual trend patterns of increasing, decreasing and staying the same, “cyclical” and “shift” patterns may occur. These special patterns may be normal, such as seasonal changes, or indicate an abnormality that needs investigation.

26) See pp. 429/30 for a brief description of these methods and the various probability distributions.

27) See next section for a discussion of special (and common) causes of variation.

- Data mining can reveal information useful for quality improvement. Westcott lists several analysis methods related to data mining on p. 434.
- Successful trend analysis depends on timely data, and the knowledge and authority to interpret and effectively respond to the trend. This latter item requires a good understanding of the theory of variation.

IV-C-5 Theory of Variation

- Variation is a fact of life and exists to some degree in all processes and products. The idea is to minimize it for good quality; i.e., we want whatever we're producing to be as close to some desired standard as possible every time.
- The following influences are normally considered the main sources of variation in a process or product: people, machinery, environmental, material, measurement, and method.
- There are two types of causes of variation: common causes and special causes.
- *Common causes* are due to the design of the process; for example the quality of the input material, the amount of worker training, or the type and quality of the machinery used. These causes are stable and predictable and only management can change them.
- *Special causes* are due to some temporary condition such as a machine going out of adjustment, an untrained worker filling in, or unusual weather. Workers can be trained to identify and eliminate or compensate for these causes.
- The ideal approach to improving any process is to first bring it under control²⁸⁾ by eliminating the special causes of variation. Then begin working on the common causes to minimize the inherent variation.

28) Meaning it is then stable and producing predictable results.

- A common problem is when an organization mistakes common causes of variation, which are inherent to the process, for special causes. Applying inappropriate fixes to the common causes, known as tampering, will almost always make things worse.²⁹⁾
- Control charts provide a way to detect and monitor special causes by showing when a process goes, or starts to go, out of control. See Figure 1 (above) for an example of a control chart. In general, if the sample data goes beyond the chart’s upper or lower control limits an “out-of-control” condition is indicated.

IV-C-6 Process Capability

- Process capability measures (indexes) determine if a stable process can operate within the required range of the specification limits. Two common indexes are C_p and C_{pk} :

Index	Purpose	Formula
C_p	To tell how the width of the process compares with the specification range.	$C_p = (\text{upper spec limit} - \text{lower control limit}) / 6 \text{ sigma}$
C_{pk}	To tell if the process is centered well enough so too much doesn’t fall outside the specification range.	$C_{pk} = (\text{upper spec limit} - \text{process average}) / 3 \text{ sigma}$ or $C_{pk} = (\text{lower spec limit} - \text{process average}) / 3 \text{ sigma}$ (whichever is lower)

Note: Sigma in this case is the *process* standard deviation, not the *sample*.

- A process with a C_{pk} lower than 1.0 is considered not capable and something needs to be done such as centering the process, decreasing its variation, etc.

29) Westcott gives three good examples of this on pp. 439/40.

IV-C-7 *Reliability and Validity*

- Since good quality management depends on data-based decision-making, it is important that the data is both reliable and valid (see Figure 5 from Westcott).

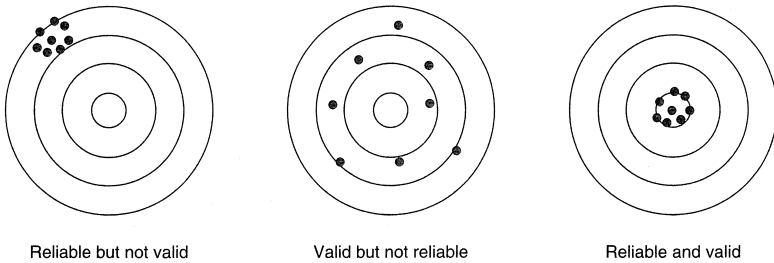


Figure 5. Examples reliability and validity (Figure 15.6 in Westcott, p. 442).

- Data is *reliable* (or “precise”) if taking the same measurement gives the same results. Data from a reliable measurement device will have minimal spread.
- Data is *valid* (or “accurate”) if it is close to the real value being measured. In this case the inherent bias of the measurement device is not significant.
- *Face, criterion, construct, and content* are other concepts related to whether a measurement instrument—such as a test or survey—is valid.³⁰⁾
- It is important for the organization to establish and maintain a disciplined system for ensuring its gages are in good condition (i.e., calibrated) and that only such gages are used.

IV-C-8 *Qualitative Assessment*

- Some aspects of quality cannot be measured quantitatively; e.g., how a customer or employee feels about something, or how the organization’s customers are being treated. In these cases qualitative assessments are

30) Discussed on pp. 442/3 of Westcott.

required.

- Some qualitative assessment methods are: survey questionnaires, interviews, observation of behavior (e.g., mystery shoppers), and content analysis (e.g., of normal business processes).

IV-C-9 Survey Analysis and Use

- Although requiring a lot of time/resources to do well, surveys can provide valuable information to support continuous improvement.
- Once the survey is completed, these are the actions recommended by Westcott:
 - Analyze the data including determining such things as the average, range, and standard deviation for each question and any differences due to demographics or other pertinent groupings.
 - Compare the data with other information such as from previous surveys.
 - Communicate the information to decision makers and others within the organization that could benefit from it.
 - Use the information to initiate continuous improvement actions when such is indicated.

Some other key points for further consideration (Measurement: Assessment and

Metrics):

- Monitoring the variation in an organization's products/services is one of the most important uses of statistics for improving quality.
- When designing a measure always involve those doing the work to be measured and be sure they understand the primary reason for the measure is quality improvement (versus, say, control of people).
- No sampling scheme will ensure detection of all nonconformances; if such is required, 100 percent inspection will be necessary.
- It is important for all parties involved in acceptance sampling to under-

stand (and agree to) the “worst” level of quality that will be acceptable; i.e., the acceptable quality limit (AQL).

- Because many things could account for differences in the central tendency and spread of two sets of data, decisions should not be based on those differences only.
- When doing trend analysis, one needs to be sure the “trend” is not actually only a “cyclic” or “change in variation” pattern.
- If data is to be presented in tabular form, a few simple rules can greatly enhance the presentation (see p. 433).
- One very useful tool for seeing “before/after” trends of some target group (e.g., customers in some particular area) is the geographic information system (GIS).
- An organization’s concern over short-term events should not blind it to long-term trends.³¹⁾
- A good understanding of variation and its causes and ways to minimize it is essential to good management.
- Determining the cause of variation should be a joint effort using both worker experience and management expertise.
- To keep the physical measurement devices (gages) in a good state of calibration, a standard traceable back to a standards organization³²⁾ should be used.
- If it is found that an uncalibrated device was used, possible problems caused by this use need to be tracked down and corrected.

