CSSBB Primer Question Contents

Primer Section		% CSSBB	Questions		
			Exam	Primer	CD
I.	Certification Overview				
II.	Organization-wide Deployment	8%	12	32	80
III.	Process Management	6.7%	10	27	67
IV.	Team Management	12%	18	48	120
V.	Define	13.3%	20	53	133
VI.	Measure - Data	7.3%	11	29	73
VII.	Measure - Statistics	9.3%	14	37	93
VIII.	Analyze	14.7%	22	59	147
IX.	Improve	14.0%	21	56	140
X.	Control	10%	15	40	100
XI.	Design for Six Sigma	4.7%	7	19	47
XII.	Appendix				
	Total	100%	150	400	1000

The solutions to all 400 questions are available through QCI in the *CSSBB Solutions Text*. QCI also offers a CSSBB Exam CD which contains 1,000 total CSSBB questions. Included are the 400 Primer questions (which may be excluded), plus 600 additional questions. The CD offers a variety of options, including full simulated exams.

Alignment Comparison B/T CSSBB Primer & ASQ BOK

Primer	II	III	IV	V	VI	VII	VIII	IX	X	XI
ASQ BOK	I A & B	II A ➜ C	III A ➜ D	IV A ➜ D	V A ➜ C	V D ➜ F	VI A ➜ D	VII A ➜ C	VIII A ➜ D	IX A ➜ C

Value of Six Sigma (Continued)

Sigma is a statistical term that refers to the standard deviation of a process about its mean. In a normally distributed process, 99.73% of measurements will fall within ± 3.0 sigma and 99.99932% will fall within ± 4.5 sigma. In a stable attribute distributed process, 99.73% of values will fall within the probability of 0.00135 and 0.99865.

Motorola® noted that many operations, such as complex assemblies, tended to shift 1.5 sigma over time. So a process, with a normal distribution and normal variation of the mean, would need to have specification limits of ± 6 sigma in order to produce less than 3.4 defects per million opportunities. This failure rate can be referred to as defects per opportunity (DPO), or defects per million opportunities (DPMO).

Figure 2.1 illustrates the ±1.5 sigma shift and Table 2.2 provides some indications of possible defect levels.

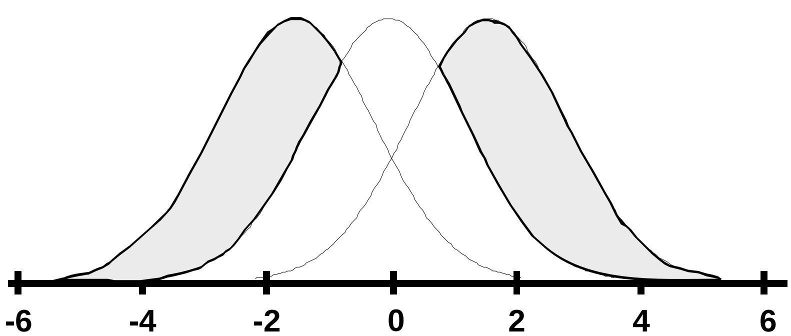

Figure 2.1 The ± 1.5 Sigma Shift

Sigma Level	ppm
6 sigma	3.4 ppm
5 sigma	233 ppm
4 sigma	6,210 ppm
3 sigma	66,810 ppm
2 sigma	308,770 ppm
1 sigma	697,672 ppm

Table 2.2 Defect Levels

Note that Table II in the Appendix provides defect levels at other sigma values. Various authors report slightly different failure rates based upon rounding effects and slight miscalculations.

It should be noted that the term "six sigma" has been applied to many operations including those with non-normal distributions, for which a calculation of sigma would be inappropriate. The principle remains the same, deliver near perfect products and services by improving the process and eliminating defects. The end objective is to delight customers.

