American Society for Quality
ASQ

Quality Connection

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Problem-Solving Success Tip

Jeanne Sawyer, Ph.D.

Define the problem first. It seems obvious, but how many times have we gone to a problem-solving meeting and the discussion started with either whose fault was it or an assertion about the proper solution?

Explain what the problem is—what went wrong, what are the symptoms, what is the impact on your business and your customer's business. These are the things that someone *knows* at this point in the problem solving process. If the someone is not you, and you're leading the problem-solving effort, you need to do some research to find out. No guesses or assumptions allowed: the problem description must give the facts clearly and accurately.

Write it down. Writing the problem down forces you to describe it carefully, completely and unambiguously. The statement is a valuable tool to help focus your team on the real problem and avoid wasting time on extraneous issues. Everyone who reads it should understand what the problem is and why it's important. No jumping ahead, either: you don't know yet what caused the problem much less what you will do to fix it.

The written statement can also be used as a "sales tool" to explain what problem you're solving and why it's important. Use it to make sure you have the support you'll need from management, your customer and any other key players. This is especially important if the significance of the problem is not universally understood or accepted.

The problem is defined when everybody who reads your problem statement, including you, understands what will be different when the problem is solved and your team agrees that it describes the correct problem.

HINT: Words like "anything," "everything," and "all" are red flags in a problem description. They start to set an expectation for results that are usually far broader than you intend and quite likely would be impossible to deliver.

Jeanne Sawyer is an author, consultant, trainer and coach who helps her clients solve expensive, chronic problems, such as those that cause operational disruptions and cause customers to take their business elsewhere. These tips are excerpted from her book, *When Stuff Happens: A Practical Guide to Solving Problems Permanently*. Find out about it, and get more free information on problem solving at her web site: www.sawyerpartnership.com.

On-Line BS in Quality Assurance Available

California State University, Dominguez Hills, is now offering on-line a Bachelor of Science in Quality Assurance either with or without a Measurement Science option.

The BSQA program blends studies of the basic sciences,

(Continued on Page 2)

On-Line BSQA(continued)

technologies, management principles, quality concepts and statistical tools needed to prepare students for careers in Quality Assurance, and enhance the careers of those already working in the Quality profession. For those students more interested in the technical areas of Quality, there is a Measurement Science option available.

Courses in both options include course such as Quality Improvement, Statistical Quality Control and Inspection, System Failure Analysis, and Value Based Quality. Additionally, the standard program offers courses in Manufacturing Processes, Quality Auditing, Safety and Reliability and Lean Manufacturing while the Measurement Science option includes Electrical Metrology, Measurement Uncertainty, Dimensional Metrology and Physical Metrology.

Admission requirements include a minimum of 56 credits and completion of all general education requirements of the California State University system with a 2.0 GPA and completion of one semester of college-level calculus.

For further information on this program, contact CSU at bsqa@csudh.edu or at 310-243-3880. You may also visit their web site at www.csudh.edu/bsqa/.

New York Residents Weigh In On Plans For 'Ground Zero' Site

By Robert Marton

Urban planning officials found out they had better be prepared for anything when they asked nearly 5,000 New Yorkers to scrutinize plans for rebuilding the World Trade Center "ground zero" site and the surrounding lower Manhattan area last Saturday, a process I was proud and excited to help facilitate.

I was one of a core group of facilitators recruited from across the country to help residents of the New York area review and provide feedback on six rebuilding plans. The diverse group of participants included family members of the nearly 3,000 people who died on September 11 at the WTC site, workers and residents of the area who survived the attacks, rescue workers and concerned residents from New York, New Jersey and Connecticut. The day-long "Listening to the City" event, held at the Jacob Javits Convention Center in Manhattan, was called the largest town hall meeting in history.

I was honored to be chosen as a facilitator. Facilitators were selected from thousands of applicants, and represented all 50 states as well as 20 foreign countries. For someone in my business, this was the ultimate challenge. In a very short period of time, we had to help almost 5,000 people absorb and understand six very complex plans, extract their views and opinions, and provide feedback to the planners, who were on hand anxiously awaiting the information.

The planners received some real surprises. None of the six plans was accepted in its entirety. The people liked some features from most of the plans, but they felt overall that the planners weren't bold enough in their designs and paid more attention to the re-establishing over 12 million square feet of commercial space than remembering those who died or the quality of life in lower Manhattan. They clearly wanted a grand and permanent memorial that would capture the world's attention, something similar to the great memorials we have in Washington. And they wanted a pleasant and affordable working and living environment.

I came away from the experience with a great appreciation for the resilience and determination of the people of the New York area. This was a very emotional experience for all of us. At my table I had a man whose wife worked, and died, on one of the upper floors of the north tower. Like many of the family members of those who died, he carries with him a laminated 8x10-inch picture of his wife wherever he goes. The first thing he did was show the picture to all of us at the table and tell us about his wife.

Another woman at the table escaped from one of the towers during the attack only to find that her apartment building, just south of the WTC site, was also damaged. Her family lived in temporary housing for months. She has been in therapy for months, dealing with "survivor guilt" syndrome.

There were lots of tears, but the tears didn't stop anyone from making sure their voice was heard. They assertively got their opinions across. There was a feeling that the great city of New York could accomplish anything.