31) Westcott cites Senge’s (1990) discussion of the U.S. automobile industry that failed to see how serious the Japanese threat was until the 1980s.

32) For example the National Institute for Standards and Technology (NIST).

V Customer-Focused Organizations

V-A Customer Identification and Segmentation (Chapter 16 in Westcott)

Brief summary of chapter:

- According to Westcott, “most quality professionals consider the customer to be any individual or group that receives and *must be satisfied* with the service, work product, or output of a process” (p. 450, emphasis added).
- To be sure all “customer” requirements are met all possible customers—primary, secondary, indirect, external, consumer/end user, etc.—need to be identified.³³⁾

V-A-1 Internal Customers

- An organization needs to identify its internal customers and be sure all service/product requirements are being met for each. If any requirements are not being met, appropriate improvements to the applicable processes should be undertaken.
- By stating specific internal customer requirements and associated measurements, a quality-level agreement (QLA) eliminates confusion about those requirements and establishes a basis for reviewing provider performance and, as needed, continuous improvement actions. A QLA is like a contract between the provider and the internal customer.
- It is important that all internal customer requirements are consistent with those of the external customers.
- It is important that a truly supportive environment is created within the organization, one that emphasizes and makes possible a high level of both internal and external customer satisfaction.

33) These customer types are discussed on pp. 450/2 of Westcott.

V-A-2 External Customers

- There are many types of external customers—wholesalers, retailers, volume buyers, service providers, etc.—each with its own set of requirements influencing the supplier. Westcott discusses several types on pp. 458/60.
- To be sure the organization's set of external customers matches its strategic objectives:
 - Determine the segments³⁴⁾ presently being served and, if needed, plan any changes to the mix to better support the strategic objectives.
 - Based on the first step identify the requirements of the key segments and determine if any internal processes need to change to fully meet those requirements.
 - Conduct feasibility and risk analyses for the proposed changes and implement those feasible.
 - On a limited basis, try out the changes, make any modifications necessary and then fully implement them.
 - Do a follow-up evaluation of the changes and repeat this set of steps.

V-A-3 Segmentation

- Instead of trying to satisfy the wants/needs of all possible customers an organization should determine which customer segments are the most important to its strategy/profitability.
- A customer (market) segment is a group of customers identifiable by one or more differentiating factors; e.g., purchase volume, type of purchases, geographic, demographic, language spoken, etc. Westcott discusses several segment types on pp. 463/4.
- Some ways customers might be segmented are either on the basis of some objective criterion such as age or income or on the basis of cus-

34) See next section.

customer product/service preferences. Regarding the latter, for example, it might be found that the customer base breaks up into definite clusters in terms of price/quality; i.e., a cluster willing to accept lower quality for a lower price, etc. Or maybe the customer will accept a limited selection of products for a lower price.

- It may be useful to refine the segmentation by using two or more criterion such as both age and income.
- Some tools to aid segmentation include cluster analysis, factor analysis, geographic information systems (GIS), and data mining.
- Some recommendations for developing a segmentation strategy:
 - Create and maintain a customer data base that includes as much information as possible on customer wants/needs. Use market research and such things as product registrations to help build up the data base.
 - Use information from a SWOT analysis³⁵⁾ to shape the segmentation strategy so that it will take advantage of the organization's strengths and not demand so much in those areas of weakness.
 - Be sure the segmentation strategy fits the organization's overall business strategy so it will indeed support it by guiding the marketing planning and quality improvement initiatives.
 - Build appropriate metrics into the segmentation strategy to both classify customers into segments and evaluate each segment's value to the organization.

Some other key points for further consideration (Customer Identification and Segmentation):

- For many organizations contact with the actual consumer/end user is

35) A SWOT analysis examines an organizations strengths, weaknesses, opportunities, and threats.

indirect via a distributor or retailer. Accordingly an extra effort may be needed to identify these customers and determine how well their needs/wants are being satisfied.

- In general, having happy (well supported) internal customers results in happy (well served) external customers.
- For service providers word-of-mouth often plays an important part both in increasing the number of customers when the service given is good/exceptional and having just the opposite effect when the service given is poor/disappointing.
- It is a mistake for an organization to think either that the market is homogenous or that it must appeal to the entire market. It is better to think in terms of logical segmentation or even one-to-one marketing if possible.
- Once identified, it may prove mutually beneficial to enter into partnerships with core customer segments.
- It may be cost-effective to establish separate service delivery processes for core and non-core customers.

V-B Customer Relationship Management (Chapter 17 in Westcott)

Brief summary of chapter:

- Customer relationship management (CRM) “aims to learn, in depth, about the customers’ needs, values, and behaviors” (p. 471).
- Given the amount of information now available on companies, products, service, etc. and the many choices available, it is becoming harder and harder to win loyal customers.

V-B-1 Customer Needs

- There are many sources of data to help an organization anticipate and understand customer needs; for example, market research, customer complaints, service records, satisfaction surveys, and information from trade

journals.

- One simple but effective way to assess the value of a product/service to the customer is a priority matrix. For each product/service offered and type of customer set up a spreadsheet listing all the significant features of that product/service. Then for each feature estimate and comment on the extent it either is or isn't likely to satisfy the customer. Finally comment on what action, if any, should be taken to change the feature.
- A much more detailed way to look at customers wants (requirements) and to compare them with the organization's response is quality function deployment (QFD).³⁶ Figure 6 is a simplified schematic of a QFD matrix. A much more complete and realistic example is shown on p. 477. In essence the QFD matrix matches up customer needs with the

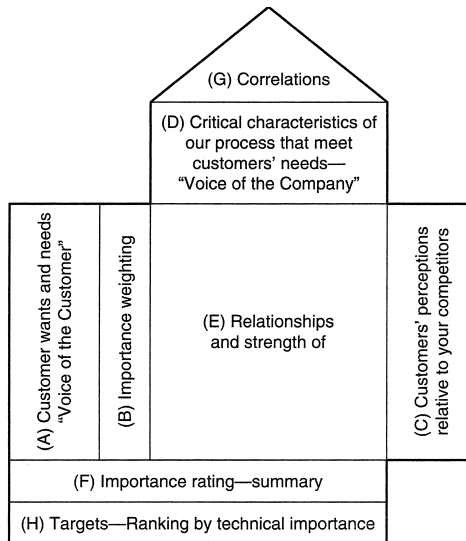


Figure 6. A schematic representation of a QFD matrix (also known as the house of quality) (Figure 17.1 in Westcott, p. 475).