Setup Reduction (Continued)

After the first step has been performed, a breakdown of the operation can begin. The setup team may be comprised of operators, setup technicians, engineers, and maintenance staff. This team reviews the setup elements. Every step in the setup process (from start to finish) is broken down and classified. A major item is to separate items that can be done when the machine is running (external setup) and to separate the items that can only be done when the machine is down (internal setup). External setup operations should include:

- Preparation of parts
- Finding parts
- Measuring parts
- Maintenance of dies and spares
- Cleaning of spares, etc.

The break down of initial elements into internal and external setup operations is just a start. The existing internal setup elements should be reexamined to convert more of those elements into external setup. The goal is to reduce the time to under 1 digit. However, it may take a series of SUR projects to lower the time to 1 digit.

The setup team will need to generate some creative options. They should look for pre-heating of dies, earlier preparation of parts, simplifying holding devices, standardizing die heights, and using common centering jigs, multipurpose dies, parallel operations (2 or more people working), functional clamps, one-turn attachments, U-shaped washers, one-motion methods, interlocking methods, elimination of adjustments, etc. Brainstorming and problem solving sessions are needed to continuously improve the setup process.

All elements of internal and external setup must be reviewed in detail and streamlined in order to attain the single digit goal. Perhaps the goal is unattainable, but efforts should be made to go as low as possible. Once a SUR procedure is agreed upon, the setup team should practice the process and critique itself for additional improvements.

Setup Reduction (Continued)

Based on specific applications, the reduction of cycle time can have a considerable impact on the containment of costs and improvement in productivity. Consider the following case study, which is not a single minute exchange, but is representative of the process.

SUR Case Study

A casting facility in Virginia decided to investigate the time necessary to replace sand molds. In past years, the process had required 2 to 3 hours per change out. Through a gradual evolutionary process, that time had been reduced to an hour. A cross functional team was assigned the investigative task. Members included representatives of production, maintenance, engineering, and supervision. The team had previously undergone problem solving and team dynamics training.

Over a period of three months, the change out time was reduced to a firm fifteen minutes regardless of station and mold type. Some of the key ingredients in this success included:

- **The mold storage method**
- **The staging of molds**
- **The timing of the change out**
- **A redesign of the die hardware**

At least two minor engineering modifications were required. Plant communications, regarding the implementation of the new methods, were also part of the team's charter. Interestingly, the team discovered that their nearest competitor was still needing two hours to do the job. In this case, benchmarking the competitor (even if ethical) would have been discouraging.

Quick Response Manufacturing

According to Professor Ryjan Suri, quick response manufacturing (QRM) is the next step for the Toyota Production System (TPS). Ryjan Suri is a Professor of Industrial Engineering at the University of Wisconsin - Madison and Director of the Center for Quick Response Manufacturing. TPS is now 30 to 40 years old and could be considered an old technology. QRM helps companies use speed and the reduction of cycle times to deliver products and services faster than their competitors. This methodology can be applied to both the shop floor and the office.

In many cases, QRM requires that the managerial mind set must change. The implementation of QRM in a company requires proper training and orientation to grasp the dynamics of the manufacturing system. It is important to understand how capacity planning, resource utilization, lot-sizing, etc., interact with each other and impact lead times. This is very important in the relentless pursuit of lead time reductions. QRM is especially useful for a product line that has a large variety of highly engineered products with variable demand.

A specialized material planning technique that is a combination of both “push” and “pull” termed “POLCA”, is used for controlling material flow. POLCA stands for Paired-cell Overlapping Loops of Cards with Authorization. This is a material control system that operates in conjunction with MRP and a cellular arrangement. Some examples of the benefits of QRM include:

- Reduction of lead times by 80% to 95%
- Lowered product costs by 15% to 30%
- Increased on-time deliveries from 60% to 99%
- Decreased scrap by 80% (Suri, 2006)[21]

The QRM methodology focuses on speed. Suri highlights these principles:

