ASQ STATISTICS DIVISION Newsletter ©

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Welcome from Geoff Vining, Division Chair

by Geoff Vining

It is a great privilege to serve the division this year as the Chair. Mark Kiel did a wonderful job last year. He has passed the division to me in very good shape.

I am grateful for the talented people who form the core of our leadership team. Gordon Clark is our Chair-Elect and also our Fall Technical Conference (FTC) representative. He has done a great job with this year's FTC program. Doug Hlavacek is doing a great job as the division's secretary. Daksha Chokshi has just started her term as the Treasurer. Frankly, the hardest jobs in the division are Secretary and treasurer. We are fortunate to have such talented people in these roles. Scott Kowalski is our Vice-Chair for Products and Services. Jonathan Andell is our Membership Chair. Brian Sersion is doing a wonderful job as the Newsletter Editor, which is another thankless job, especially when the new Chair is chronically late with his contributions.

The leadership committee has spent a great deal of time on planning for the division's future. In March, we gathered in Jacksonville, Florida to develop a strategic plan for the next five-year horizon. We started by considering the history of the Statistics Division. We next considered who the division's "audiences" are. We felt that audience was a better term than customer stakeholder. Our brainstorming clearly indicated that our primary audiences are industrial statisticians/analysts and practitioners. We reaffirmed that the primary level for our products and services should be aimed primarily at an intermediate level. We also reaffirmed that we need to serve the beginning and advanced levels. Ultimately, we saw the need for our more advanced members to share their knowledge and experience with our other members. As our conversations continued, it became clear that the division's focus should be on data-driven decisions guided by statistical thinking.

Our new Vision is: Data Driven Decisions through Statistical Thinking. Our aspiration is to be the recognized forum that advances data-driven decision making through statistical thinking. Our missions are:

- Advance data driven decision making through statistical thinking
- Improve the public's perception and understanding of statistical thinking and data driven decisions.
- Be the source for the statistical components of the ASQ body of knowledge
- Support the growth and development of ASQ Statistics Division members
- Increase the credibility, marketability, and influence of ASQ Statistics Division members.

We decided that we needed to focus our efforts over the next five years in the following areas:

- Body of Knowledge
- Communication
- Voice of the Customer
- Data Driven Decisions

In terms of the Body of Knowledge, our basic goals are: 1. to understand what it is, 2. to organize the current resources within the division, 3. to disseminate these resources via the web, 4. to keep these resources current, and 5. to partner with ASQ headquarters. Our primary mechanisms for communicating with our members are

Continued on page 3

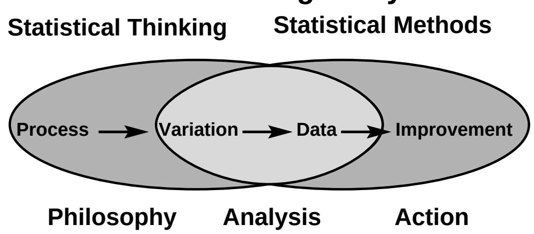
Inside This Issue

MISSION

- Promote Statistical Thinking for quality and productivity improvement.
- Serve ASQ, business, industry, academia, and government as a resource for effective use of Statistical Thinking for quality and productivity improvement.
  - Our primary customers are Statistics Division members.
  - Other key customers are:
    - Management
    - Users and potential users of Statistical Thinking
    - Educators of the above customers
- Provide a focal point within ASQ for application-driven development and effective use of new statistical methods.
- Support the growth and development of ASQ Statistics Division members.

VISION

Statistical Thinking Everywhere



DESIRED END STATE

- Our members will be proud to be part of the Statistics Division.
- Our Division's operations will be a model for other organizations.
- We will be a widely influential authority on scientific approaches to quality and productivity improvement.

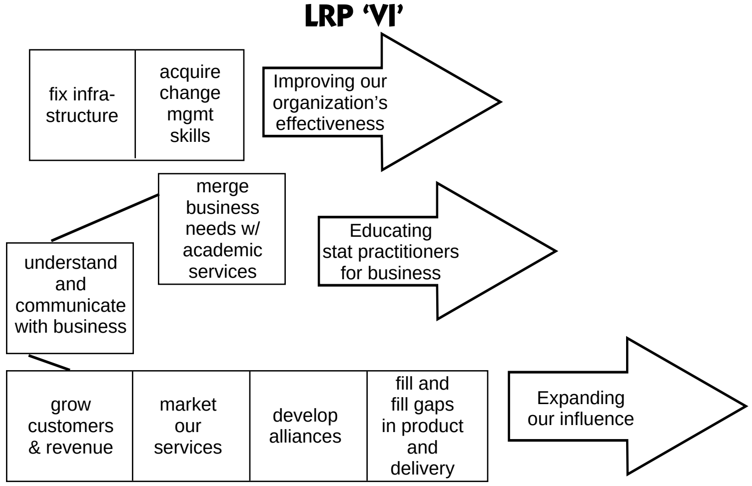
PRINCIPLES

- Our customers' needs will be continuously anticipated and met (i.e. Customer focused rather than customer driven).
- Our market focus for products and services is weighted as follows:
  - Greatest weight on intermediate level.
  - Nearly as much weight on basic level.
  - Much less weight on advanced level.
- Focus on a few key things.
- Balance short-term and long-term efforts.
- Value diversity (including geographical and occupational) of our membership.
- Be proactive.
- Recognize that we exist for our customers.
- View statistics from the broad perspective of quality management.
- Apply Statistical Thinking ourselves; that is, practice what we preach.
- Uphold professional ethics.
- Continuously improve.

STRATEGY

- Improve our organizational effectiveness
- Educate statistical practitioners for business
- Expand our influence

LRP 'VI'



MEETING GROUND RULES

- Respect and listen to all participants.
- No speeches.
- No "side-bar" discussions.
- Decisions by consensus, if possible.
- We will be open and honest, even if it hurts.
- Support your ideas, don't defend them.
- We will delegate word-smithing to small groups.
- All help facilitate, although we will have a formal leader, facilitator, scribe, and timekeeper (including at breakouts).
- We will rotate scribes.
- We will keep a separate flipchart for To-Do's.
- Mission, Vision, Principles, Strategy, Ground Rules should be visible.

Disclaimer

The technical content of material published in the ASQ Statistics Division Newsletter may not have been refereed to the same extent as the rigorous refereeing that is undergone for publication in **Technometrics** or **J.Q.T**. The objective of this newsletter is to be a forum for new ideas and to be open to differing points of view. The editor will strive to review all articles and to ask other statistics professionals to provide reviews of all content of this newsletter. We encourage readers with differing points of view to write to the editor and request an opportunity to present their views via a letter to the editor. The views expressed in material published in this newsletter represents the views of the author of the material, and may or may not represent the official views of the Statistics Division of ASQ.

Criteria for Basic Tools and Mini-Paper Columns

Basic Tools

Purpose: To inform/teach the "quality practitioner" about useful techniques that can be easily understood, applied and explained to others.

Criteria:

1. Application oriented/not theory
2. Non-technical in nature
3. Techniques that can be understood and applied by non-statisticians.
4. Approximately three to five pages or less in length (8 1/2" x 11" typewritten, single spaced.)
5. Should be presented in "how to use it" fashion.
6. Should include applicable examples.

Possible Topics:
New SPC techniques
Graphical techniques
Statistical thinking principles
"Rehash" established methods

Mini-Paper

Purpose: To provide insight into application-oriented techniques of significant value to quality professionals.