36) Also known as the house of quality.

organization's production processes to see how well those processes are meeting the needs. The matrix also permits a look at how the organization stacks up against its competitors in meeting those needs.

- Other ways to learn of customer needs/wants include: focus groups, surveys, via the Internet, customer advisory boards (usually made up of the best/largest customers), and Westcott's listening post process.
- The steps in the listening post process are: listen–capture–analyze–learn–improve (LCALI). The basic idea is to train the organization's personnel to constantly be listening for any comments that might give a clue to how it is doing in serving its customers; for example, a casual comment made by a customer on poor or exceptional service or about something in the product they don't like. The process includes a systematic way to capture, analyze, learn from, and use such information for improving customer service or giving recognition for a job well done. Appendix D is an example from Westcott of a very good way to capture such comments for further processing.

V-B-2 Customer Satisfaction and loyalty

- There are many reasons for obtaining customer satisfaction data; e.g., to identify problems, to measure performance, to aid new product development, to adjust strategic plans, goals, and objectives, etc. The ultimate reason is to improve customer satisfaction.
- A good customer satisfaction system has formal processes for gathering, analyzing, maintaining, and effectively using customer data to improve satisfaction.
- One way to think about the factors affecting customer satisfaction is the Kano³⁷⁾ model (Figure 7). The “must be” factors will always cause dis-

37) Noriaki Kano, Professor Emeritus, Tokyo University of Science.

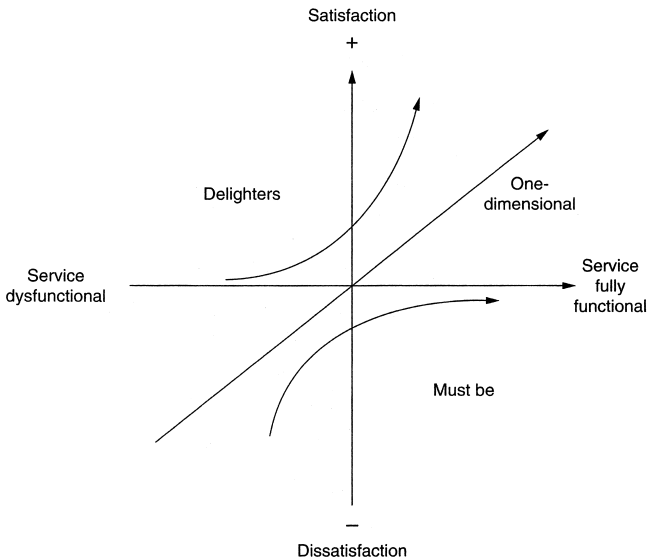


Figure 7. The Kano model (Figure 17.6 in Westcott, p. 485).

satisfaction if not present. The “one-dimensional” factors are linearly related to satisfaction (for example interest rates on savings). Absence of the “delighters” will not cause dissatisfaction but can have a major impact on satisfaction as their number/amount increase. By the nature of things “delighters” soon move into the “must-be” category.³⁸⁾

- Surveys can provide quantitative or qualitative data on customer satisfaction. When quantitative data is used as a sample it must be taken randomly and the sample size must be large enough if a valid statistical inference is to be drawn about the population as a whole.
- This chart (next page) shows some of the common methods for gathering customer satisfaction data, each with its advantages and disadvantages. For example, the amount and quality (depth) of information from in-person

38) Westcott gives the example of the automobile cup holder that was a “delighter” when first introduced but is now a “must-be.”

surveys can be much greater than that from other types but in-person surveys are much more costly.

- When seeking customer satisfaction data the organization should think in terms of how the customer views value. Figure 8 from Westcott shows examples of product and service characteristics that typically represent value to the customer.

Surveys	Written/mail
	Telephone
	Web/e-mail
	In-person
	Comment card/suggestion boxes
Observations (of customer behavior)	
Mystery shoppers	
Listening-post	
Data mining	
Product/warranty cards	
Call center data (from 800-type calls)	
Customer databases	
Data from complaint system	

Characteristics—Product (examples)	Performance	Serviceability
	Reasonable price	Ease/flexibility of use
	Durability	Simplicity of design, aesthetics
	Safety	Ease of disposal
Characteristics—Service (examples)	Responsiveness	Credibility/image
	Reliability	Confidentiality/security
	Competence	Understanding the customer
	Access	Accuracy/completeness
	Courtesy	Timeliness
	Communication (sensitivity, genuine interest/concern)	

Figure 8. Examples “value” characteristics (Table 17.1 in Westcott, p. 491).

- Once collected, the organization should have a well defined process for integrating, analyzing, and using customer satisfaction data to carry out corrective/preventive (improvement) actions.
- There are many potential problems associated with gathering and using customer satisfaction data. For example: poorly designed survey questions, nonrepresentative samples, survey questions asked for no specific reason, and failure to effectively use the data for product/service improvements.

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- Ideally an organization’s customers are loyal, “committed advocates” who are so delighted with its products/service they tell others. To make such a reality, customer satisfaction needs to be the focus of every person in the organization along with supporting plans, processes, and practices.
- Organizations should strive to understand what specifically represents value to its customers. One approach is to use the customer satisfaction data to create a customer’s perceived value matrix (CPVM) showing which product/service characteristics are most important to the customer.³⁹⁾ Assigning a weight to each characteristic will help the organization to know how best to apply its improvement resources.

V-B-3 Basic Customer Service Principles

- Westcott list the following ten steps (here summarized) for creating a customer-focused organization (pp. 498/9):

1. Top management personally champions outstanding customer service.
2. The vision/mission statement clearly states the importance of customers to the organization.
3. The strategic plans/goals/objectives support and reinforce the vision/mission statement regarding the importance of the customer.
4. Actions supporting the achievement of customer-related strategic goals are measured and continually improved.
5. Internal customers receive good service from the internal providers.
6. Management seeks to empower employees with effective support so they can better serve the customer.
7. Effective means for obtaining and using customer feedback are maintained. Complaints are especially welcomed and quickly acted upon.
8. Employees are continually educated in how to give superior customer service.
9. Benchmarking is used to study and learn from other organizations that provide world-class service.
10. Ultimately the organization adopts an unconditional guarantee policy.