- Change the management mindset
- Find ways to complete a job, focusing on lead time minimization
- Plan to operate critical resources at 70% to 80%, not 100%
- Use reduction of lead time not utilization as the main performance metric
- Do not use equipment efficiency or utilization as the main metrics
- Lead time reduction is more important than on-time delivery
- Install the POLCA material control system
- Move the suppliers to QRM
- Educate customers on QRM in order to enable smaller lot sizes
- Use quick response office cells (teams) for product families
- QRM will lead to a truly lean company

(Center for QRM, 2006)[3]

Kaizen

Kaizen is Japanese for continuous improvement (Imai, 1997)[9]. The word kaizen is taken from the Japanese kai "change" and zen "good." This is usually referred to as incremental improvement, but on a continuous basis, and involving everyone. Western management is enthralled with radical innovations. They enjoy seeing major breakthroughs, the home runs of business. Kaizen is an umbrella term for:

- Productivity
- Total quality control
- Zero defects
- Just-in-time
- Suggestion systems

(Imai, 1997)[9]

The kaizen strategy involves:

- Kaizen management: Management maintains and improves operating standards.

- Process versus results: Improvement of processes is the key to success.

- Use the PDCA/PDSA cycles: Plan-do-check-act is the method of improvement. The check cycle refers to verification that implementation has taken place and is on target to meet goals.

- Quality first: Quality is of the highest priority.

- Speak with data: Problems are solved with hard data.

- The next process is the customer: Every step of the process will have a customer. Provide the next step with good parts or information.

(Imai, 1997)[9]

Kaizen (Continued)

The Kaizen Blitz

While most kaizen activities are considered to be of a long-term nature by numerous individuals, a different type of kaizen strategy can occur. This has been termed a kaizen event, kaizen workshop, or kaizen blitz, which involves a kaizen activity in a specific area (involving planning, training, and implementation) within a short time period. (Gee, 1996)[5], (Laraia, 1999)[10]

The kaizen blitz, using cross functional volunteers in a 3 to 5 day period, results in a rapid workplace change on a project basis. The volunteers come from various groups, such as accounting, marketing, engineering, maintenance, quality and production. If the work involves a specific department, more team members are selected from that department.

Depending on the experience levels of the group, a 5 day kaizen blitz starts with 2 days of intense sessions on continuous improvement concepts. This is followed by 3 days of hands on data collection, analysis, and implementation at the source. The last portion of the workshop truly requires deep management commitment. Plant managers must trust the decision-making process as determined by the kaizen blitz team and facilitator.

A significant amount of time and money is involved at the implementation stage. The team makes a final presentation of the project to the plant manager and all interested plant employees. All project team members are encouraged to take part in the presentation. Every project has the possibility of bringing immediate changes and benefits. (Gee, 1996)[5]

Laraia (1999)[10] emphasizes that kaizen blitz events must occur with minimum expense and maximum use of people. The basic changes are in the process flow and methodology.

Various metrics are used to measure the outcomes of a kaizen blitz:

- Floor space saved
- Line flexibility
- Improved work flow
- Improvement ideas
- Increased quality levels
- Safe work environment
- Reduced non-value added time

Theory of Constraints

The theory of constraints (TOC) is a system developed by E. Goldratt. In 1986, Goldratt and Cox published a book titled *The Goal* (Goldratt, 1986)[7], which introduced the subject. *The Goal* describes a process of ongoing continuous improvement. Additional books have followed on the subject, including *Theory of Constraints* (Goldratt, 1990)[8].

Goldratt describes the theory of constraints as an intuitive framework for managing based on the desire to continually improve a company. Using TOC, a definition of the goals of the company are established along with metrics for critical measures.

