Stochos 30 Years of Quality

QC Report

February 1998

Published by Stochos Inc., 14 N. College Street. Schenectady, New York 12305

1998-THE YEAR TO IMPROVE YOUR QUALITY PROCESSES!
Stochos to promote big savings in "98"…Watch for 30th Anniversary "Special" Notifications

Some Sample Size Questions and Answers

(Don Holmes)

Questions about sample size required to achieve some desired level of accuracy arise very often. There are a rather wide variety of these questions. Examples include (you may have others - let us know):

Question # 1: How large a sample do I need to estimate the average value of my process?

Question # 2: What sample size do I need to decide whether or not to accept a lot?

***Question # 3*: How large a sample do I need from a lot generated by a multiple stream process to be confident that the sample includes an item from each stream?**

I'll discuss these sample size questions (and others, if you send them) in separate QC Reports. Questions 1 & 2 were discussed in Previous QC Report issues. Please call Stochos if you would like to obtain a copy.

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Market Trends

The current results of the survey indicate the top 3 major trends for future concerns are in:

Complete Traceability Systems (ISO 9000)
Quality Cost Analysis
Closed Loop Corrective Action

In this report we'll talk about **traceability** systems. The structure of this type of system lends itself to employee empowerment by having all production and quality related information handled at the factory floor level. This provides an extraordinary amount of information to factory personnel and management without the perception of one way communication impeding continuous improvement.

A **complete traceability system**, such as *Stochos'* **Quality Management and Shop Floor Data Collection System** can save time and money in many areas of a facility. *Stochos* has spent 30 years developing and improving these systems and has integrated the modules into an easy-to-use factory floor system that eliminates paperwork and provides shop floor and quality information to the business systems immediately and seamlessly. The *Stochos* system tracks every phase of the manufacturing process, from raw materials, to laboratory, to finished product, collecting product and process data along the way. This traceability helps your quality improvement efforts and your ability to gain and to maintain **ISO 9000 certification**.

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Product Watch 98

QAR Quality Action Reporting
For Microsoft Windows™

Eliminate your unmanageable paper system
Speed the resolution of your quality issues

QAR FEATURES:

Control of Nonconforming product
Nonconformity review and Disposition
Corrective and Preventative Action
Tracking Cost of Production
Cost of Quality
Pareto Analysis

The **QAR** is an **ACTION** orientated, closed-loop Corrective Action and Problem Solving software tool. Its features help satisfy the paperwork and effort necessary in conforming to **ISO 9000** standards.

See page 3 for more details

STOCHOS THANKS ALL WHO PARTICIPATED IN OUR RECENT SURVEY.

Sample Question # 3

How large a sample do I need from a lot generated by a multiple stream process to be confident that the sample includes an item from each stream?

I am filling jars or making cans from a multiheaded machine that has no ability to label the product as to the head on which it was produced. How large a sample (n) is required to give me a selected level of confidence that I have not missed covering all (k) heads in the sample?

Solution: The probability of "full coverage" (Pfc) is:

$$Pfc = n!*(n-1)!/((n-k)!*(n+k-1)!) \quad (1)$$

$$\text{Or Approximately, } Pfc = (n/(n+k-1))^{k} \quad (2)$$

$$\text{So that } n = (k-1)*Pfc^{(1/k)}/(1-Pfc)^{(1/k)} \quad (3)$$

Example: I have a filling machine with ten heads (k=10). I would like to know the sample size required so that I have a 95% chance of covering all ten heads in the sample. Using equation (3), we find: **n = 1750.**

Question #3 is essentially an "occupancy" problem. There are k boxes into which n items are thrown at random. We would like to know the probability that each box is occupied by at least one item.

k = # of streams (boxes)
n = sample size (X's)
Pfc = probability of full coverage

For example, suppose that we take a sample of size 3 (n = 3) from a machine that generates 3 streams (K = 3) of product. We will solve for the probability that the sample size 3 will contain one item from each stream (Pfc).

There are 3 boxes into which we are going to throw, at random, 3 samples (designated by X's in diagram 1). There are 2 internal sides of the boxes and 3 X's. There are thus (3+2)!/(3!*2!) = 10 permutations of these symbols. The 10 different permutations are shown below.

X	X	X	Success! We got one sample from each stream.
XX		X	
	X	XX	
XX	X		We missed one stream.
X	XX		
X		XX	
XX		X	
XXX			We missed two streams.
	XXX		
		XXX	

Diagram 1

Only 1 permutation out of the 10 is a success. The Pfc = 1/10. To get a Pfc value of about .90 with three streams, we need, according to equation (3), a sample of size 56. (To get Pfc = 0.99, we need a sample of size 596.)

In general the number of permutations is:

$$(n+k-1)!/(n!*(k-1)!).$$

For full coverage, there must be one x in each of the k boxes - which leaves (n-k) X's to distribute with the (k-1) internal sides. There is thus a total of (n-1) X's & sides.