While they didn't criticize each other, in typical New York style they didn't hesitate to take on the authorities. They expressed doubt that officials would take their desires into account. However, at a press conference following the meeting, officials pledged to reevaluate the plans, especially the requirement to duplicate the amount of commercial space previously located at the WTC.

I believe the planners have to respond to the concerns expressed by the residents. You can't ask 5,000 New Yorkers for their opinions and then ignore them. Especially about this issue.

This experience has had a profound effect on me. Everyone at my table knew someone who died in the attacks or knew families that suffered losses. It was a shared emotional experience unlike anything I've ever encountered. I felt honored that they were willing to share their lives with me. These are the toughest people I've ever met.

Laurel resident Robert Marton is a business development manager for Honeywell Technology Solutions in Columbia and an organization development consultant in private practice.

Special Thank You

As always, the Section would like to recognize those members who serve as assistant proctors for the various certification examinations. For the October 2002 set of CQ Manager, CRE, CQT, CMI and Six Sigma examinations, held at CCBC-Catonsville, the Section was fortunate to have **William (Scotty) Scott** and **Michelle Bandy** assist Chief Proctor **Maria Burness**. The Section thanks each of these members for giving up a Saturday morning to assist with this important task.

Statistical Thinking
Applying SPC (Statistical Process Control) to Prevent Long-Term Affects of Type I and II Diabetes

By John W. Jennings III; Dr. Arline S. Yen, MD; Dallas Diagnostic Assoc.

Key Words
Control, Statistical Thinking, factors, SPC (Statistical Process Control)

Summary

This paper will demonstrate the use of Statistical Thinking and SPC to monitor and assist in the control of blood sugar level variation in Type I and Type II diabetics. It will compare the use of daily blood sugar averages as an acceptable method to measure blood sugar variation, as compared to HbA_{1c} blood sugar test. The charts shown were generated using Microsoft Excel.

Introduction

I have been a Type II diabetic for 25 years and in the quality field for 20 of those years. I am a Senior Member of ASQ and current Awards Chair for the Inspection Division. While teaching SPC at a local community college, I realized that SPC might be used to monitor my blood sugar control process. I also realized that the Statistical Division Vision of "Statistical Thinking Everywhere" would compliment the assumption.

Type I and II diabetics control their daily blood sugar levels by taking blood sugar readings with a home monitoring device and adjusting their various body system process factors, such as, medication, stress, exercise or food intake, to achieve control of their blood sugar levels. They usually have daily goals set by their doctors that control their daily adjustments. During this process adjustment phase the patient will identify various foods to avoid, usually those with high fat and/or carbohydrate content, or in other words – the ones that just taste good!

SPC has typically been associated with manufacturing processes. The main function of **SPC** is to provide a means to monitor a process and analyze the variation within the process. If there are no special variations present, then the process is in statistical control. The main purpose is to identify and eliminate special (assignable) causes of variation. It can also help reduce normal random process variation.

Statistical Thinking supports SPC diabetic blood sugar control by three basic assumptions:

- All work occurs in a system of interconnected processes,
- Variation exist in all processes,
- Understanding and reducing variation are keys to success

Several studies have shown that intense control of the blood sugar levels result in putting off diabetic complications; heart attack, blindness, kidney failure, etc. for 10-15 years. The **SPC** charts can provide visual means to understand and reduce the variation in daily blood readings and assist in obtaining tight control.

Type I and Type II Diabetes

Insulin is the "magic key' that converts the blood sugar into cell nutrients. Diabetes is a condition where the pancreas does not provide the correct amount of insulin to be used by the body's cells, or the cells have lost their sensitivity to

insulin or both. The 16 million people affected with this condition are divided into two types. Type I diabetes, (Juvenile) formerly called insulin-dependent diabetics whose pancreas no longer produces insulin and take insulin injections. Type II (Adult On-set) diabetics that control their blood sugar levels by modifying their diet, exercising, and/or taking oral diabetes medications; a significant number, however, take insulin injections also. Both Type I and II use a home monitoring device to measure their blood sugar levels 2-4 times a day. They maintain a 'log' of the readings to evaluate the level of **control** they have over their body's blood sugar assimilation process.

Studies on Type I and Type II Tight Control

In 1993, the landmark Diabetes Control and Complications Trial (DCCT), showed clear evidence of the importance of controlling glucose levels in people with Type I diabetes. Diabetic complications; heart attacks, retinopathy (blindness), kidney failure, amputation, and neuropathy (loss of feeling in feet and legs) were found to be delayed by 10-15 years by achieving tight control of their glucose levels. It was suspected that the same results would be applicable to Type II diabetics, but no proof existed. A 20-year study called the United Kingdom Prospective Diabetes Study (UKPDS) ending in 1997 provided that proof. The final outcome of both studies showed the major benefits of tight **control** of blood sugar levels in both types of diabetics.

SPC and Blood Sugar Control

A diabetic's **control** of their blood sugar is similar to a process with a 'special cause', the blood sugar/insulin interaction does not occur automatically as with non-diabetics. Most diabetics manually track their daily blood sugar levels and modify their food intake, exercise and/or insulin injections based on those readings. **Control** is dependant on the 'data spread' and the overall average of the blood sugar levels. The overall average 'X-Double bar' and 'Sigma' (standard deviation) of the blood sugar readings would be the key parameters to track. Most insulin dependant diabetics have not been trained to use statistical tools such as **SPC**, (Statistical Process Control) so they work with their doctors to establish a 'range' to maintain their readings, usually LSL = 80 and USL = 180, so that the X-Double Bar would be 130. They may start with 4-5 readings a day, then progress to two or three as the 'process' becomes controlled. This controlled process should have only 'random variation' and conforms to a 'six sigma' data spread, unless some other **'factor'** is 'out-of-control'.