(Goetsch, 2000)[6]

***The Goal* is a novel written in a story format describing the dual trials of a plant manager as he struggles to simultaneously manage his plant and his marriage. The key concept, "theory of constraints" is never mentioned as such, but is fed to the reader in bits and pieces. Listed below are many of the key elemental pieces:**

- **Bottlenecks**
- **Throughput**
- **Inventory**
- **Operational expenses**
- **Socratic way**
- **Jonah**
- **Common sense**
- **Delivery of results**
- **Goals**
- **Assumptions (most are incorrect)**
- **Return on investment**
- **Cash flow**
- **Local optimums**
- **Systems thinking**
- **Lead times**
- **Reduction of batch sizes**
- **Cost accounting**
- **Fear of change**
- **Resistance**
- **Net profit**

***The Goal* reminds readers that there are three basic measures to be used in the evaluation of a system.**

- **Throughput**
- **Inventory**
- **Operational expenses**

These measures are more reflective of the true system impact than machine efficiency, equipment utilization, downtime, or balanced plants.

Theory of Constraints (Continued)

A few of the most widely used TOC concepts are detailed below:

- **Bottleneck resources are resources whose capacity is equal to or less than the demand placed upon it. A non-bottleneck is any resource whose capacity is greater than the demand placed on it. If a resource presents itself as a bottleneck, then things must be done to lighten the load. Some of the appropriate steps might be to offload material to relieve a bottleneck or to make the bottlenecks work only on parts needed now. One should beware of lost production at a bottleneck, due to poor quality or rejects.**

- **Balanced plants are not always a good thing. One should not balance capacity with demand, but balance the flow of product through the plant with demand from the market. The plant may be capable of generating inventories and goods at record levels, which jam up the plant's systems. The idea is to make the flow through the bottleneck equal to market demand. One can do more with less by just producing what the market requires at the time. It is possible that the existing plant has more than enough resources to do any job, but the flow must be controlled.**

- **Dependent events and statistical fluctuations are important. A subsequent event depends upon the ones prior to it. The story of Herbie and the local scout pack describes how the slowest member of a group will restrain the pace of the group. A bottleneck will restrain the entire throughput.**

- **Throughput is the rate at which the system generates money through sales. The finished product must be sold before it can generate money.**

- **Inventory is all the money that the system has invested in purchasing things that it intends to sell. This can also be defined as sold investments.**

- **Operational expenses are all the money that the system spends in order to turn inventory into throughput. This includes depreciation, lubricating oil, scrap, carrying costs, etc.**

- **The terms throughput, inventory, and operational expenses define money as incoming money, money stuck inside, and money going out.**

(Goldratt, 1986)[7]

10.22. There are several different varieties of median control charts. If median values and ranges are plotted, what would be expected to be different than experienced with an X bar and R chart for the same sample size? Assume that control limits are used.

a. The middle value would be circled on the median chart
b. The range chart would have different control limits
c. The median control limits would be wider apart
d. The lower limit on the range chart could not be zero

10.23. What organizational documentation levels describe who will accomplish specific tasks and how they are to be accomplished?

a. The control manual and operating procedures
b. Work instructions and work records
c. Operating procedures and work instructions
d. Operating procedures and work records

10.24. An X-bar chart has been in control for a long time. However, the points for the last 50 samples are all very near the center line on the chart. In fact, they are all within one sigma of the center line. This probably indicates that:

a. It is a desirable situation
b. It is an undesirable situation
c. The process standard deviation has decreased recently
d. The control limits are incorrectly computed

10.25. A p chart has been plotted for some time. Recently, steps have been made to substantially improve the process. One would not be surprised to find that:

a. The chart demonstrates more out-of-control conditions
b. The chart must be converted into a variable chart
c. A larger sample size must be taken
d. The chart requires the samples to be taken more frequently than in the past

10.26. Tool boards, jidohka devices, and red lights all combine to:

a. Make problems visible
b. Prevent defective products
c. Maintain management control
d. Display targets for improvement

10.27. The most important determination of a postmortem project analysis is:

a. Whether the project was achieved within the time deadlines
b. The effectiveness of the entire project
c. How well the project team was recognized for their efforts
d. Whether the project was completed within the cost constraints

10.28. At the early stages of the DMAIC project, the voice of the customer shouted “safety” in every customer focus group, customer interview, and customer survey. The control plan is now missing the team member list. The control plan also addresses product performance in detail, but not product safety. Can this control plan be implemented?