Criteria:

1. Application oriented.
2. More technical than Basic Tools, but contains no mathematical derivations.
3. Focus is on insight into why a technique is of value.
4. Approximately six to eight pages or less in length (8 1/2" x 11" typewritten, single spaced.)
   Longer articles may be submitted and published in two parts.
5. Not overly controversial.
6. Should include applicable examples.

General Information

Authors should have a conceptual understanding of the topic and should be willing to answer questions relating to the article through the newsletter. Authors do not have to be members of the Statistics Division.

Submissions may be made at any time to the Statistics Division Newsletter Editor. All articles will be reviewed. The editor reserves discretionary right in determination of which articles are published.

Acceptance of articles does not imply any agreement that a given article will be published.

Past Chair's Farewell

by Mark Kiel

This past year has been a year of many changes in the Statistics Division. We started off the year with a very aggressive agenda, new and innovated products, new awards, and some new members in the leadership team. All have come to pass and are continuing to mature. I'm happy to say in a survey recently conducted by ASQ, the Statistics Division was rated the Division with the highest member value. This has been our agenda for the past several years and it's gratifying to see the members are responding to the leadership's efforts.

Some of the changes included a new "Mission" and "Vision" for the division, looking toward the new direction of ASQ. A new FTC contract, broader in scope with the Statistics Division and equal partner with ASA Sections on SPES & Q&P along with ASQ CPID, was also negotiated this year.

The Statistics Division over the last several years has embraced the new age of the Internet and has moved to maximize its ability to serve our members. Hopefully, ASQ will allow us to lead our members into fully utilizing its abilities. We will not wait for the rest to catch up.

I want to thank all of the leadership team in their support during this year, especially Bob Mitchell and Davis Balestracci for their help and guidance as past chairs of the Division. The Statistics Division will greatly miss Bob Mitchell's involvement in future years, unless we can talk him into a new position in the Division to use up his spare time. Any leadership group in the Division would be amiss if they didn't ask his advice on Division leadership matters. I want to thank Marcey Abate for all her years of service to the Division along with Doug Hlavacek, Scott Kowalski, Gordon Clark and Jonathon Andell. A group of leaders second to none. I want to send a special thanks and farewell to Laura Augustine, the Division's McDermond Chair who I know will be successful in any new endeavor. She took a very thankless job, but important, and moved it to a higher level.

Geoff Vining, the new chair, has hit the ground running. I know we're in capable hands as he starts the new year with the same great team. His management skills, his thousands of contacts in the Statistical world, and his knowledge of the Division will keep us moving forward.

And finally, I want to express my gratitude to everyone for their support and sympathy of my wife's illness and passing this past year. It was a trying time for my family and I. But I found that not only are the members of this division colleagues, officers and committee chairs, they are also friends.

Editor's Corner

by Brian Sersion

As we go through our lives, we commonly encounter things that peak our interest. As an example, while studying for the CQE credential, I became interested in Quality Function Deployment and Reliability Analysis. This interest led me to study these subjects in further detail. Recently, I was reviewing articles submitted for the Fall Newsletter and I found my interest peaked. I came across an article entitled *Availability* so off I went to my reference shelf; first stop, Juran's Quality Handbook. Unfortunately, the one page theoretical description that I found on the subject did not meet my needs. I wanted to learn more. What I needed was a practical discussion of how this subject is applied in the workplace. Where do the Stats meet the Street? I found the answer in this Fall's Newsletter Mini-Paper.

The thing that I liked most about *Availability*, by Dr. Jorge Romeu, is that it brings together many of the concepts that I learned in a variety of somewhat disconnected courses taken during my MSQA studies. In addition, it brought back fond memories of my time at the University of Cincinnati; excluding Markov models of course. As a result of reading this applied statistics Mini Paper, I learned a lot about availability and how it is used in the workplace in the areas of design reliability and maintainability. This paper was originally published through the Reliability Information Analysis Center in a series of papers known as START (Selected Topics in Assurance Related Topics) sheets (Volume 11, Number 6). More information is available at the following URL; http://quanterion.com/riac/index.asp. Dr. Romeu is a Senior Engineer with Alion and a Research Professor at Syracuse University.

So if you're like me, sit back, relax, and take a nice trip back to your alma mater. I hope you will learn something as well . . . but beware of those Markov models.

CHAIR'S MESSAGE

Continued from page 1

the newsletter, e-zines, and the webpage. We see the need to solicit input from our members, from other divisions, and from other general audiences. Finally, we need to determine how we can advance data driven decisions and how we can broaden our audience.

In May at the World Conference, we held our tactical planning meeting for the upcoming year. In this meeting, we reviewed the new strategic plan and made basic decisions as to what activities we need to pursue this year to advance that plan. Specific activities are:

- To develop a series of narrated PowerPoint presentations. These presentations are usually 15-20 minutes in length and provide basic tutorials on topics of interest to our audiences. Scott Kowalski, our Vice-Chair for Products and Services, is in charge of this program. Please feel free to email Scott at SKowalski@minitab.com with any ideas or suggestions.
- To make all Statistics Division Newsletters and Special Publications searchable from our website.
- To establish an inventory of the Body of Knowledge on our website.
- To offer a special publication this year.
- To conduct informal interviews of our members at the World Conference booth and hospitality suite. We plan to continue these interviews at the FTC.
- To develop a World Conference session on Data Driven Decisions.
- To approach the Quality Management Division about areas for co-operation and possible partnerships.
- To pursue linkages with our co-sponsors of the FTC: SPES, Q&P, and CPID.
- To bring good new people into the Council who can assume major leadership roles in the near future.

The Statistics Division Council recognizes that our objectives are ambitious, but we feel confident that we can make significant strides in these areas. The division's leadership is very excited about serving our members and we look forward to a productive and fruitful year.

MINI PAPER

Availability

by Dr. Jorge Romeu

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Introduction

There is a fundamental difference between the approaches used to perform statistical and reliability analyses of non-maintained (some times called "one-shot") and those used for maintained systems. Non-maintained systems either fulfill their missions (by surviving beyond mission time) or fail it (by perishing before the mission is completed). In contrast, maintained systems can be repaired (maintained) and put back into operation. During "maintenance," however, the system is "down" and unavailable for its intended use. This situation changes the analysis approach because maintenance introduces the related and new concept of "availability" (that the system will be "up" and "available" for use, when needed, in lieu of undergoing maintenance). The main objective of this START sheet is to help engineers better understand the meaning and implications of the statistical methods used to develop performance measures (PM) for assessing system "availability" (A).

We start by reviewing some relevant definitions. RAC's Reliability Toolkit defines availability as "a measure of the degree to which an item is in an operable state at any time." It defines "maintainability" as "a measure of the ability of an item to be retained in, or restored to, a specified condition, when maintenance is performed using prescribed procedures and technician skill levels."

From these definitions, we can deduce that system availability is a probabilistic concept. It is based on the system life (X), a random variable (RV). Since the system can fail at any random time, availability is also based on a second RV: the maintenance time (Y). We calculate their "long run averages" (i.e., results obtained as time goes to infinity, $t \to \infty$) or "expected values" and denote them respectively E(X) and E(Y). E(X) is the expected system life or the up time, often measured as "Mean Time Between Failures" (MTBF). E(Y) is the expected maintenance time (which includes the activities of fault isolation, repair or removal and function check), often measured as "Mean Time To Repair" (MTTR).