39) Essentially the same as the priority matrix discussed at the second bullet under V-B-1 Customer Needs.

- When the organization does have a complaint it should (1) sincerely apologize, (2) restate the complaint for understanding, (3) *sincerely* empathize with the customer, (4) take immediate action to resolve the problem, and (5)⁴⁰⁾ check back later to be sure the customer is satisfied.
- One key to customer satisfaction is having well-trained customer service representatives who are knowledgeable about the product/service and how to treat the customer.

V-B-4 Multiple and Diverse Customer Management

- It is important for an organization to understand and be responsive to the special needs of different customers; for example, any special security requirements to protect proprietary information or any special delivery requirements.
- An organization may conclude it is not worth keeping a customer who is too demanding. However in such a case consideration must be given to the potential damage such a customer could cause by “bad-mouthing” the organization.
- To the extent possible, those dealing directly with the customer should be given the training and authority to resolve most customer problems immediately.
- Because of its importance in customer satisfaction, an organization needs to constantly be aware of both its current capacity and the possibility of needing more capacity; the latter perhaps due to adding a new product or a sudden surge in demand. Contingency plans should be developed to cover the possible need for a sudden increase in capacity.

Some other key points for further consideration (Customer Relationship Management):

- If it is truly “customer-focused,” *everything* done in an organization is

40) As Westcott puts it: “This area [#5] is where most programs fail” (p. 499).

with the customer in mind!

- Although requiring more time and effort, a QFD matrix is a very effective way to help an organization to concentrate its resources on what is most important to the customer.
- Another advantage of QFD is its ability to reveal product features that will delight the customer.
- It should be easy for the customer to register a complaint.
- When conducting a mail survey of customer satisfaction several things can be done to maximize the response rate including prior notification, a good (and short) cover letter, and a follow-up of some sort to nonrespondents.
- To minimize interviewer bias those conducting telephone surveys must be trained so the interviews are carried out in a uniform way across interviewers.
- The ultimate level of customer satisfaction is the unconditional guarantee that is truly followed; that is: quick replacement or refund, no challenge to the claim, a sincere apology, etc. Such behavior often leads to word-of-mouth spreading of the organization's positive reputation!
- A major problem is an organization thinking it already knows what its customers want and that they are satisfied.
- A key to customer retention/loyalty is understanding and satisfying the customer's perception of value.
- Good customer service often carries more weight than the product/service provided. In fact customers will often pay a premium for good service.

VI Supply Chain Management (Chapter 18 in Westcott)

Brief summary of chapter:

- Because much of what is purchased from a supplier becomes a part of an

organization's product (or service), it is important to have good supplier management processes.

- It is usually better to work closely with less suppliers on a long-term basis than having multiple suppliers who are played off against each other for the sake of a lower price.
- The total cost of supplies is more than just the purchase price since it also involves such things as supplier reliability, transaction costs, how well problems are resolved, etc. This is another reason to have good customer-supplier relations.

VI-A Supplier Selection

- If the supplies are standard items such as office supplies, any reputable supplier will do. However in most cases it is necessary to first develop supplier selection criteria for the product/service desired and this should be done using a cross-functional team.
- The supplier selection criteria will typically include such things as the supplier's experience/past performance, level of quality management, ability to deliver on time, financial stability, environmental friendliness, technical support ability, and potential for working together with the organization to improve the supplied product or service.
- Several methods can be used to see how well each candidate meets the selection criteria including a formal quote, site visits, evaluation of samples, and discussions with other customers.
- The result of a supplier selection process is usually a contract spelling out exactly what is to be supplied and other terms of the transaction such as price, delivery, and quality requirements.
- A supplier rating system may be appropriate and can range from a very simple measure of quality to a comprehensive system that measures many factors (such as quality, delivery, price, service, etc.). The key question

to ask is do the benefits significantly outweigh the costs of setting up and maintaining the system.

- The supplier must be involved and agree with the design of the supplier rating system including metrics to be used and the level(s) of acceptable performance.

VI-B Supplier Communications

- To minimize the chance for misunderstanding, the organization's requirements must be clearly spelled out in writing to the supplier. These are only some of the requirements that typically need to be spelled out (Westcott, p. 515):

- quote requirements
- product technical requirements
- process requirements
- product verification requirements
- product traceability requirements
- quality mgt system requirements
- delivery requirements
- order requirements
- corrective action requirements
- safety requirements
- security requirements
- environmental requirements
- financial stability requirements
- ethical requirements

Each requirement could involve considerable detail; e.g., the delivery requirement could include specifying how the product/material is to be protected during shipment and even the type of transportation to be used.

- There are many ways of communicating with suppliers including contracts, specifications, provision of a sample, visits by the supplier to the customer and vice versa, and regular supplier-customer meetings.

VI-C Supplier Performance

- It is important for the organization to provide their suppliers feedback on performance. To do this the organization must have a system for collecting, analyzing, and reporting supplier performance data.
- Typical performance areas of interest include information on the

supplier's quality management system (perhaps collected via survey or an on-site audit), product quality including data on the supplier's processes (e.g., C_{pk}) and number of defects, delivery performance, responsiveness to corrective action requests, and progress on reducing costs.

- There are many metrics an organization can use for tracking supplier performance such as the number of defects, order processing accuracy, delivery timeliness, responsiveness to problems, and process stability/capability. Each metric must be based on a definite purpose for its use and a determination that it will be worth the cost to set up and measure.
- The information gained from the metrics needs to be consolidated into an easy to understand report showing how well the supplier's performance is, rated on factors considered important to the organization. Figure 9 shows an example of such a report. Note acceptable performance levels are indicated along with how the supplier has performed over the past three quarters.

ABC Company Supplier Performance Report for: Fourth Quarter 2000		
Supplier: XYZ Company, Anywhere U.S.		
Category	Possible Score	Actual Score
Product quality	30	25
Delivery	30	30
Quality system	20	15
Corrective action	20	20
	100	90
Performance for past three quarters:	80, 80, 85	
Average score of all suppliers:	88	
Performance of best supplier:	95	
Performance categories:		
Preferred partner	95–100	
Acceptable	80–94	
Probation	<80	

Figure 9. Example of a supplier performance report (Figure 18.1 in Westcott, p. 519).

- One important aspect of customer-supplier relations is what action the customer should take when a nonconformance occurs. This is something

that should probably be clearly spelled out in the initial contract/agreement.