a. Yes, the team is better informed than the customer
b. No, the main CTQ requirement was not addressed in the control plan
c. No, the paper work is not complete
d. Yes, safety is not a CTQ

10.29. When should an X - MR chart be used?

a. When the number of defectives is being monitored
b. When an exceptionally large run size is expected
c. When range data is unreliable
d. For destructive testing applications

10.30. The most common subgrouping scheme for X-bar and R control charts is to separate the variation:

a. Within stream versus stream-to-stream
b. Within time versus time-to-time
c. Within piece versus piece-to-piece
d. Inherent process versus error of measurement

10.31. What is the equipment availability if there are 7.5 hours available per shift, 30 minutes of setup time, 15 minutes of planned downtime, and 15 minutes of unscheduled equipment failure?

a. 87%   c. 90%
b. 93%   d. 85%

Functional Requirements (Continued)

Parameter Design Case Study (Continued)

The two arrays are combined to form the complete parameter design layout. The L9 array is called the inner array, while the L8 array is the outer array. See Table 11.7 below.

L_8 ARRAY

8	7	6	5	4	3	2	1	#
2	2	2	2	1	1	1	1	E
2	2	1	1	2	2	1	1	F
1	1	2	2	2	2	1	1	E x F
2	1	2	1	2	1	2	1	G
1	2	1	2	2	1	2	1	E x G
1	2	2	1	1	2	2	1	F x G
2	1	1	2	1	2	2	1	E x F x G
120h	120h	120h	120h	24h	24h	24h	24h	(E) Time
150F	150F	72F	72F	150F	150F	72F	72F	(F) Temp
75%	25%	75%	25%	75%	25%	75%	25%	(G) R. H.

L_9 ARRAY

	#	A	B	C	D	Inter-ference (A)	Wall Thickness (B)	Ins. Depth (C)	Percent Adhesive (D)	Response								Avg.	S/N RATIO (db)
Experimental Conditions	1	1	1	1	1	Low	Thin	Shallow	Low	19.1	20.0	19.6	19.6	19.9	16.9	9.5	15.6	17.5	24.025
	2	1	2	2	2	Low	Medium	Medium	Medium	21.9	24.2	19.8	19.7	19.6	19.4	16.2	15.0	19.5	25.522
	3	1	3	3	3	Low	Thick	Deep	High	20.4	23.3	18.2	22.6	15.6	19.1	16.7	16.3	19.0	25.335
	4	2	1	2	3	Medium	Thin	Medium	High	24.7	23.2	18.9	21.0	18.6	18.9	17.4	18.3	20.1	25.904
	5	2	2	3	1	Medium	Medium	Deep	Low	25.3	27.5	21.4	25.6	25.1	19.4	18.6	19.7	22.8	26.908
	6	2	3	1	2	Medium	Thick	Shallow	Medium	24.7	22.5	19.6	14.7	19.8	20.0	16.3	16.2	19.2	25.326
	7	3	1	3	2	High	Thin	Deep	Medium	21.6	24.3	18.6	16.8	23.6	18.4	19.1	16.4	19.9	25.711
	8	3	2	1	3	High	Medium	Shallow	High	24.4	23.2	19.6	17.8	16.8	15.1	15.6	14.2	18.3	24.833
	9	3	3	2	1	High	Thick	Medium	Low	28.6	22.6	22.7	23.1	17.3	19.3	19.9	16.1	21.2	26.152

Table 11.7 Example Orthogonal Design Layout

The completed matrix contains the mean response results. In addition, the variation of the signal-to-noise (S/N) ratio has been determined. The larger the S/N ratio the better. S/N ratios are computed for each of the 9 experimental conditions. An ANOVA can also be used in the calculations to supplement the S/N ratios. Taguchi prefers to use graphing techniques to visually identify the significant factors, without using ANOVA.

The optimum combination of factors and levels can be determined from the analysis. A confirmation run should be conducted to verify the results.

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