HbA_{1c} Blood Sugar Test

The transfer of oxygen in the body is accomplished by Hemoglobin, the protein in red blood. It bonds with oxygen transporting it throughout the body and releasing the oxygen when it reaches its destination. cell. The hemoglobin test, also called the HbA_{1c} Test, measures the percent of hemoglobin molecules Hemoglobin also bonds with glucose, which remains bonded to the hemoglobin for the life of the red blood bonded to glucose. Target level for normal function is less than 7%. The test shows the general condition of blood sugar levels for the previous three months. This provides a 'calibration' standard to compare three-month average home meter test.

Using Process Development

The classic process development cycle is:

Process Design
Process Capability
Variation Control
Optimization
Change Control

Process Design:

The design of a diabetic blood sugar control process is done through coordination with the doctor, patient and a dietician. The doctor will prescribe the medication required, the dietician will help plan and educate the patient on correct diet planning. All of this is based on the severity of the diabetes. The hard part is the patient changing their current life-style in favor of a rigorous manually controlled process.

Process Capability:

The capability of a process (Cp) is the process specification spread divided by the process six sigma spread. Referring to Figure 1, I measured my Process Capability by this calculation; Cp = (80-180)/(6*21) = 100/126 = 0.79. To be capable the ratio must equal or exceed 1.0. Since the control limits were beyond the specification limits, my current

control process is not capable of operating within the specifications. The key factor is the Standard Deviation (21), it defines the spread of the process data. My blood sugar variation control process is then 'defined' by the 'Sigma' of my blood sugar readings.

NOTE: Your doctor, based on your history, sets the process specifications.

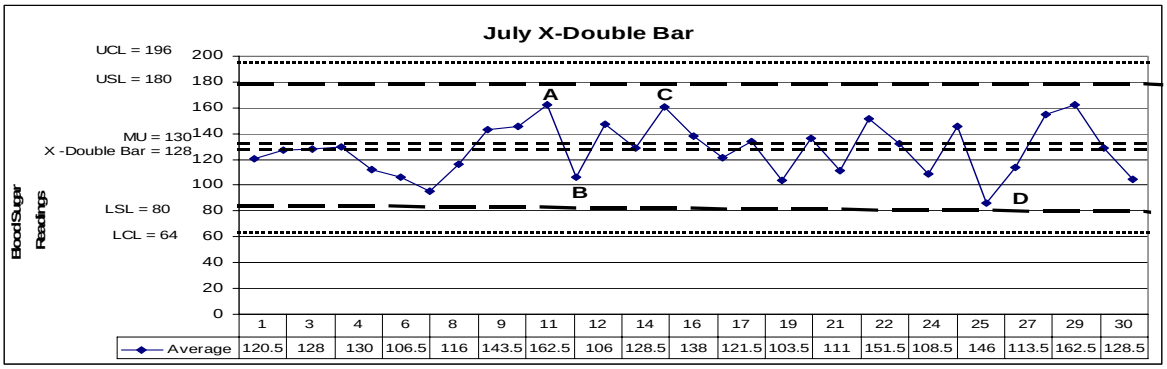


Figure 1 -- Variation Control:

Identification of the key process control factor is the most important phase of process control. The factors may be diet, exercise, weight lose, or medication. I decided to use a monthly time frame for my data analysis. Figure 1 is a chart of my average (two samples per day) readings for the month of July 1999. I targeted the points with the widest variation for analysis. Point A occurred on a Sunday when I exercised very little and was a 'Couch Potato', most of the day. My Sunday afternoon reading was high; I either exercised at night or increased my medication based on the doctor's sliding scale chart given to me. Point B shows the results of my corrective action. Point C was a reoccurrence of a high reading. D is a low reading point that also requires investigation because low readings can cause insulin shock, which can cause symptoms similar to drunkenness. An adult brain normally extracts about 60 to 80 milligrams of glucose per minute from circulating blood. If there is not enough glucose available for an extended period of time, it can result in coma, severe memory loss, disability and even death.