The random nature of system life (X) and maintenance times (Y) demands the use of statistics for obtaining system PM. Therefore, we need to redefine Availability in statistical terms. Hoyland et al (Reference 1), for example, define "availability at time t", A(t), as "the probability that the system is functioning at time t". If we call X(t) the "state" of a system at time "t" (which can be either "up" and running [X(t) = 1], or "down" and failed [X(t) = 0]), then this definition of A(t) can be written as:

$$A(t) = P\{X(T) = 1\};\ t > 0$$

The availability concept becomes even more complex when we realize that it is divided into several classes. For example, Blanchard (Reference 2) states that "availability may be expressed differently, depending on the system and its mission" and defines three types:

1. Inherent availability (A_i) is the probability that a system, when used under stated conditions … will operate satisfactorily at any point in time, as required. A_i excludes preventive maintenance, logistics, and administrative delays, etc.

$$A_i = \frac{MTBF}{MTBF + MTTR}$$

2. Achieved availability (A_a) is the probability that a system when used under stated conditions … will operate satisfactorily at any point in time. A_a includes preventive maintenance but excludes logistics and administrative delays, etc.

3. Operational availability (A_o) is the probability that a system when used under stated conditions … will operate satisfactorily when called upon. A_o includes all the fac-

tors that contribute to system downtime for all reasons (i.e., maintenance actions and delays, access, diagnostics, active repair, supply delays, etc.). We call it Mean Down Time (MDT).

$$A_o = \frac{\text{MTBM}}{\text{MTBM} + \text{MDT}}$$

Notice that, as opposed to A(t), these formulae do not include any reference to a random time "t". The reason is that they are based on the "long run averages" of the system life (X) and maintenance times (Y) and, hence, about the "long run average" (or expected) Availability. To better understand this statistical concept, consider the whole cycle of "up-time plus maintenance" (i.e., X + Y). The cycle repeats itself again and again, throughout the entire system life, and constitutes the "totality" of possibilities for the RV system state X(t) within a single cycle. Now consider "system up-time" (X(t) = 1) as our "event" of interest. Since the probability of any "event" is defined as the ratio of its "favorable" to its "total" possibilities, we can state that the "long run availability" A is:

$$A = P(\text{System Up}) = \frac{\text{Favorable Cases}}{\text{Total Cases}} = \frac{\text{Up Time}}{\text{Cycle Time}}$$

$$\cong P(X(t) = 1);\ \text{as } t \to \infty$$

Since we are not interested in the "up-time" during a specific cycle but in the long run ($t \to \infty$), we substitute Up (X) or Down (Y) times by their respective long run averages, E(X) and E(Y). For example, if a system has MTBF = 500 hours and MTTR = 30 hours we obtain:

$$A = A(\infty) = P\{X(\infty) = 1\} = \frac{E(X)}{E(X) + E(Y)}$$

$$= \frac{\text{MTBF}}{\text{MTBF} + \text{MTTR}} = \frac{500}{500 + 30} = 0.9433$$

Finally, we must select which Availability definition we want to discuss. The three classes of "availability" differ only in their respective definition scope. For example, in A_i, Inherent Availability, the average up-time (MTBF) includes only design and manufacturing failures, and the average maintenance (MTTR) only includes active repair time. In Operational availability, average up-time (MTBM) includes all downing events, whatever the cause (e.g., design or manufacturing failure, induced failure, preventive maintenance event, etc.), and average maintenance (MDT) includes all possible downtime (Reference 3).

Without diminishing the practical importance and impact of the differences, the conceptual treatment of availability, from a strictly statistical point of view, is similar in all these cases. Their parameters, "expected values" (and perhaps even the distributions of the variables involved) may change, and with them, also the interpretation and form of their results. However, such differences will not modify the basic statistical philosophy used for obtaining them, nor the concepts on which their approaches rest. Since the main objective of this START sheet is helping the engineer better understand such statistical philosophy and approaches, we will consider all three cases as a single one and adopt the nomenclature given previously for A_i when referring and dealing with availability.

In the remainder of this START sheet, we first overview and give numerical examples of the statistical treatment of the availability of a simple, repairable system in discrete times. Then, we will consider the case of a simple, repairable, parallel redundant system, comparing two different statistical modeling and analysis approaches. We will illustrate these approaches by developing more numerical examples, performing systems analyses, and comparing their results. Finally, we will mention several ways to improve system availability and provide additional bibliography for further study of these topics.

Statistical Models for Simple Systems (Up/Down) and Interpretation

In the Introduction, the "long run average" Availability was obtained as the ratio of the "long run averages" of Up-Time to Cycle Time. However, Availability is a (cycle) RV itself. Hence, like any other RV, it has its own distribution, density function, etc. In this section, we overview a statistical model that describes Availability (A) as the RV resulting of the algebraic combination of the RV "time between failures" (X) and the RV "time to repair" (Y), at every cycle. In the following section, we describe Availability as a two-state, discrete time Markov Chain. The objective for presenting two contrasting models is to enhance the understanding of different statistical approaches, so engineers can better use them and get meaningful results from their implementation. We will briefly illustrate their mathematical derivations using a practical example. In For Further Study, we reference documents that provide more in-depth information on the subject.

We start by defining random variable (cycle) Availability as the following ratio:

$$A_i = \frac{X_i}{X_i + Y_i};\ X_i, Y_i > 0, i = 1, \ldots, n$$

The problem of obtaining the "density function" or statistical description of A is resolved using a variable transformation of the joint distribution of the Availability (A) and of some other convenient function (denoted B), of time between failures X and time to repair Y, such as B(X, Y) = X + Y.

Assume that system times between failures and to repair (X and Y) are independent of each other and Exponentially distributed, with mean μ = MTBF = MTTR = 1 hour. Hence, their individual density functions are $f_1(X)$ = Exp (-X) and $f_2(Y)$ = Exp (-Y). Their joint density function, denoted f(X, Y), is just the product of the two individual Exponential densities, since both (failure and repair) times X and Y are independent of each other. Therefore:

$$f(X,Y) = f_1(X) \times f_2(Y) = \text{Exp}\{-X\} \times \text{Exp}\{-Y\} = \text{Exp}\{-(X+Y)\}$$

Define the (cycle) Availability function A(X, Y) = X/(X + Y). Define auxiliary function B(X, Y) = X + Y. Then, their inverse functions are X = W (A, B) = AB and Y = Z (A, B) = B (1 - A). Finally, obtain the matrix of the partial derivatives of the inverses W (A, B) and Z (A, B) and denote it J (W, Z). To derive the joint distribution g(A, B) of A and B, just substitute the values of X and Y in the original joint distribution function f(X,Y), with their inverses [X = W(A, B) = AB and Y = Z(A, B) = B(1 - A)] and multiply this by the absolute value of the matrix of the partial derivatives |J(W,Z)|=|B|. That is:

$$g(A,B) = f(AB; B(1-A)) \times |J(W,Z)|$$

$$= \text{Exp}\{-(AB + B(1-A))\} \times |B| = B\text{Exp}\{-B\}$$

This variable transformation yields the density of Availability. For, density function g_1 (A) of the resulting system Availability (A = X/(X + Y)) is just the "marginal distribution" of the above derived, bivariate density function g (A, B).

Hence, the desired marginal (Availability density) is obtained by integrating function g (A, B) out on B:

$$g_1(A) = g_1\left(\frac{X}{X+Y}\right) = \int g(A,B)dB = \int_0^\infty B\text{Exp}\{-B\}db = 1;$$

$$\text{for } 0 < A < 1$$

Hence, g_1 (A) = 1 is the theoretical density of Availability and corresponds to the density of the Uniform (0, 1). As a result, all performance measures (PM) of interest, such as the expected value, variance, percentiles, probabilities, etc., are now obtained from the theoretical Uniform (0, 1) distribution parameters. For the simple example given, where both times between failure (X) and to repair (Y) are distributed Exponentially with mean μ = MTBF = MTTR = 1, we obtain:

1. Expected Availability = E{Uniform(0,1)} = ½ = 0.5.
2. Variance of Availability = Var {Uniform(0,1)} = 1/12 = 0.083.
3. L_{10} = Percentile of 10% of Availabilities = P{A < 0.1} = 0.1.
4. First and Third Quartiles of Availability = 0.25 and 0.75.