VI-D Supplier Improvement

- There are a number of ways the organization (customer) can help the supplier improve; for example through joint corrective and preventive action efforts, by assessing and recommending changes to the supplier's quality management system, by providing technical assistance to improve the product and/or production process, and by training supplier personnel.

VI-E Supplier Certification, Partnerships, and Alliances

- A certified supplier is one the organization can trust to consistently deliver conforming product/service so that there is little (if any) need to verify its quality.
- Once the organization determines which suppliers are to be certified, the certification criteria and process are developed and used to evaluate the selected suppliers. In general the assessment methods already discussed in sections IV-A and IV-C apply to the certification process.
- The certification process should also define how performance will be monitored to ensure the supplier continues to meet the certification criteria.
- Whereas an alliance usually means simply working together, a partnership is a more formal arrangement "implying a shared fate, mutual benefits, and equal relationships. ...and can involve technology, licenses, or supply/marketing agreements" (p. 524).
- Some reasons an organization might want to enter into a partnership with one of its suppliers are: to outsource part of its production process when it makes economic sense, to gain the synergies that result by combining resources, to facilitate a breakthrough in technology or the development of a new product/service, and to enable it to more easily enter a new market.

- Some ways two organizations might work together in an alliance or partnership are: designing and marketing a new product/service, having similar long-term strategies, communications of demand and resource planning information well beyond the normal short-term period, lending of employees, and sharing in profits resulting from the arrangement.
- Key aspects of a successful alliance/partnership are: working for mutual benefit (win-win), continually working to build mutual trust, open/complete communications, and using their “interdependence” to advantage (e.g., by helping each other out whenever possible).

VI-F Supplier Logistics

- Supplier logistics is mainly about the interface between the organization and the supplier and depends on when and how much of the supplies are needed taking into account the costs of transportation, receiving, and storage. Here are some possible (good) interfaces:
 - If the supplier meets certain standards (e.g., through certification) the supplies are shipped directly to stock, no incoming inspection is required.
 - Given a level demand, a certified supplier, and appropriate transportation arrangements, certain supplies are scheduled to arrive just-in-time at their point of usage.
 - As a further refinement of the last way, the organization works out an arrangement with the supplier to do part of the final assembly in the form of modules which are then shipped just-in-time for use.
- Although difficult, good supply chain management ensures all the organizations in the supply chain work together so “the right product or service, in the right quantity, of the right quality, gets to the customer at the right time” (p. 529).
- The use of information technology is important for coordinating the

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activities of all parties in the supply chain.

- It is essential that a decision be made early on which organization and person will be responsible for management of the supply chain.⁴¹⁾

Some other key points for further consideration (Supply Chain Management):

- In general it is better for an organization to develop long-term relations with fewer suppliers thus giving it more time to work with those suppliers on improving quality.
- The metrics used to rate a supplier “must be meaningful, fair, objective, and easy to understand with little chance for error in the methodology used” (p. 514).
- The communications plan for a supplier should address not only routine communications but also who to contact in case an emergency or other unusual event occurs. This means specifying an individual by name and keeping such information up to date.
- Due to its own performance being dependent on the supplier’s performance, the organization must ensure it will be immediately advised of any delays in fulfilling an order.
- When the organization is assessing a supplier’s quality management system, those doing the assessment must not only be highly knowledgeable in that area but also able to make the supplier feel they are there to help, not criticize.
- In terms of preventive action taken with the supplier to eliminate causes of nonconformance, a key area for examination is how good is the process for placing an order so the requirement is clearly transmitted and acknowledged.

41) An example would help to better understand exactly what Westcott means by this.

VII Training and Development (Chapter 19 in Westcott)

Brief summary of chapter:

- It is important to distinguish between education and training. Education means gaining knowledge and training means gaining a skill or set of skills. Education usually involves not only learning facts but also how to think. As an example, the refresher course in this body of knowledge deals with both the acquisition of knowledge and effective ways of thinking to improve an organization's quality. An example of training would be learning how to make a proper rivet on an aircraft—a narrow (but important) skill.
- Due to the rapid change in technology and competition it has become important for organizations to continually renew the knowledge and skills of their people—that is, truly become a learning organization.

VII-A Training Plans

- Training plans should be part of the organization's overall strategic planning effort so the actual training directly supports some strategic goal/objective. This means top management must be personally committed to and give high priority to the organization's training efforts.
- An example of how training might support a strategic goal of improving customer satisfaction would be using it to improve customer relations by training front-line personnel on how to show more genuine concern for the customer.
- As with any other improvement initiative, training plans should be evaluated on the basis of costs versus benefits. Although costs, such as salaries of trainers and other associated costs, are relatively easy to determine, benefits, such as improved customer satisfaction or reduced scrap/rework, usually require the organization's best estimate based on prior experience.

- The *first* question to ask when addressing a performance problem is: “Is training the answer?” In fact an employee’s poor performance could be due to a system that makes it impossible for the employee to perform well.⁴²⁾ In that case, of course, the system must be changed.
- If training *is* the answer then a plan is developed just as it would be for any project by identifying the outcomes needed, actions necessary to achieve those outcomes, a proposed budget, how outcomes will be evaluated, etc.⁴³⁾

VII-B Needs Analysis

- Some things that could trigger a need for training and/or education are: a regulation (e.g., for safety or quality-level reasons), a mandate by management (e.g., to meet a specific strategic goal/objective), or to correct a lack of some specific skill or knowledge that is affecting employee performance.
- When the need is not mandated or obvious there are several ways to find areas where training/education might help the organization such as a review of records (e.g., audit reports), focus groups, job/task analyses, and by simply talking with workers and their bosses.
- Once the specific need is identified the following are some of the questions that need to be answered:
 - Is it a knowledge or skill deficiency?
 - What are the specific deficiencies?
 - What outcome should be expected?
 - Who is affected?
 - Will the training/education be accomplished on-the-job, in the classroom, by individual study, or some combination of these?

42) Deming’s famous red-bead experiment dramatically illustrates this.

43) See VII-B too.

- What facilities/materials will be needed?
- Who will conduct the training/education?
- How will accomplishment of the desired outcomes be measured?