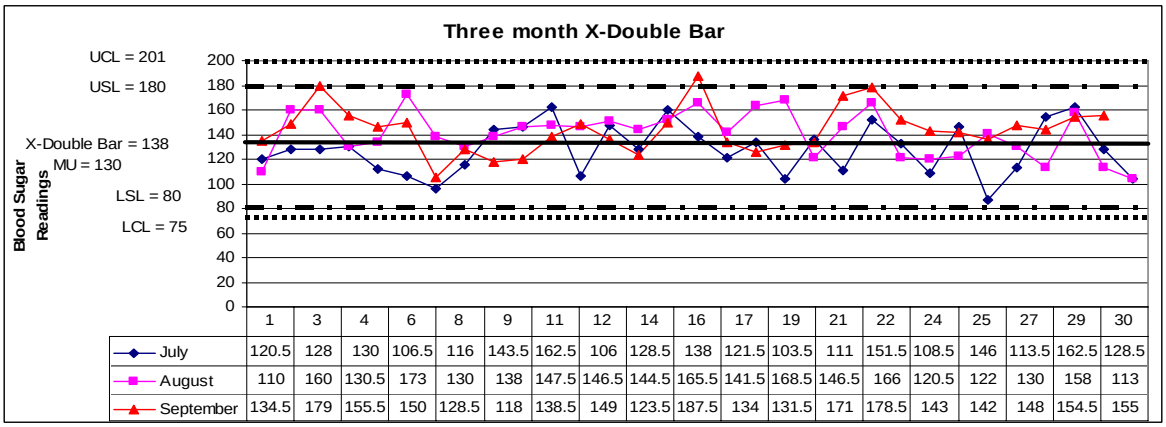
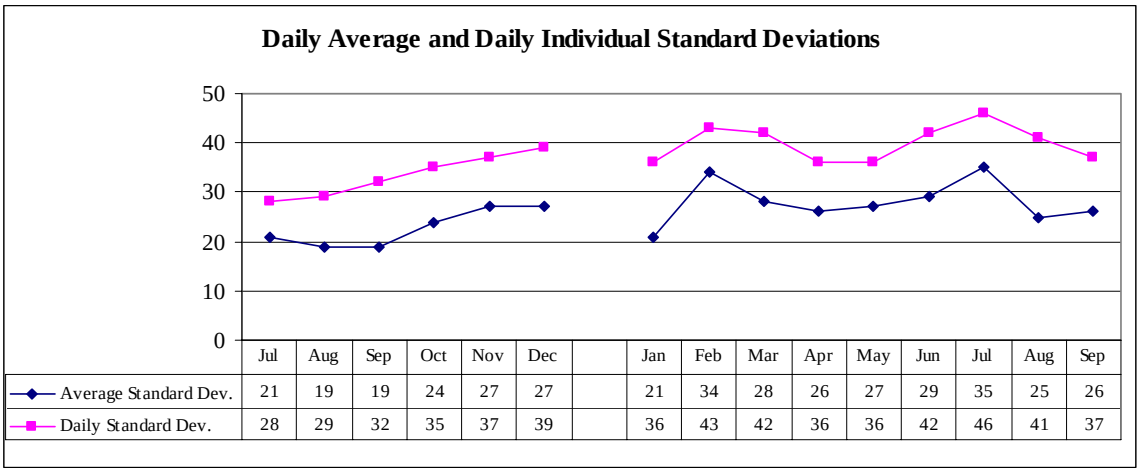


Figure 2

Figure 2 is a three-month SPC chart of daily blood Sugar average (Sample = 2) readings. To validate the results the three-month X-Double Bar value was compared to lab results of the HbA_{1c} Test. The test results were 6.7%, which equates to 137. The value of the three months X-Double Bar is 137.6, so the results were great. This 'calibration' process usually falls within a 10% range. Home meters use samples of blood from capillaries and labs use blood from veins. This will result in a certain amount of difference even if the samples are taken at the same time, but the difference should be small if you have fasted for at least eight hours.



	Jul	Aug	Sep	Oct	Nov	Dec		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Average Standard Dev.	21	19	19	24	27	27		21	34	28	26	27	29	35	25	26
Daily Standard Dev.	28	29	32	35	37	39		36	43	42	36	36	42	46	41	37

Figure 3

Figure 3 is a comparison of my Daily Average and Daily Standard Deviation Chart used to evaluate the 'Tight Control' of my process. In the past the 'Range' chart has been the standard used to show variation, mainly because of ease of calculation. The availability of automated data collection systems allows the use of Standard Deviation, which shows a better picture of the process variation. The Average Standard Deviation was calculated using the daily averages. The Daily Standard Deviation was calculated using the individual daily readings. My monthly average chart is used to detect any trends in the long-term control. It can be seen in Figure 4 that my monthly average reading is trending upward, so I need to review by factors and achieve corrective action. I have started exercising at night, staying more active during the day, controlling late night eating and cutting down on carbohydrates. My Sept. average is 156 as of the 23rd, so my corrective action is working.

Optimization:

The most important task at this point is to use the **factors** found in the Variation Control section to optimize the process control. This will help identify the various limits of the **factors** to establish a 'zone of control' that would show the maximum and minimum limits of the various factors. A paper in Quality Engineering [1] explained the use of DOE to determine the factor levels that would minimize the variation in glucose levels after exercise. Using a similar approach, can help determine how many calories can be consumed at one time, what the best times to eat and what are the best types of food to eat.

Change Control:

After optimization, you need to constantly monitor the major factors that determine control. For instance, if you plan to take a trip where eating on time may be an issue, changing time and quantity of medication regime, and/or carry glucose tablets to control low blood levels may be required to maintain control. Starting a new job can cause excessive stress and disrupt your normal control patterns.