The number of full coverage permutations is:

$$(n-1)!/((n-k)!*(k-1)!)$$

and the probability of full coverage is:

$$Pfc = \frac{(n-1)!/((n-k)!*(k-1)!)}{(n+k-1)!/(n!*(k-1)!)}$$

Let's try two boxes and four x's : **n = 4 k = 2**

n+k-1 = 5 k-1 = 1 n-1 = 3 n-k = 2

$$Pfc = \frac{3!/(2!*1!)}{5!/(4!*1!)} = \frac{3}{5}$$

There is full coverage in the first three permutations

XX	XX	Success! We got hits in each stream
X	XXX	
XXX	X	
XXXX		We missed.
	XXXX	

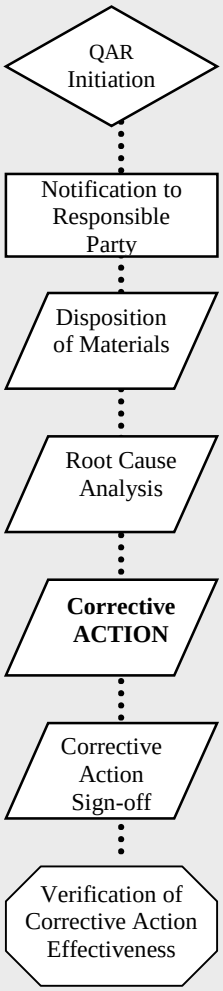
Diagram 2

There are five permutations **Pfc = 3/5**

These sets of permutations shown above are also referred to as "partitions" of (in this case) four objects. The partitions are (4,0), (3,1), and (2,2).

Quality Management and Shop Floor Data Collection Systems Features

- **Off-line Statistical Process Control/Statistical Quality Control software**
- **On-line, real-time Statistical Process Control software**
- **User-type definable closed-loop nonconformance problem solving module (QAR)**
- **Gauge Calibration Tracking module**
- **Employee Training Log**
- **Process Improvement Team module**
- **ISO 9000-style Documentation Control and Routing module**
- **On-line user friendly data entry and analysis**
- **Order/Job history retrieval**
- **Complete Product-to-Process links and Raw Materials to Finished Goods traceability**
- **Quality Lab data entry and analysis**
- **Complete automatic downtime recording and identification**
- **Real-time links via PLC to processes for recording of production and quality-related information**
- **Waste tracking via process input and output production monitoring**
- **User-definable table structure and display options**
- **Windows 95 and NT compatible, Microsoft SQL Server-based (other databases are available at possible alternative pricing)**
- **User-configurable automatic generation of Certificates of Analysis**
- **Manufacturing-style Production Reporting**
- **Shift, crew, and/or employee levels of time tracking**
- **WIP ticket generation**
- **Warehouse management, material receipt via wireless bar-coding**
- **Maintenance Management (PM, Tooling Inventory, w/links to SFDC)**



(Diagram3)

QAR System Steps

The **QAR Program** tracks all the steps (diagram3), while the Quality System Supervisor monitors the progress of Individual QARs. Persons assigned to a task have the **QAR** show up in their "***QAR Work Queue***" with instructions on what steps to take. Let the **QAR** take a tremendous workload off your staff and focus on effective management of Quality related problems, NOT paperwork.

QAR Tracking Nonconformance in Production

Proper planning and proper use of the QAR system can determine the sources of nonconformance in production. For example a Quality Manager from Georgia Pacific Corporation recently used the QAR System and a windows based report writer to poll and group required information by apparent cause. In less than 20 minutes to write the report and query the data, he found that the source of a particular nonconformance was one machine. This information was not so evident in other methods of evaluating the information.

The **QAR** has been extremely successful as part of the *Stochos* integrated complete factory floor system. Now, you can have the same type of traceability that large corporations have profited from for a fraction of the cost. Call *Stochos* for more information or a QAR slideshow.

You Ask, We Answer…Readers' Question

Submitted by Howard Swartz, AAI Corporation

Is it better to limit levels in DOE and perform multiple experiments or perform the experiment to the level needed?

1. "Screening" experiments are usually run at just two levels of each of many factors. The intent of the experiment is to determine the factors which have the major impact on the response variable.

2. Once the major factors have been identified, it may be desirable to determine the functional form of the relationship between the factors and the response variables. In this case, the subset of important factors should be investigated at more than two levels. The greater number of levels, the more diverse the types of relationships that may be explored. For example, the use of two levels allows for only linear models. The use of three levels allows for fitting quadratic models. These quadratic models have some curvature, and may have maximums or minimums over the range of experimentation.

If you have lots of time and money, you can go directly to the second option. However, use of the first option, (a screening experiment), has proven to be extremely beneficial in many cases.

How Stochos Can Help: Stochos and Product Integrity Company have developed a **Sequence Leveled Experimental Design (SLED)** program that helps design multi-factor statistical experiments. This Windows™ based system analyzes results, identifies defect causes, and determines process capabilities to reduce quality costs while optimizing your process conditions and productivity.

Stochos offers consulting analysis to determine **Critical Control Variables** from historical process data obtained from your plant and provides detailed **CCV** analysis for multiple **Quality Variables** selected by plant personnel. Our broad experience base means that we can effectively apply the best SPC data analysis, utilizing the finest software programs and our extensive professional experience to achieve the greatest results in the shortest time possible.