VII-C Training Materials/Curriculum Development and Delivery

- The training of managers differs from the training of nonmanagement personnel in that managers need to know a broader range of skills that go beyond the “technical” aspects of the function managed; e.g., planning, organizing, staffing, and people/project management skills.
- Also, as the level of management goes up the organization there is more emphasis on knowledge education vs. training in specific skills.
- It is up to the quality manager to ensure that the need for training in quality principles and practices at all levels is identified and appropriate training takes place.
- When carrying out a training program it is important that those trained understand how it will personally benefit them and such should be made explicit at the outset of the training program.
- Training programs should take into account adult learning principles.⁴⁴⁾ In general adult learners need to be more involved in the development and implementation of the program so it takes advantage of their experiences and knowledge.
- A good training program will have specific learning objectives to measure how successful the training has been. Each learning objective should state: (1) the observable action that should result from the training (e.g., correctly assemble module X), (2) the criterion for measuring the correctness of the action, and (3) the conditions under which the action will be performed (e.g., within a certain time or type of environment).

44) See for example Knowles, 1996.

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- A useful guide for developing objectives is Bloom’s Taxonomy. See Anderson, L. W., et al., 2001.
- A lesson plan specifying what will be covered should be carefully prepared for each training session. Also the instructor should be so well prepared that he/she can present the material in a confident and positive way.
- Although traditional classroom lectures and on-the-job training are the two usual methods of education/training, there are many other possibilities as alternatives to, or to supplement, those two⁴⁵⁾:
 - Learner-controlled instruction
 - Discussion format
 - Experiential training
 - Coaching
 - Case studies
 - Workbooks
 - Instructional games/simulations
 - Role-playing
 - Remote learning⁴⁶⁾
 - Distance learning⁴⁶⁾
 - Computer-based instruction
 - Job aids
- Some ideas for a good training experience: use examples to illustrate what’s being taught, frequently check for understanding, and provide “hands-on” opportunities whenever possible.

VII-D Training Effectiveness and Evaluation

- Training can be evaluated at various levels as shown on the chart on the next page.

45) These and others are discussed on pp. 554/61 of Westcott.

46) Remote learning is by correspondence and distance learning is by electronic participation in a scheduled class.

Level	Description
Reaction	The “smile” evaluation—simply asking the participant how he or she felt about the training experience.
Learning	Using testing to see if the predetermined training objectives (outcomes) were met.
Behavior	Determining if the desired behavior changes are actually applied back in the workplace.
Results	Was there a net positive gain for the organization due to the training? For example has the scrap rate been reduced in that part of the organization where training took place?
ROTI	Return on Training Investment—similar to “results” but placing a dollar value on the costs of the training and the resultant gains in quality.

- There are many reasons why a quality training program might fail such as an inadequate needs analysis resulting in training the wrong people, failing to adequately show the connection between the training and the strategic objectives and/or the specific job involved, poorly trained trainers, lack of involvement by the line managers, and simply a cultural bias within the organization against training.
- Ongoing training needs to be continuously evaluated during the planning and delivery stages and after it has taken place. For example, during planning have all possible alternatives for accomplishing the training objectives been considered? During delivery what parts of the program are working and what parts aren't? And why aren't they working so adjustments can be made.
- After the training were all concerned satisfied? If not, why? Also were the training objectives met? If not why? And how can the training program be improved?
- The best way to reinforce quality training is by management and first-line supervisors praising work well done when it is the result of a training experience.

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- Although individual development through the acquiring of knowledge, skills, experience, and “wisdom” is ultimately each person’s responsibility, the organization can play an important supportive role. Appendix E from Westcott shows this mutual investment in an individual’s development.⁴⁷⁾

Some other key points for further consideration (Training and Development):

- The truly professional manager understands the need to continually increase his/her knowledge and skills and takes appropriate action to do so.
- Quality improvement often means empowering employees to take on more and more responsibility. And, to do this, they must get the requisite training.
- It is important that the manager of each individual work unit is part of the training effort so he or she not only agrees with the need for an employee’s training but also makes sure the gains from that training are maintained once the employee returns to the work unit.
- When a skill is to be formally taught, this should occur as close to the time the skill will be used to avoid “fade out.” Also, if a skill hasn’t been used for some time, refresher training may be needed.
- A training/knowledge needs assessment should not be based on what an employee checks off from a list of available courses but rather on what he or she really needs.
- It is important to determine the present skill level of a training candidate so the training builds on that skill level instead of being redundant.
- For any training program to be truly effective, the trainee must be able to see how the training will personally benefit him or her.
- A carefully prepared “critical incident” can be an effective way to teach employees how to respond to a specific situation that might well come up in the organization.

47) This appendix also appeared in Part 1 of this paper as Appendix D.

- No matter the size or level of the training, it should be explicitly planned and evidence of successful completion documented.
- Although relatively simple and inexpensive, a job aid is often a very effective way to improve performance.⁴⁸⁾
- Even OJT requires specific planned objectives to avoid inconsistencies in what is learned by different people receiving that same training.
- Although there are many “bells and whistles” one can add to a training program, it is better to keep it as simple and practical as possible, as Westcott puts it: “a theme-park type of production is seldom needed.”
- If the training is by lecture, steps should be taken to make the lecture less boring by providing an outline of what’s said (so participants can concentrate more on the lecture) and involving the participants in the training process with pertinent questions, encouraging questions, and inviting them to share their experiences.
- When training is perceived as helping an employee do his/her job better and as a way for personal growth it will usually be very well received.
- A comprehensive training/education program based on strategic goals/objectives is a good way to ensure the organization continually improves and stays abreast of its rapidly changing environment.

Summary and Conclusion To Part 2

The purpose of this paper (Parts 1 and 2) is to provide a relatively brief overview of what today’s quality manager is expected to know, essentially the body of knowledge (BOK) which the American Society for Quality (ASQ) uses to develop its examination for Manager of Quality/Organizational Excellence (MOQ/OE) certification. Westcott’s handbook is the basic reference for the information

48) Westcott lists several types of job aids on p. 559.

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in the paper. Due to the magnitude of the information in Westcott (and the BOK) this paper is divided into two parts. Part 1 covered the following:

- I Leadership (Chapters 1–4 in Westcott)
- II Strategic Plan Development and Deployment (Chapters 5–7 in Westcott)
- III Management Elements and Methods (Chapters 8–12 in Westcott)

Part 2—this document—has covered the following:

- IV Quality Management Tools (Chapters 13–15 in Westcott)
- V Customer-Focused Organizations (Chapters 16 & 17 in Westcott)
- VI Supply Chain Management (Chapter 18 in Westcott)
- VII Training and Development (Chapter 19 in Westcott)

As I noted in Part 1, as even a quick look at this paper will reveal, the knowledge a quality manager is expected to know essentially covers the full range of management. This is an indication that today's quality manager is also expected to be knowledgeable in all aspects of good management and in fact the two areas—quality and good general management—are really one and the same!