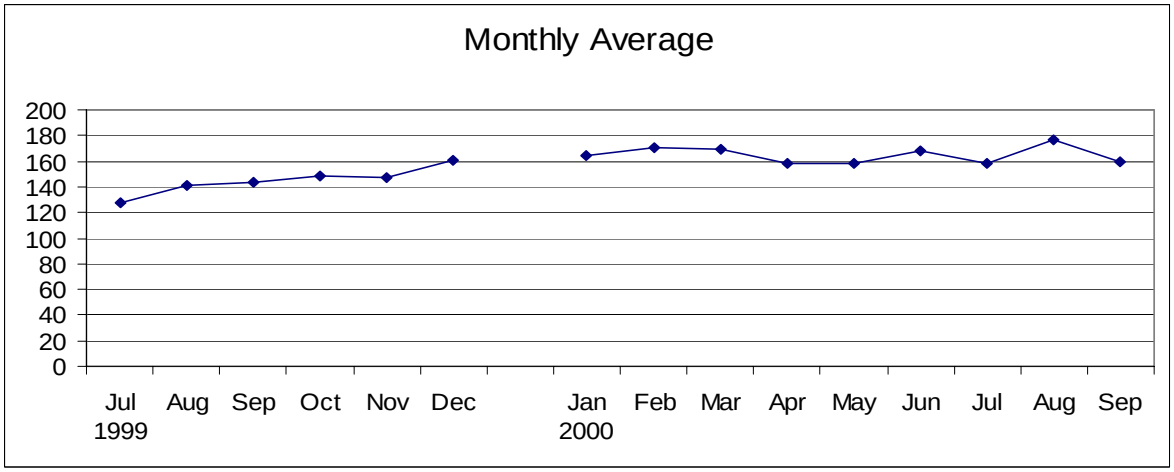


Figure 4

Future Trends:

A blood sugar meter worn by the diabetic that monitors the blood at variable time periods without skin penetration is being developed for use. The meter stores the readings to be downloaded at the doctor's office to show the daily picture of the patient's blood sugar readings. The doctor and patient can then modify the 'Process Factors' for optimum readings. Can a combination of this meter and an insulin pump be far away?

Acknowledgements:

I would like to thank my wonderful loving wife, Nicole for helping me live with diabetes and my doctor, Arline Yen for her assistance in reviewing the medical material in this presentation.

References:

1. *Quality Engineering, 12-(1), 83-87 (1999-2000); Designed Experiment to stabilize Blood Glucose Levels; Robert E. Chapman and Valerie Roof.*
2. *Dr. Arline S. Yen, MD; Dallas Diagnostic Association, 800 N. Shiloh Road, Garland, TX 75042*
3. *Diabetes Self-Management; R.A. Rapaport Publishing Inc. 150 West 22nd Street, New York, NY, 10011.*

What Is CMM, And Why Should You Care?

By Hillel Glazer

Seeking the stability and, thanks to the increased spending on Homeland Defense, the opportunity of government work, many software companies are facing a rude surprise called the "CMM."

What is CMM?

CMM stands for "Capability Maturity Model." Rather than a software development model, it's a software management model. The difference is that a development model is a way for programmers to code, test, deploy and build on their software. A management model is a way for software projects to plan, organize and identify what needs to get done to run the project, a way to gain insight into and control over the development, so you can predict and adjust project activities towards success.

Why did it come about?

In the 1980s a Standish Group study found that over 30% of all large software projects failed to be delivered and, of the remaining, nearly 80% failed to come in on time and budget. These figures account for the evidence that smaller companies' success rates were nearly twice as high as the success rates of larger companies. The research also indicated that most of the money in software development was spent on fixing buggy software, rather than on the initial development. In effect, only about 16% of all software projects surveyed were delivered on time, on budget and with the expected functionality, with most of it being developed by smaller companies.

To beat these odds, and to lower the overall cost of buying software, the Department of Defense funded the Software Engineering Institute (SEI) at Carnegie Mellon University to find ways to help defense contractors build software more economically.

The SEI defined "successful project" in terms of a project's ability to meet cost, schedule and quality objectives. "Quality" was defined as how many post-delivery corrections, fixes and upgrades were required before the product finally did what the customers expected. "Failed projects" were those that were cancelled or significantly overran cost, schedule or quality expectations. Instead of focusing on the mistakes, overruns and what not to do, the SEI focused on what the successful projects had in common. The result became the Capability Maturity Model, or CMM.

Today, the CMM is the de facto standard for software management throughout the government and is internationally recognized as a very powerful business tool and competitive differentiator.

What does it look like?

The SEI found that successful projects had specific key processes in common. Eighteen total key processes were organized into five maturity "levels." Level 1 is where most companies operate using undisciplined "ad hoc" processes, often relying on heroics to complete projects and rarely doing the same thing the same way twice.

Level 2 is called the "repeatable" level. "Level 2" companies are mature enough to re-use their processes to plan, estimate and execute projects. Six basic software development key processes are in level 2: Requirements Management, Project Planning, Project Tracking and Oversight, Subcontract Management, Quality Assurance and Configuration Management.

Companies providing custom software to the government are required to be assessed to level 2, and increasingly to level 3 -- called the "defined" level -- which has seven key process areas (KPAs). This article won't go into details of each level, but for

completeness, the remaining five KPAs are in level 4, "managed," and level 5, "optimizing."

Why should you care?
The first reason is above, the other reason is: competition. Your competition may already be applying the CMM. What if your competition not only institutes the industry's best practices, but reaps the benefits of doing it? Even though the CMM was developed based on "large and complex" software projects, its business value has been recognized by companies of every size and in every industry. Companies are using their CMM appraisals in their marketing strategies.