The Uniform distribution is a special case of the Beta, which is the general distribution of Availability when the failure and repair times are exponentially distributed. Such theoretical results allow us to obtain empirically the Availability distribution via Monte Carlo (MC) simulation. To verify this for the results just given, we generate n = 5,000 Exponentially distributed random failure and repair times, X_i and Y_i, i = 1, …, n, with μ = MTBF = MTTR = 1. We then obtain the corresponding Availabilities $A_i = X_i/(X_i + Y_i)$, sort them, and calculate the n = 5,000 results numerically, via MC.

The Expected Value is obtained from the sample average (0.5067); the Variance, from the sample variance (0.0826). Percentile L_{10} (Availability achieved 90% of the times) and all other probabilities are obtained by manipulating the sorted ranks of the total number of data points "n", of the MC generated values. For example, L_{10} corresponds to the 500^{th} sorted rank (10% of the n = 5,000 MC data points) and yields a value 0.1048. The quartiles are 0.2558 and 0.7559. Empirical and theoretical results agree closely.

For Exponential means different than unit (μ = MTBF = MTTR ≠ 1) the mathematical treatment is more difficult and we use the Beta distribution, directly. For a more realistic example, we reuse the example of times between failure (X) with μ = MTBF = 500 hours, and to repair (Y) with μ = MTTR = 30 hours. We generate n = 5,000 random Beta values with parameters corresponding to the said failure and repair times and obtain the (cycle) MC Availabilities, A_i. Results are given in Figure 1 and Table 1.

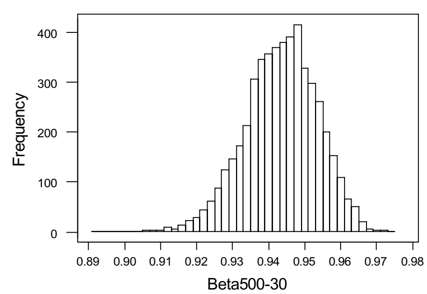


Figure 1. Histogram of Realistic Example

Table 1: Realistic Availability Results – MC Results for Beta (500,30) Example:

Average Availability	=	0.9435
Variance of Availability	=	9.92×10^{-5}
Life L_{10}	=	0.9305
Quartiles	=	0.9370 and 0.9505
P{A > 0.95}	=	0.2694

For example, the probability that the Availability is greater than value 0.95, P{A > 0.95}, is obtained by looking at the sorted rank corresponding to a MC Availability closer to 0.95: (A =

0.9499 → Rk = 3,653). Then, we divide this Rank by n = 5,000 and subtract it from unit:

$$P\{A > 0.95\} = 1 - P\{A \le 0.95\} \approx 1 - \frac{3,653}{5,000} = 1 - 0.7306 = 0.2694$$

Markov Models for Simple Systems (Up/Down) and Interpretation

Now, consider the previous problem, approached as a two-state Markov Chain (References 4, 5, 6, and 7). Here we monitor the "status" of the system at time T, denoted X(T), instead of its "availability" A(T). Denote State 0 (Down) and State 1 (Up), and assess the status X(T) of your system S every hour (T = 0,1, …). Hence, X(T) = 0 means that system S was Down at time T and X(T) = 1, that system S was Up at time T. We are interested in studying how the System S develops (transitions) over time. That is, we want to know what is the probability q (or p) that system S is Up (or Down) at time T, given that it was Down (or Up) an hour earlier (at time T - 1). We represent this problem using the Markov Chain state diagram shown in Figure 2.

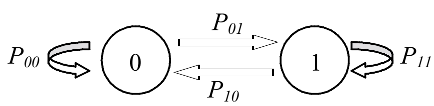


Figure 2. State Diagram for System S

The transition probabilities are:

$$p_{01} = P\{X(T) = 1 | X(T-1) = 0\} = q$$

$$p_{10} = P\{X(T) = 0 | X(T-1) = 1\} = p$$

$$p_{00} = 1 - q$$

$$p_{11} = 1 - p$$

For example, let system S be Down at time T - 1. Then, either the system is Up at time T, with probability q, or it will be Down with probability 1 - q. If the system was Up at T - 1 then it is either Down at T with probability p, or it is Up at T, with probability 1 - p. This occurs because there are only two possibilities (Up or Down) for S at any given time T. The two state probabilities have to add up to Unit. Let's analyze this situation further.

Each time unit (hour) T, transitioned by system S, can be considered as an independent trial, and the probability p_{ij} of moving from i into the other state j, as the probability of "success". For example, let system S be in state Up. Then, moving to state Down by one step with probability p_{10} = p = 0.002 yields a Geometric distribution with Mean μ = 1/p = 500 hours. If, instead, system S is in state Down then, moving to state Up by one-step (hour), with probability p_{01} = q = 0.033, yields a Geometric, with Mean μ = 1/q = 30 hours. These are the same parameters of the "realistic" example of the previous section.

The Geometric distribution is the discrete counterpart of the continuous Exponential and, as the units of time T become smaller (hours to minutes, seconds, etc.), the two distributions converge. Therefore, this numerical example is equivalent to the one given in the previous section, which used similar time parameters, and will serve as a vehicle for comparison and contrast.

One important property of Markov Chains is their "lack of Memory." This means that only the system status at the immediately previous time has any bearing on the status at the current time, and every other past history goes into oblivion. In addition, these Markov Chains are time homogeneous (the transition probabilities p_{ij} do not change over time). Hence, it is enough to know the "one-step state transition probabilities" or the probabilities p_{ij} of going from any state "i" to any other state "j" in one step, to resolve the problems.

Markov Chains can be represented by a "Transition Probability Matrix" P, where rows represent every system state we can be in at time T, and columns represent every other state we can go to, in one step (i.e., where we will be, at T + 1). Entries of Matrix P (p_{ij}) correspond to the Markov Chain's one-step transition probabilities and must add up to unit, on every matrix row. For our numerical example, the Transition Probability matrix P is:

States	0	1		States	0	1
0	(1 - q	q)	=	0	(0.967	0.033)
1	(p	1 - p)		1	(0.002	0.998)

If we need the probabilities of moving from one state to any other, in two steps, we raise matrix P to the second power. For example, moving from states Up to Down in two steps, entails either moving from Up to Down in first step, and remaining in Down state another step. Or it may entail first remaining Up for one step, before moving from states Up to Down in the second step. In matrix language, this is expressed in the following way:

$$p^2 = \begin{bmatrix} 1-q & q \\ p & 1-p \end{bmatrix}^2 = \begin{bmatrix} 1-q & q \\ p & 1-p \end{bmatrix} x \begin{bmatrix} 1-q & q \\ p & 1-p \end{bmatrix}$$

$$= \begin{bmatrix} (1-q)^2 + pq & q(1-q) + q(1-p) \\ p(1-q) + p(1-p) & pq + (1-p)^2 \end{bmatrix} = \begin{bmatrix} p_{00}^{(2)} & p_{01}^{(2)} \\ p_{10}^{(2)} & p_{11}^{(2)} \end{bmatrix}$$

In our example, the $p_{10}^{(2)}$ result provides the probability that system S is Down, if it was initially Up, after operating for two hours (T = 2): $p_{10}^{(2)} = p(1 - q) + (1 - p)p = 0.003$. The $p_{11}^{(2)}$ result (probability that S is Up after 2 hours, given that it started Up) can be obtained as one minus the probability that S is down, after 2 hours: $p_{11}^{(2)} = 1 - p_{10}^{(2)}$. We can then interpret $p_{11}^{(2)}$ = A(T) = 0.997 as the system Availability, after T = 2 hours of operation, if it started in state Up (at T = 0).