Once again I would like to emphasize that the contents of the paper (Parts 1 and 2) are my best understanding of the material in Westcott and therefore may not always be exactly what was intended. Also, I would like to express my appreciation for Westcott's book, which is one of the best compilations of general management guidelines I have seen. It is comprehensive and replete with excellent examples that have greatly helped in understanding the many concepts and techniques, discussed. I trust what I have summarized in this paper has done that excellent work justice.

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Appendix A (page 1 of 3 pages)

Outline of the Manager of Quality/Organizational Excellence Body of Knowledge

(<http://www.asq.org/certification/manager-of-quality/bok.html>)

Note: The numbers in parentheses indicate the corresponding chapter in Westcott (2006).

I. Leadership

- | | |
|---|---|
| <i>A. Organizational Structures and Culture</i> (1) | <ol style="list-style-type: none">1. Organizational structures2. Organizational culture |
| <i>B. Leadership Challenges</i> (2) | <ol style="list-style-type: none">1. Roles and responsibilities of leaders2. Roles and responsibilities of managers3. Change management4. Motivating, influencing, negotiating, resolving5. Empowerment |
| <i>C. Teams and Team Processes</i> (3) | <ol style="list-style-type: none">1. Types of teams2. Stages of team development3. Team-building techniques4. Team roles and responsibilities5. Team performance and evaluation |
| <i>D. ASQ Code of Ethics</i> (4) | |

II. Strategic Plan Development and Deployment

- | | |
|---|---|
| <i>A. Strategic Planning Models</i> (5) | |
| <i>B. Business Environment Analysis</i> (6) | <ol style="list-style-type: none">1. SWOT analysis2. Market forces3. Stakeholder analysis4. Technology5. Internal capability analysis6. Legal and regulatory factors |
| <i>C. Strategic Plan Deployment</i> (7) | <ol style="list-style-type: none">1. Action plans2. Resource allocation and deployment3. Organizational performance measurement4. Quality function in strategic deployment |

Appendix A (page 2 of 3 pages)

**Outline of the Manager of Quality/Organizational Excellence Body
of Knowledge** (continued)

III. Management Elements and Methods	
A. <i>Management Skills and Abilities</i> (8)	<ol style="list-style-type: none">1. Principles of management2. Management theories, styles, and tools3. Interdependence of functional areas4. Human resources (HR) management5. Financial management6. Risk management7. Knowledge management
B. <i>Communication Skills and Abilities</i> (9)	<ol style="list-style-type: none">1. Communication basics2. Communications in a global economy3. Communications and technology
C. <i>Project Management</i> (10)	<ol style="list-style-type: none">1. Project management tools2. Project planning and estimation tools3. Measure and monitor project activity4. Project documentation
D. <i>Quality System</i> (11)	<ol style="list-style-type: none">1. Quality mission and policy2. Quality planning, deployment, and documentation3. Quality system effectiveness
E. <i>Quality Models and Theories</i> (12)	<ol style="list-style-type: none">1. MBNQA criteria for performance excellence2. ISO and other third-party standards3. Other quality methodologies4. Quality philosophies

IV. Quality Management Tools	
A. <i>Problem-Solving Tools</i> (13)	<ol style="list-style-type: none">1. The seven classic quality tools2. Basic management and planning tools3. Process improvement tools4. Innovation and creativity tools5. Cost of quality (COQ)
B. <i>Process Management</i> (14)	<ol style="list-style-type: none">1. Process goals2. Process analysis3. Lean tools4. Theory of constraints (TOC)

Continued on next page

Appendix A (page 3 of 3 pages)

Outline of the Manager of Quality/Organizational Excellence Body of Knowledge (continued)

IV. Quality Management Tools (continued)

- C. Measurement: Assessment and Metrics* (15)
1. Basic statistical use
 2. Sampling
 3. Statistical analysis
 4. Trend and pattern analysis
 5. Theory of variation
 6. Process capability
 7. Reliability and validity
 8. Qualitative assessment
 9. Survey analysis and use

V. Customer-Focused Organizations

- A. Customer Identification and Segmentation* (16)
1. Internal customers
 2. External customers
- B. Customer Relationship Management* (17)
1. Customer needs
 2. Customer satisfaction and loyalty
 3. Basic customer service principles
 4. Multiple and diverse customer management

VI. Supply Chain Management (18)

- A. Supplier Selection*
- B. Supplier Communications*
- C. Supplier Performance*
- D. Supplier Improvement*
- E. Supplier Certification, Partnerships, and Alliances*
- F. Supplier Logistics*

VII. Training and Development (19)

- A. Training Plans*
- B. Needs Analysis*
- C. Training Materials/Curriculum Development and Delivery*
- D. Training Effectiveness and Evaluation*

Appendix B

Priorities Matrix Example

(From Westcott, 2006, p. 342, Figures 13.13a/b/c)

	Handling	Acceleration	Comfort	Price	Row Total	Row %
Handling		1	10	5	16.0	42.3
Acceleration	1		10	5	16.0	42.3
Comfort	1/10	1/10		1/5	.4	1.1
Price	1/5	1/5	5		5.4	14.3
Total					37.8	

- 10 Overwhelmingly more important
- 5 More important
- 1 Equal
- 1/5 Less important
- 1/10 Overwhelmingly less important

Figure A

	Auto 1	Auto 2	Auto 3	Auto 4	Row Total	Row %
Auto 1		5	1/10	1/10	5.2	10.2
Auto 2	1/5		1/5	1/10	.5	1.0
Auto 3	10	5		1/10	15.1	29.7
Auto 4	10	10	10		30	59.1
Total					50.8	

- 10 Overwhelmingly better
- 5 Somewhat better
- 1 Same
- 1/5 Somewhat less good
- 1/10 Overwhelmingly less good

Figure B

	Handling	Acceleration	Comfort	Price	Row Total	Row %
Auto 1	(Criteria row total × option row total)	(42.3 × 10.2) 431				
Auto 2		(42.3 × 1.0) 42				
Auto 3		(42.3 × 29.7) 1256				
Auto 4		(42.3 × 59.1) 2500				