Another reason to consider implementing CMM: Software subcontractors to companies creating software for the government must either themselves be following CMM, or be covered by their client. In fact, all the parts of the software product delivered to the government must be following CMM. This means that either your client is covering for you and your lack of CMM, or they're going to ask you to follow it too.

What can you do?
Visit the Software Engineering Institute's web site (www.sei.cmu.edu) and obtain a copy of Mark Paulk's "The Capability Maturity Model: Guidelines for Improving the Software Process." Introductory CMM classes are offered by the SEI, and through one of many CMM consultants. CMM training is very important because nowhere in the model is there an explanation of how to implement it. Understanding how to make it work takes significant acclimation. This is where an experienced CMM assessor will be very helpful. The SEI's web site has a list of lead assessors and companies licensed to teach and perform CMM assessments.

What else?
Beyond merely getting government work, this model is a success-based model. Many companies, however, are turned off by what seems to be a major bureaucracy required to implement CMM. This results from the "large and complex" software project approach taken by many of the companies and consultants who implement and follow the CMM, not as a result of the CMM itself. Find a consultant that will help you implement what will work best for your company, whether it's CMM or not.

Rest assured, when you want to pursue developing software for the government, there are ways to implement the CMM, specifically, and disciplined processes, in general, that don't create a bureaucracy. Best practices should not blunt your competitive edge. Don't let anyone tell you that your business positioning or objectives must be sacrificed on the altar of process.

Hillel Glazer is the principal of Entinex, Inc., a technology development and business technology optimization consulting firm. He can be reached at 301-384-4203, or hillel@entinex.

New Calibration Technician Certification

Education and/or Experience:
Have five years of on-the-job experience in one or more of the areas of the Certified Calibration Technician Body of Knowledge (BOK).

If you have completed a degree* from a college, university, or technical school with accreditation accepted by ASQ, part of the five-year experience requirement will be waived, as follows (only one of these waivers may be claimed):

- Diploma from a technical or trade school—one year will be waived
- Associate degree—two year waived
- Bachelor's degree—two years waived
- Master's or doctorate—two years waived

**Degrees/diplomas from educational institutions outside the United States must be equivalent to degrees from U.S. educational institutions.*

Proof of Professionalism
Proof of professionalism may be demonstrated in one of three ways:

1. Membership in ASQ, an international affiliate society of ASQ, or another society that is a member of the American Association of Engineering Societies or the Accreditation Board for Engineering and Technology
2. Registration as a Professional Engineer
3. The signatures of two persons—ASQ members, members of an international affiliate society, or members of another recognized professional society—verifying that you are a qualified practitioner of the quality sciences

Examination
Each candidate is required to pass a written examination that consists of multiple-choice questions that measure comprehension of the BOK. The Calibration Technician examination is a one-part, 125-question, four-hour exam and is offered in English only.

Examinations are conducted in June and December. All examinations are open-book. Each participant must bring his or her own reference materials.

Calibration Technician Certification (CCT) BOK

Note Regarding IM&TE (inspection, measurement, and test equipment): The Test Specification Committee that created this BOK recognizes that different industries and branches of the military use various descriptors and abbreviations to refer to the units being calibrated. To avoid confusion, the committee decided to use the term IM&TE as the most globally descriptive term. This term will be used in both the BOK and the CCT examination itself.

I. **General Metrology** (30 Questions)

A. **Base SI Units** (Comprehension)
Describe and define the seven base units: meter, kilogram, second, ampere, kelvin, candela, mole.

B. **Derived SI Units** (Analysis)
Define and calculate various derived units, including degree, ohm, pascal, newton, joule, coulomb, hertz, etc.

C. **SI Multipliers and Conversions** (Application)
Define and apply various multipliers (e.g., zeta, kilo, deci, centi, milli) and convert between them (e.g., mega to kilo, micro to milli).

D. **Fundamental Constants** (Knowledge)
Recognize various fundamental constants and identify their standard symbols and common applications, such as *c* (velocity or speed of light in a vacuum), *g* (gravitational constant), *R* (universal gas constant), etc.

E. **Common Measurements** (Evaluation)
Describe and apply IM&TE in measuring the following: temperature, humidity, pressure, torque, force, mass, voltage/current/resistance, time/frequency, linear displacement, etc.

F. **Principles and Practices of Traceability**
Identify various aspects of traceability, including traceability through commercial and national laboratories and international metrology organizations. (Comprehension)

G. **Types of Measurement Standards** (Application)
Recognize and distinguish between various types of standards, including primary, reference, working, intrinsic, derived, consensus, transfer

H. **Substitution of Calibration Standards**
Determine when and how calibration standards are substituted based on measurement requirements, equipment availability, equipment specifications, etc. (Application)

II. **Measurement Systems** (25 Questions)

A. **Measurement Methods** (Evaluation)
Describe and use various measurement methods, including direct, indirect, ratio, transfer, differential, and substitution—i.e., replacing a reference standard device with a unit under test.

B. **Measurement Data** (Analysis)
Identify and respond to various measurement data considerations, including readability, integrity, confidentiality, resolution, format, suitability for use, etc.