To obtain the probability of moving from one state to another in "n" steps, we raise the matrix P to the "nth" power (P^n). For example, the probability that S is Down after T = 10 hours (steps) if it was initially Up, is $p_{10}^{(10)} = 0.017$ (this includes that S could have gone Down or Up, then restored, and this may have occurred more than once during the T = 10).

For a sufficiently large "n" matrix P^n yields quasi identical rows. Results are interpreted as "long run averages" or limiting probabilities "p_i" of S being in the state corresponding to column "i". These results are similar to the ones obtained using the Expected Availability and Unavailability and the variable transformations approaches. To obtain these limiting probabilities (i.e., to calculate P^n) we need a practical result. For any two-state (e.g., Up, Down) system, as the one described above, this practical method is as follows.

$$p^n = \begin{bmatrix} 1-q & q \\ p & 1-p \end{bmatrix}^n = \frac{1}{p+q}\begin{bmatrix} p & q \\ p & q \end{bmatrix} + \frac{(1-p-q)^n}{p+q}\begin{bmatrix} q & -q \\ -p & p \end{bmatrix}$$

Then, for a sufficiently large "n", the second term goes to zero and the matrix P^n reduces to:

$$\underset{n\to\infty}{\text{Limit}}\, P^n = \underset{n\to\infty}{\text{Limit}} \left\{ \frac{1}{p+q}\begin{bmatrix} p & q \\ p & q \end{bmatrix} + \frac{(1-p-q)^n}{p+q}\begin{bmatrix} q & -q \\ -p & p \end{bmatrix} \right\}$$

$$= \begin{bmatrix} p/(p+q) & q/(p+q) \\ p/(p+q) & q/(p+q) \end{bmatrix}$$

Verify, for our given numerical example, that the probability of being in state Up at any arbitrary time T is $q/(p+q) = 0.943$, and the probability of being in state Down, is $p/(p+q) = 0.057$. These two "state occupancy rates", E(X) and E(Y), can also be interpreted as the percent of the time that the system S will spend in states Up and Down.

A Markov Model for a Simple Redundant System

In Reference 8, we developed a statistical model for a non-maintained, simple redundant system, composed of two identical devices in parallel. The approach was based on the two RV, corresponding to the two device lives. In this section we also analyze a simple redundant system composed of two identical devices in parallel. The differences now are that we use a Markov Chain approach, and that system S is maintained and can function at a degraded level with only one unit. The advantages of Markov modeling of system Availability, as will become apparent from the numerical example that follows, increase as the system becomes more complex (as also do the mathematics behind the analyses involved).

Let, as before, X(T) be the state of the system at time T (= 0,1,2, … hours). Let State 0 be the Down state, where both devices have failed and one of them is being repaired. Let State 1 be the Degraded state, where one device has failed and is being repaired and the second is working (and the system is operable but with lesser capabilities). Finally, let State 2 be the Up state, where both units are operating and the system is working at full capacity. The state diagram for this model is shown in Figure 3.

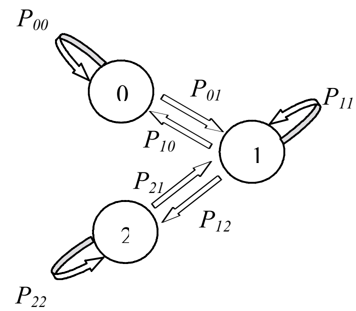


Figure 3. Markov Chain for Redundant System

The state equations are:

$$p_{01} = P\{X(T)=1 \mid X(T-1)=0\} = q$$

$$p_{10} = P\{X(T)=0 \mid X(T-1)=1\} = p$$

$$p_{12} = P\{X(T)=2 \mid X(T-1)=1\} = q$$

$$p_{21} = P\{X(T)=1 \mid X(T-1)=2\} = 2p$$

$$p_{ii} = P\{X(T)=i \mid X(T-1)=i\} = 1 - \sum_{j\neq 1} p_{ij}$$

As before, we can consider every step (hour) T as an independent trial, having probability of success p_{ij} corresponding to the feasible transitions from our current state "i" into state j = 0,1,2. Hence, we can again think of the distribution of every change of state (produced by the occurrence of a failure or a repair) as being geometric, the discrete counterpart of the Exponential. It will have "probability of success" $p = p_{ij}$ (corresponding to the change into that state) and a mean time to accomplishing such change of $\mu = 1/p_{ij}$.

The transition probability matrix P for this model is given by:

$$p = \begin{array}{cccc} \text{States} & 0 & 1 & 2 \\ 0 & p_{00} & p_{01} & p_{02} \\ 1 & p_{10} & p_{11} & p_{12} \\ 2 & p_{20} & p_{21} & p_{22} \end{array} = \begin{array}{cccc} \text{States} & 0 & 1 & 2 \\ 0 & 1-q & q & 0 \\ 1 & p & 1-p-q & q \\ 2 & 0 & 2p & 1-2p \end{array}$$

Rows must add to one (probability is unity because the system is always in one of its three states). And, if we want to know the probability $p_{ij}^{(n)}$ of being in some state "j" after "n" steps, given that we started in some state "i" of the system, we raise matrix P to the power "n" as we did before, and look at entry p_{ij} of the resulting matrix P^n. With the advent of modern computers and math software, these operations are no longer tedious or difficult.

Modify the numerical example of previous section, now using two units instead of one. The probability p of either unit failing in the next hour is 0.002. The probability q of the repair crew completing a maintenance job in the next hour is 0.033. Only one failure is allowed in each unit time period, and only one repair can be undertaken at a time.

With these new conditions, the probability that a degraded system (State 1) remains degraded after two hours is the sum of the probabilities corresponding to three events. First, that system status has never changed. Second, that one unit is first repaired and then another unit fails during the second hour. Third, that remaining unit fails in the first hour (the entire system goes down) then, a repair is completed in the second hour (system goes up, at degraded level):

$$P_{11}^2 = [P \text{ x } P]_{11} = p_{11}^{(2)} = p_{10}p_{01} + p_{11}p_{11} + p_{12}p_{21}$$

$$= pq + (1 - p - q)^2 + 2pq$$

$$= 0.002 \text{ x } 0.033 + (1 - 0.035)^2 + 2 \text{ x } 0.002 \text{ x } 0.033$$

$$= 0.9314$$

We are also interested in the mean time that the system spends in any given state. For example, System S can change to Up or Down, from state Degraded, in one step, with probabilities p and q. Hence, S will remain in the state Degraded with probability 1 - p - q. Then, on average, S will spend a "sejour" of length 1/{1 - (1 - p - q)} = 1/0.035 = 28.57 consecutive hours in the Degraded state, before moving out to either Up or Down states.