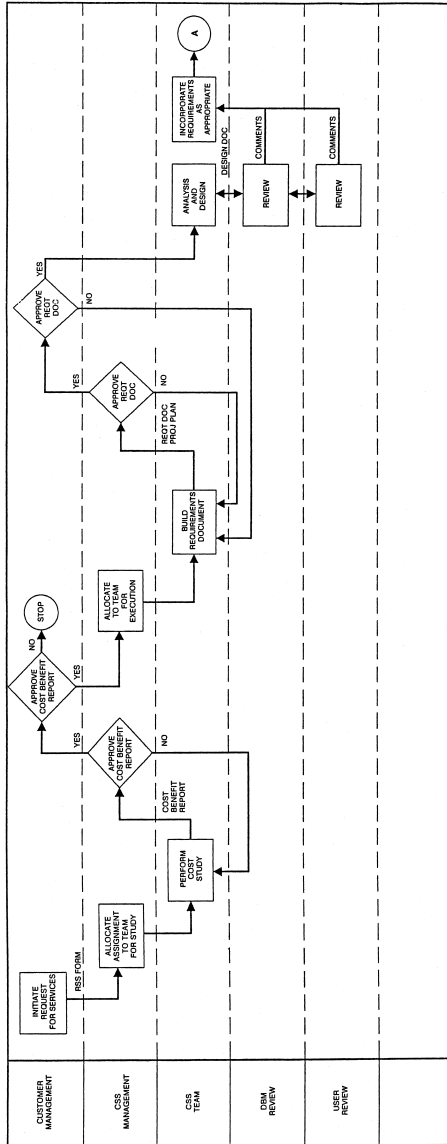
Figure C

Explanation: In Figure A each criteria to be used is weighted according to its perceived importance relative to each of the other criteria. Figure B is an example of how well each possible choice stacks up against one of the criteria (acceleration)—this is done for each of the other three criteria also (handling, comfort, and price). In Figure C the results of the relative importance of each criteria as shown in Figure A are combined with the “objectively” determined degree to which each of the possible choices (autos 1–4) meets each criteria (Figure B for acceleration). This give a final Row Total/% for each possible choice and the highest value is theoretically the best choice.

Appendix C (page 1 of 2)

Flowchart/Process Map Example

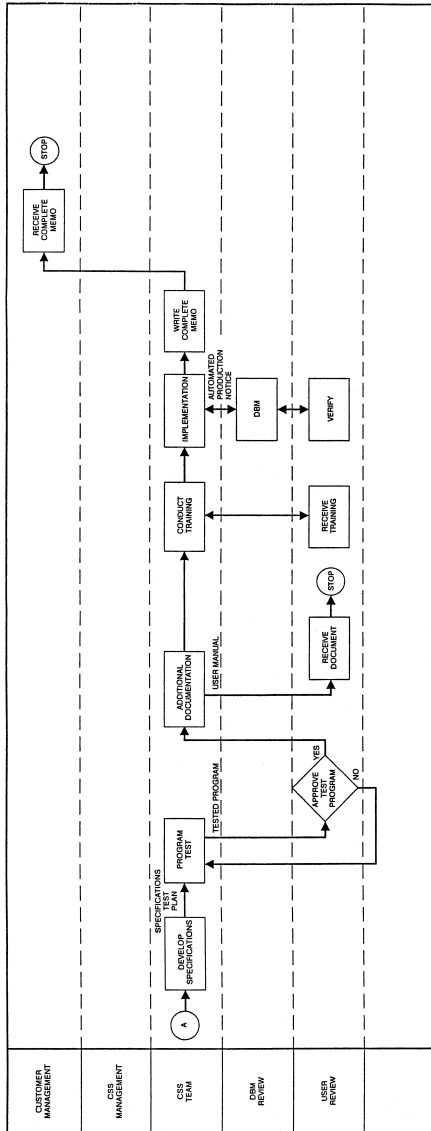
FLOW CHART — SYSTEM DEVELOPMENT



Appendix C (page 2 of 2)

Flowchart/Process Map Example (continued)

FLOW CHART — SYSTEM DEVELOPMENT



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Appendix D

Customer/Client Contact Record Example

(From Westcott, 2006, p. 482, Figure 17.4)

Customer/Client Contact Record (CCR) [CCR no.]			
A. Identification			[Cust./client no.]
Contact from:	[Person's name] [Location] [Customer/client's name] [Address] [City]	[Title] [Phone] [Fax] [E-mail] [Country]	
Field listener:	[Name] [Dept./location] [Supervisor's name]	[Position] [Phone] [Title]	[State/province] [Mail stop]
B. Context/situation/place of contact			
<input type="checkbox"/> Complaint <input type="checkbox"/> Compliment <input type="checkbox"/> General observation [What?] <input type="checkbox"/> Letter: [Date] <input type="checkbox"/> Phone call: [Date] <input type="checkbox"/> Face-to-face: [Date] <input type="checkbox"/> Other: [Date] [Describe context in greater detail if "other" is checked:]			
C. Quote or best recollection of words from customer/client and nature of the contact			
<input type="checkbox"/> Related to specific order/product: [Order no.] [Date] [Product] <input type="checkbox"/> Related to specific representative of this organization: [Who] [Date] [Record words used by customer/client's contact. If a direct quote, use quotation marks.]			
[Describe any details that will make the understanding of the customer/client's perspective clear to persons reading this CCR. Note if customer/client specifically requested notification of resolution or other feedback. Use back of form if needed.]			
[Field listener's commentary (viewpoint, opinion, interpretation)]			
D. Action activity			
Triage: <input type="checkbox"/> Action needed now (Corrective action) <input type="checkbox"/> Investigate further (Preventive action) <input type="checkbox"/> Watch trend			
Action assigned to:	[Name]	[Location]	[Phone] [Date]
Follow-up:	[How?]	[Date]	[Date] [Date] [Date]
Status reports:	[How?]	[Date]	[Date] [Date] [Date]
E. Resolution and Closeout			
[State how problem/question was resolved:] [By whom] [Date]			
[Corrective action no.] [Preventive action no.] [Returned material auth. no.] [Other?]			
[Procedure/work instruction affected] [Date to be changed] [By whom]			
[Forms/computer programs affected] [Date to be changed] [By whom]			
[Status/feedback to be provided—how?] [To whom] [By whom] [By date]			
[Closeout code] [Closed by:—print] [Signature] [Date]			

Appendix E

The Many Factors That Go Into the Mutual Development of an Employee

(From Westcott, 2006, p. 175)