C. **Characteristics of Measurements**
Define and distinguish between various measurement characteristics, including variability, sensitivity, repeatability, bias, linearity, stability, reproducibility, etc. (Comprehension)

D. **IM&TE Specifications** (Application)
Describe and use IM&TE specifications in terms of common descriptors (e.g., percent of full scale (FS), percent of range, parts per million (ppm) of reading, number of counts).

E. **Primary Error Sources** (Evaluation)
Identify and correct for various types of error sources that can affect measurement uncertainty, including drift, bias, operator error, environment.

F. **Measurement Systems and Capabilities**
Describe and distinguish between measurement systems and measurement capabilities. (Comprehension)

G. **Measurement Assurance Programs (MAPs)**
Identify and describe basic concepts of MAPs, including inter-laboratory comparisons, proficiency tests, gage R&R studies, etc. (Comprehension)

III. **Calibration Systems** (25 Questions)

A. **Calibration Procedures** (Comprehension)
Identify and define common components of calibration procedures, such as required equipment, ambient conditions, revisions, equipment listing, environmental restraints, etc.

B. **Calibration Methods**
Define and use common calibration methods, including spanning, nulling, zeroing, linearization, etc. (Application)

C. **Industry Practices and Regulations**

1. **Industry-accepted practices**
Recognize various sources of industry-accepted metrology and calibration practices (e.g., published, manufacturer, ANSI). (Comprehension)

2. **Directives and mandates** (Application)
   Define and describe different types of calibration directives such as state and federal regulations, traceability and other requirements mandated by legal metrology, and guidance from national or international standards, and identify which rules or conventions take precedence in various situations.

D. **Control of the Calibration Environment**
   Define and describe various environmental parameters for humidity, dust levels, electrostatic discharge (ESD), temperature, vibration, etc., and their influence on the calibration function. (Application)

E. **Calibration Processes for IM&TE**

1. **Process flow** (Comprehension)
   Identify and describe the basic flow of IM&TE throughout the calibration process.

2. **Logistical information** (Comprehension)
   Identify various aspects of IM&TE logistical information, such as equipment identification, ownership, service history, process tracking, etc.

3. **Roles and responsibilities** (Comprehension)
   Identify various roles and responsibilities of staff such as technical manager, scheduler, quality manager, technician, etc.

4. **Scheduling** (Knowledge)
   Describe various IM&TE scheduling considerations, including calibration intervals, recalls, how overdue schedules are determined, steps in the notification process, etc.

F. **Manual and Automated Calibration**
   Recognize various issues related to developing, validating, and using both manual and automated calibration processes, including software-driven processes. (Comprehension)

G. **Systems Records and Records Management**
   Identify the importance of maintaining document control, confidentiality, and integrity in relation to various records (e.g., training records, audit results, uncertainty budgets, customer data) in both electronic and hard-copy format. (Comprehension)

H. **Reporting Results** (Application)
   Identify and distinguish between various types of calibration results reports, including certificates, test reports, labels, reports of nonconforming calibration, etc.

IV. **Applied Mathematics & Statisics** (20 Questions)

A. **Technical & Applied Mathematics** (Application)

1. **Scientific and engineering notation**
   Express a floating point number in scientific and engineering notation.

2. **English/Metric conversions**
   Convert various units of measurement between English and metric units, including length, area, volume, capacity, and weight.

3. **Ratios**
   Express ratios in terms of parts per million (ppm), percentage, decibels (dB), etc.

4. **Linear interpolation and extrapolation**
   Interpret tables and graphs to determine intermediate and extrapolated values.

5. **Rounding, truncation, and significant figures**
   Round and truncate a given number to a specified number of digits.

6. Number bases
   Convert numbers between various number bases (e.g., decimal, binary, octal, hexadecimal).

7. **Volume and area**
   Calculate volume and area of various geometric shapes (e.g., cube, sphere, pyramid, cylinder).

8. **Angular conversions**
   Convert between various angular units (e.g., degrees, radians).

9. **Graphs and plots**
   Determine the slope, intercept, and linearity of data sets.

B. **Applied Statistics**

1. **Basic statistical tools** (Application)
   Define and use basic statistics such as measures of central tendency (mean, standard deviation, etc.), sample vs. population, degrees of freedom

2. **Common distributions** (Application)
   Classify data distributions as being normal, rectangular, triangular, or U-shaped.

3. **Descriptive statistics** (Application)
   Calculate the variance, root mean square (rms), root sum square (rss), and standard error of the mean (SEM) for a data set.

4. **Sampling issues** (Knowledge)
   Recognize various terms, including acceptance sampling, sample size, sufficient number of points

V. **Quality Systems and Standards** (15 Questions)

A. Quality Management Systems

1. **System components** (Application)
   Define and distinguish between various components of a quality system, including organizational leadership, market and customer focus, organizational performance measures and analysis, employee training and development, continuous improvement models, etc.
2. **Procedures** (Comprehension)
   Identify various methods and tools used in the development, validation, improvement, and review of a quality system, including mission and goals, strategic planning, cross-functional teams, etc.

B. **The Seven Quality Control Tools** (Analysis)
Select and apply the basic quality tools: cause and effect diagrams, flowcharts/process maps, check sheets, Pareto diagrams, scatter diagrams, control/run charts, and histograms.

C. **Quality Audits** (Comprehension)
Define basic audit types (e.g., internal, external, product, process) and roles (e.g., auditor, auditee, client), and identify basic components of an audit (e.g., audit plan, audit purpose, audit standard) and describe various auditing tools (e.g., checklist, final report).