Let's now analyze "Availability at time T" = A(T) = P{S is Available at T}. But this just means that system S is not Down at time "T" (it can be Up or Degraded). In addition, S could have initially been Up, Down or Degraded. Hence, A(T) depends on the initial state of S (States 0,1,2), actual system availability level (States 1,2) and time (T). Assume we are interested in S being "Degraded Available" at T, given it was Degraded at T = 0: $p_{11}^{(T)}$. Since for matrix P^T every row has to add to unit, we can obtain such Availability via:

$$p_{10}^{(T)} + p_{11}^{(T)} + p_{12}^{(T)} = 1 \Rightarrow p_{11}^{(T)} = 1 - p_{10}^{(T)} - p_{12}^{(T)}$$

$$A(T) = P\{X(T) = 1 \mid X(0) = 1\} = p_{11}^{(T)} = 1 - p_{10}^{(T)} - p_{12}^{(T)}$$

We may instead be interested in "long run averages" or "state occupancies". These are the asymptotic probabilities of system S being in each one of its possible states at any time T, or the percent time spent in these states, irrespective of the state they were in, initially. These results are obtained by considering the Vector (denoted Π) of "long run" probabilities:

$$\Pi = \lim_{T\to\infty} [\text{Prob}\{X(T) = 0\}, \text{Prob}\{X(T) = 1\}, \text{Prob}\{X(T) = 2\}]$$

$$= (\Pi_1; \Pi_2; \Pi_3)$$

Vector Π fulfills two important properties that allow the calculation of such values:

$$(1): \Pi \text{ x } P = \Pi; (2) \sum \Pi_i = 1; \text{with}: \Pi_i = \lim_{T\to\infty} \text{Prob}\{X(T) = i\}$$

In plain English, Π × P = Π (Vector Π times the matrix P equals Π) defines a system of linear equations, that are "normalized" by the second property (that probabilities in the components of Vector Π add to Unit). For our example, we have the following.

$$\Pi \text{ x } P = (\Pi_0, \Pi_1, \Pi_2) \text{ x } \begin{bmatrix} 0.967 & 0.033 & 0 \\ 0.002 & 0.965 & 0.033 \\ 0 & 0.004 & 0.996 \end{bmatrix} = (\Pi_0, \Pi_1, \Pi_2)$$

$$\Rightarrow \begin{cases} 0.967\Pi_0 + 0.002\Pi_1 = \Pi_0 \\ 0.033\Pi_0 + 0.965\Pi_1 + 0.004\Pi_2 \ \Pi_1; \\ 0.033\Pi_1 + 0.996\Pi_2 = \Pi_2 \end{cases}$$

$$\text{with}: \sum_i \Pi_i = \Pi_0 + \Pi_1 + \Pi_2 = 1$$

The solution of this linear system of equations yields the long run or asymptotic occupancy rates:

$$\Pi = (\Pi_0, \Pi_1, \Pi_2) = (0.0065, 0.1074, 0.8861)$$

A Π_2 = 0.8861 indicates that the system S is operating at full capacity 88% of the time. A Π_1 = 0.1074 means that S is operating at a Degraded capacity 10% of the time. Only Π_0, the probability corresponding to State 0 (Down state), is associated with the system being Unavailable. The "long run" system Availability is then: 1 - Π_0 = 1 - 0.0065 = 0.9935.

Finally, we are also interested in the expected times for System S to go Down if initially S was in State Up (denoted V_1) or Degraded (V_2), or in the average time S spent in each of these states before going "Down". We obtain them by assuming Down is an "absorbing" state (one that, once entered, can never be left) and solving the linear system of equations leading to all such possible situations. That is, one step is taken at minimum (when the system goes Down, directly). If S is not absorbed in one step, then it will necessarily move on to any of other, non-absorbing (Up or Degraded) states, with the corresponding probability, and the process restarts.

$$V_1 = 1 + p_{11}V_1 + p_{12}V_2 = 1 + 0.965V_1 + 0.033V_2$$

$$V_2 = 1 + p_{21}V_1 + p_{22}V_2 = 1 + 0.004V_1 + 0.996V_2$$

Average times until System S goes down yield V_1 = 4,625 hours (starting in state Degraded) and V_2 = 4,875 (starting Up). For comparison, the non maintained system version referred to initially, would work an Expected 3/2λ = 3/0.004 = 750 hours in Up state, before going Down (Reference 8). The fact that maintenance is now possible, while S continues operating in a Degraded state (with a single unit), results in an increase of $\mu/2\lambda^2 = 0.033/2 \times 0.002^2 = 4{,}125$ hours in its Expected Time to go Down (from Up). Verify that the new Expected Time is due to the sum of Expected times to failures, plus *maintenance*: $V_2 = 3/2\lambda + \mu/2\lambda^2 = 750 + 4{,}125 = 4{,}875$.

Model Extensions and Comparisons

We have seen how a stochastic process is just a R.V. X(T), indexed in some parameter T called "time." The processes overviewed here are collectively known as "discrete time parameter" Markov Chains, because transitions only occur at regular intervals (in our examples, every hour). Hourly time intervals can be shortened (to minutes, seconds, etc.) and X(T) approximates a "continuous time parameter" Markov Chain (also known as a Markov Processes) just like a Riemann sum approximates an Integral.

We have not dealt with continuous time parameter Markov Chains in this START sheet, because their mathematical treatment requires using differential equations, Laplace Transforms and other tools of advanced calculus and mathematics. The objective of this START sheet is not to discuss mathematics, but to convey important statistical principles to the engineer who uses software and tools that implement them. The reader interested in learning more about these advanced methods is referred to the sources in the Bibliography.

Reference (6), is a START sheet that discusses the mathematical derivation of a simple continuous time parameter Markov Chain and some uses. It is available on our web site at: <http://rac.alionscience.com/pdf/MARKOV.pdf>. Reference 7, also discusses these models in more detail. Reference 5, Chapter 10, is an older but classic reliability book that treats this problem at introductory level. Reference 1, Chapter 6, is a recent textbook that treats the subject extensively and in a more mathematically advanced way. Reference 4, is a mathematics book about stochastic modeling with a clear approach to the topic. Finally, Reference 8 develops the system example used for comparison here.

We have discussed extensively, however, the understanding and use of several important statistical models. Among them, Availability via RV transformation and via defining a Markov Chain that represents the system as it moves through time. In doing so, we have shown how different but complementary statistical modeling approaches provide different answers to different types of problems and questions.

For example, if the problem is one of characterizing the RV Availability (A) via finding a confidence interval, a percentile (Life L_{10}) or the specific probability of some events (say, $A > 0.9$) then we may want to derive the distribution of A, directly. Obtaining such theoretical distributions may not always be easy. But then, one can resort to MC methods, which will provide working approximations to the exact but unavailable solutions.

If the system is more complex, involving redundancy, degradation, etc. and one is more interested in asymptotic or steady state results, we may want to implement a Markov model. PM such as "long run" Availability (state occupancies), Expected time to failure, etc. can also be obtained as the system X(T) moves through time. Markov Model assumptions (e.g., that distributions of times to failure, to repair, etc. should be Exponential) are some times unrealistic. But here too, one can resort to Monte Carlo methods.

Some software packages (e.g., BlockSim) implement some of these models and methods. Knowledge of the mathematics involved in model development is no longer necessary for the engineer. But a better understanding of the nature and implications of the methods they implement provides a safer use of such software packages.

Finally, it becomes clear that there are two ways of improving Availability: either extending the system life or improving its Maintainability. Logistics deals directly with the latter issue and its implications. Due to its complexity, Logistics will be the topic of a forthcoming START sheets.

For Further Study

1. System Reliability Theory: Models and Statistical Methods, Hoyland, A. and M. Rausand, Wiley, NY, 1994.
2. Logistics Engineering and Management, Blanchard, B.S., Prentice Hall, NJ, 1998.
3. Criscimagna, N., RAC, Personal communication.
4. An Introduction to Stochastic Modeling, Taylor, H. and S. Karlin, Academic Press, NY, 1993.
5. Methods for Statistical Analysis of Reliability and Life Data, Mann, N., R. Schafer, and N. Singpurwalla, John Wiley, NY, 1974.
6. Applicability of Markov Analysis Methods to Availability, Maintainability and Safety, Fuqua, N., RAC START Sheet, Volume 10, No. 2, <http://rac.alionscience.com/pdf/MARKOV.pdf>.
7. Appendix C of the Operational Availability Handbook (OPAH), Manary, J. RAC.
8. Understanding Series and Parallel Systems Reliability, Romeu, J.L., RAC START Sheet, Volume 11, No. 5 <http://rac.alionscience.com/pdf/S&PSYSREL.pdf>.

About the Author

Dr. Jorge Luis Romeu has over thirty years of statistical and operations research experience in consulting, research, and teaching. He was a consultant for the petrochemical, construction, and agricultural industries. Dr. Romeu has also worked in statistical and simulation modeling and in data analysis of software and hardware reliability, software engineering, and ecological problems.

MEET THE OFFICERS

G. Geoffrey Vining: Chair

Geoff Vining is Professor and Head of Statistics at Virginia Tech. He holds a B.A. from the University of Tennessee at Knoxville (1981), and a M.S. (1986) and Ph.D. (1988) from Virginia Tech. His primary areas of interest are experimental designs and their analysis for quality improvement, response surface methodology, statistical process control, and regression. Dr. Vining has significant consulting experience in industry. He has received research grants from Alcoa and Shell.

From 1988-1999 he served on the faculty of the Department of Statistics at the University of Florida. Prior to going to graduate school, he was a Process Engineer with the Faber-Castell Corp. His responsibilities included technical support to the pencil lead operation and the development of a company wide Deming based quality improvement program.

Dr. Vining has authored or co-authored three books. He was the editor of the Journal of Quality Technology from 1998-2000. He received the 1990 Brumbaugh Award from the American Society for Quality. He was elected a Fellow of both the American Statistical Association and the American Society for Quality in 2001.

Gordon Clark: Chair-Elect

Gordon Clark is currently a Professor Emeritus of Industrial and Systems Engineering at The Ohio State University and a Principal of Gordon Clark & Associates. Previously, he was a Professor of Industrial and Systems Engineering at The Ohio State University for 27 years. He is a registered Professional Engineer in the State of Ohio. He was a member of a team which completed thirty-one performance-improvement assessments at manufacturing companies. His recent consulting activities emphasize statistical analysis of data to improve quality. Current and recent projects involve experimental design, statistical process control, regression analyses, and the development of process control models to improve quality.

He is active in professional organizations. He is the program chair for the Fall Technical Conference in 2005, and he is a past program chair for the Winter Simulation Conference. He has been an associate editor for three professional journals. He has fifty papers appearing in journals and conference proceedings and he has given 47 presentations to national or international professional society meetings. He is a Certified Six Sigma Black Belt, and he teaches the Six Sigma Black Belt certification class for the Columbus Section of ASQ.

Daksha Chokshi: Treasurer

Daksha is a Technical Fellow in the discipline of Statistical Methods & Quality Technologies for United Technologies (UTC), Pratt & Whitney Division, in West Palm Beach, Florida. She chairs and provides technical leadership to United Technologies Corporation's Process Certification (ProCert) Council, comparable to the industry's Six Sigma Program. She is an ambassador, driving force, and key contributor to launch and diffuse ProCert throughout UTC. She is recognized for her ability to apply statistical methods to quality technologies that have improved manufacturing as well as business processes and produced significant monetary savings. Largely responsible for developing and deploying Process Certification tools throughout UTC, Daksha has earned a reputation for solving complex problems by combining manufacturing, engineering, and statistical disciplines. In addition, Daksha runs numerous classes and workshops in Statistical Methods and Quality Technologies disciplines, which include classroom instruction and projects aimed at improving quality, cost and schedule company-wide.

Daksha is a Ph.D. Candidate in Industrial Engineering from the University of Miami. She holds three Masters degrees, one in Management of Technology, one in Industrial Engineering and another in Mathematical Statistics. Daksha has authored many technical publications and served as speaker and manager for many technical sessions.

Daksha is a senior member of the American Society for Quality (ASQ) and a member of the American Statistical Association. As a member of ASQ's Statistics division, she has previously served on Fall Technical Conference Program Committee and 2004 Annual Quality Congress Statistics division track manager.

Doug Hlavacek: Secretary

Doug Hlavacek is a statistician with Ecolab, a global leader of cleaning, sanitation and service solutions for the hospitality, institutional and industrial markets. Doug joined Ecolab in 2000 and uses statistical, quality and marketing research techniques in order to define customer needs and subsequently translate those needs into successful product and service offerings.

Prior to Ecolab, Doug worked at 3M, Imation and Kraft General Foods in various consulting, training, and project leadership capacities. Doug has received excellence, quality and divisional awards for his use of statistical methods. These efforts have helped to accelerate the development of new products, reduce product variation through increased process understanding, and successfully defend against a lawsuit by providing objective evidence to refute a competitor's claim.

Doug received his MS in Statistics from Virginia Tech (1979) and BA in Mathematics from Rutgers University (1977). His primary areas of interest are in statistical education, experimental design, graphical display and statistical process control. Doug is a member of ASA, Senior member of ASQ and has been a Certified Quality Engineer since 1988.

Scott Kowalski: Vice-Chair, Products & Services

Scott Kowalski is a Technical Training Specialist at Minitab Inc. His main role is teaching statistics with MINITAB to corporations in the United States, Canada and Mexico. Scott is also involved in software development at Minitab Inc. Before joining Minitab Inc., he worked for two years in academics: one year for Stetson University and one year for the University of Central Florida, where, in addition to teaching, he was the Associate Director of the Statistics Institute.

Scott received his B.S., M.S. and Ph.D. in Statistics from the University of Florida. His concentration was on design of experiments and response surface methodology. His dissertation and continued research focuses on designing industrial experiments with hard to change factors.

Scott is a Senior Member of ASQ and a member of the American Statistical Association. In addition, he is on the Editorial Review Board for the *Journal of Quality Technology*.

59th Annual Council/Open Business Meeting Minutes – May 16, 2005

Council Members in Attendance:
Jonathon Andell, Daksha Chokshi, Gordon Clark, Doug Hlavacek, Mark Kiel, Geoff Vining, and Ed Schilling