D. **Preventive and Corrective Action**
1. **Process improvement techniques** (Application)
   Determine and select areas for improvement using various quality tools (e.g., PDCA, confidence checks, brainstorming, mistake-proofing, fishbone diagram).
2. **Nonconforming material identification**
   Determine conformance status and apply various methods of identifying and segregating nonconforming IM&TE materials. (Evaluation)
3. **Impact assessment of nonconformances**
   Define and use various tools (e.g., reverse traceability, customer notification, product recall, calibration standard evaluation, root cause analysis) in response to out-of-tolerance conditions for IM&TE. (Application)

E. **Supplier Qualification and Monitoring**
Identify various activities used to qualify, monitor, and sustain approved suppliers. (Knowledge)

F. **Professional Conduct and Ethics** (Application)
Identify appropriate behaviors, such as those listed in the ASQ Code of Ethics, for various situations requiring ethical decisions.

G. **Occupational Safety Requirements**
1. **Hazards and safety equipment** (Knowledge)
   Identify potential hazards within the working environment (e.g., ventilation, mercury, lighting, soldering) and describe the proper use of personal protective equipment (PPE).
2. **Hazardous communications (HAZ-COM)**
   Identify and interpret various HAZ-COM directives (e.g., right-to-know (RTK), material safety data sheet (MSDS), material labeling). (Comprehension)
3. **Housekeeping** (Knowledge)
   Describe the importance of good housekeeping tools and methods (e.g., maintenance, cleaning).

H. **Quality Standards and Guides** (Comprehension)
Explain the benefits and importance of the following in relation to calibration: Quality standards such as ISO/IEC 17025, ANSI/NCSL Z540-1-1994, ISO/IC 10012, ISO 9000- 2000, etc.; Quality guides such as GUM, ANSI/NCSL Z540-2-1997, VIM, etc.; Accreditation and registration boards such as NVLAP, A2LA, IAS, LAB, RAB

VI. **Uncertainty** (10 Questions)

A. **Uncertainty Budget Components** (Application)
Identify various type A and type B uncertainty components, including environment, human factors, methods and equipment, item under test, reference standards, materials, etc., and identify the key elements of developing an uncertainty budget.

B. **Uncertainty Management** (Knowledge)
Define basic terms, such as guardbanding, test uncertainty ratio (TUR), test accuracy ratio (TAR), bias, error, percent of tolerance, etc.

C. **Uncertainty Determination and Reporting**
Identify and use various methods to determine and report measurement uncertainty, including combined and expanded uncertainty, weighted factors, explanatory graphics, coverage factors, confidence levels, effective degrees of freedom, etc. (Application)

Certification Exam Schedule

Examination	Application Date	Exam Date
CQT/CRE/CMI/ SSBB/HACCP/ Biomedical/ Quality Mgr.	January 10, 2003	March 1, 2003
CQE/CQA/ CSQE/CQIA/ CCT (Pilot)	April 4, 2003	June 7, 2003

Bullets From the Board Meeting

The following are bullet points from the November 7-8, 2002 ASQ Board of Directors Meeting.

- ***Dr. Madhav N. Sinha Named Recipient of Distinguished Service Medal.***
- ***18 Named ASQ Fellows.***
- ***Board Agrees on Strategic Direction.***

The Board approved strategic direction for the Society. The eight prioritized themes are:

1. Support the quality profession in its efforts to grow in value in the workplace and community
2. Assure workplace value for members and customers.
3. Prove the Economic Case for quality
4. Assure a vital, growing body of knowledge accessible to everyone
5. Ensure that ASQ becomes a "community" of choice
6. Promote the importance and value of quality worldwide
7. Provide support for people who believe quality can make a difference in the world
8. Grow the use and impact of quality in every segment of the economy

- ***Funds, Policy Approved for "Good Works" Initiative.***

The Board passed policy governing an ASQ community-based initiative that uses matching grants and knowledge transfer to improve local communities and creates a body of evidence that documents the value of quality.

- ***Joint ASQ/AQP Membership Studied***
- ***Koalaty Kid, Education Initiatives Momentum Continue.***

Over 240 organizations now belong to the Koalaty Kid Alliance; 59 new schools were trained through Koalaty Kid in the past year; and there were three Education Baldrige winners. Also, the educational environment is changing with state-mandated school improvement plans and federal legislation in "No Child Left Behind" program that require accountability and measuring improvement. The new draft vision: *Lead continuous improvement in education*. The new draft mission statement:: *Lead the educational community by providing quality information, methods, and resources to continuously improve student achievement and organizational performance.*

- ***Major Integrated Communication Campaign Proposed.***

A communication campaign that incorporates activities at three levels—grassroots or membership, enhanced public relations efforts from headquarters, and a multi-media image advertising campaign—was presented to the Board for consideration. The first tier features successful case studies of grassroots community involvement by both sections and sustaining members. The second tier encompasses increased public relations activities including advocacy white papers, enhanced web site, media tours, video, leadership speaking and awareness articles. The third tier is an image advertising campaign in print, television and radio. The Board recommended that the campaign be focused on ASQ making a difference. The Board approved a new advertising/promotion tagline: ***Real tools Real people Real results.***

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