Members in Attendance:
John McCool, Jim Duarte, and Alex Georgiev

Agenda Items	Discussion	Action Items
Introduction	• Brief introduction of meeting attendees	• GV will share new vision/mission in his first chair message
Review Agenda	• FTC council meeting minutes approved without changes	
General Budget Review	• As of April 2005, anticipating that Division revenues will end 2004-2005 fiscal year at 80% of budget forecast • Much discussion over division budgeting process, cannot overspend budget but can over forecast annual revenues given our positive balance sheet • Will target to have the Special Publication out in early 2006 for points, but expenses will likely not hit until 2006-2007 fiscal year • Reviewed Ott Scholarship fund and role in selecting recipients • Treasurer's Report approved	• MK and GV to define a process for awarding testimonials. What recognition (versus $50 for piece of paper) is appropriate especially for frequent receivers?
2005-2006 Budget Line Item Review	• Cut member mailings from $2500 to $1500 • Reduce Strategic Planning from $9000 to $6500 (Meeting=$4000, Travel=$2500) • Cut Standards Committee from $8500 to $6000 • Increase Outreach from $1100 to $7100 with additional line items under Outreach for FTC Sponsorships=$3500, ISBIS Conference Short Courses=$2500, Other=$1100 • Modified budget approved	• DH to communicate 2005-2006 budget modifications to Marcey Abate
Topics of Discussion	• Motion to accept slate of candidates (Geoff Vining-Chair, Daksha Choski-Treasurer, Gordon Clark-Vice Chair, Doug Hlavacek-Secretary) accepted • Statistics Division has decided not to migrate to ASQ sanctioned website	• Pursue Data-Driven discussion at Operation Planning, sessions track at AQC track via Cheryl • GV to propose Dennis Lin as Statistics Division Fellow
Recognition	• Currently at 540 McDermond points per Laura Augustine	
Information Sharing	• Division's Spring Newsletter went out in April 2005 thanks to Brian Sersion • Spec Pubs committee was created consisting of Geoff, Gordon, and Bill Rodebaugh • Gordon mentioned that FTC was looking good, only needed two session moderators and one short course • Ed reviewed Standards Committee report • Two Ott Awards were issued	
Benefits and Concerns	• Jim Duarte expressed his desire that the division spend less time during Open Business Meeting on budgeting and more on member issues. Specifically, "What is division doing to close the gap between corporate IS departments which regurgitate but do not analyze data," and "Are we spending revenues wisely to support our members?"	

TREASURER'S REPORT

Statistics Division

6/30/05

Revenue (as of May 31, 2005)	2004-2005 Budget	YTD Actual
Dues	$60,000.00	$49,178.90
Retail Sales	1,500.00	119.00
Interest/Royalties	2,000.00	1,079.25
Teleclass Revenue	0.00	
AQC Tutorials	0.00	
FTC Short Courses	0.00	
Total	**$63,500.00**	**$50,377.15**

Expenses (as of June 30, 2005)

New Member Mailings	$5,000.00	1,130.30
Teleconferences	1,000.00	439.26
General Fund	**$6,000.00**	**$1,569.56**

DAC Meetings (Nov., May)	1,000.00	1,878.85
Travel, Hotel	*1,000.00*	*1,878.85*
Strategic Planning (Mar., AQC)	6,500.00	13,754.72
AQC Meeting	*4,000.00*	*3,452.13*
AQC Travel	*2,500.00*	*1,549.56*
Strategic Planning Mtg.	*2,500.00*	*8,753.03*
Operational Planning (Aug.)	6,000.00	6,806.73
Travel, Hotel, Meals	*6,000.00*	*6,806.73*
Tactical Planning (FTC)	2,700.00	4,322.57
FTC Meeting	*200.00*	*3,500.00*
FTC Travel	*2,500.00*	*822.57*
Long Range Planning (3 yrs)	0.00	
Planning Committee	**$16,200.00**	**$26,762.87**
Auditing Committee	**0.00**	
Bylaws Committee	**0.00**	
Certification Committee	**0.00**	
Examining Committee	**0.00**	
AQC Exhibitor Fees	2,000.00	
AQC Promotional Items	1,000.00	146.00
Membership Committee	**3,000.00**	**146.00**
Regular Newsletter (3)	4,500.00	1,090.76
Printing (Layout, pdf files)	*4,000.00*	*1,090.76*
Postage/Miscellaneous	*500.00*	
Spring 2004 - Six Sigma	1,000.00	8,236.07
Sp Pub Printing	*0.00*	*5,825.00*
Sp Pub Postage	*0.00*	*2,411.07*
Sp Pub Reprints	*1,000.00*	
Sp Pub Honorarium	*0.00*	
Newsletter Committee	**5,500.00**	**9,326.83**

Expenses (continued)	2004-2005 Budget	YTD Actual
Nominating Comm	**0.00**	
Programs Comm	**0.00**	
Publications Comm	**1,000.00**	
Standards Comm	**6,000.00**	**4,726.13**
Promotions Comm	**0.00**	
Committees Sub-Total	**$31,700.00**	**$40,961.83**

Web Design & Maintenance	7,000.00	1,474.63
Teleclasses	1,000.00	179.40
Virtual Academy	0.00	
Outreach Projects	12,975.00	525.00
Tactical Plans Sub-Total	**$20,975.00**	**$2,179.03**

Hunter Award (plaque)	300.00	203.24
Hunter Awardee Honorarium (travel)	1,250.00	1,239.00
Youden Speaker gift (FTC)	125.00	
FTC Student Grants	1,500.00	1,468.23
ASQ Testimonials ($50 each)	100.00	
Service Awards (AQC, FTC Reps)	300.00	
Outgoing Chair's Gift	500.00	
Awards Sub-Total	**$4,075.00**	**$2,910.47**

Misc/postage	100.00	
Misc/travel	500.00	
Misc/other	150.00	499.00
Misc- Sub-Total	**750.00**	**499.00**

Total Expenses	**$63,500.00**	**$48,119.89**

Ott Scholarship	Proposed	YTD Actual
Assets		
Scholarship Fund	$200,000.00	$211,725.67
Expenses		
Scholarship (2)	$20,000.00	$10,000.00

Ending Balances (as of May 31, 2005)		
Checking	$26,382.98	
Money Market	$96,159.43	
Accounts Receivable	$8,208.80	
ASQ	*$8,208.80*	
Dividends		
Current Assets	**$130,751.21**	
Capital Assets	**$6,413.24**	
depreciated to	**$0.00**	
Long Term Assets	**$273,233.16**	
from reserve fund	*61,507.67*	
Ott fund	*211,725.67*	
Total Assets		**$403,984.37**

IN CASE YOU MISSED IT

Volunteers Needed

- We need your help. Please consider becoming an active member of the division. For more information contact Mark Kiel, Past Chair. Current Stat Division job openings are as follows: Vice Chair - Outreach, 2006 FTC Program Rep, 2006 WCQI Paper Reviewer, 2006 WCQI Tutorial Manager, Division Marketer, McDermond Chair, How ... To Series Editor, Short Course Development. An E-Zine containing more details on these positions is forthcoming.

Useful Information

- Reminder – 49th Annual Fall Technical Conference, Thursday October 20 through Friday October 21, 2005 in St. Louis, Missouri.

  This conference provides a forum for discussing topics at the interface of statistics and quality. This year's theme is "Statistics: Gateway to Quality." The American Society for Quality, Statistics Division and Chemical & Process Industry Division are co-sponsors of this event, along with ASA Sections on Physical & Engineering Sciences and Quality & Productivity. The conference is being held at the Hilton St. Louis Airport. For more information go to www.asq.org/cpi/conferences.

- ASQ Awards Nomination Deadline – The deadline to nominate people deserving of recognition through ASQ's awards program is November 1, 2005. Recipients do not have to be members of ASQ and can live anywhere in the world. Recipients will be recognized at the ASQ World Conference on Quality & Improvement to be held in Milwaukee, Wisconsin May 1-3, 2006. Applications and additional information regarding ASQ National Medals and Awards can be found at http://www.asq.org/about-asq/awards/.

- Discussion Forums for your amusement:

  http://www.asq.org/discussionBoards/index.jspa
  The ASQ discussion boards (Basic Statistics, Process Capability Studies, Designed Experiments, Six Sigma)

  http://elsmar.com/Forums/
  Covers a wide range of quality and statistical related topics

  http://www.edwardtufte.com/bboard/q-and-a?topic_id=1
  Emphasis on techniques for displaying data/information

  http://www.isixsigma.com/forum/
  Anything remotely connected to six sigma

Book Review

GLOSSARY AND TABLES FOR STATISTICAL QUALITY CONTROL

ASQ Statistics Division, ASQ Quality Press, 2005, 200pp., $30.50 member, $38 list (book).

The fourth edition of *Glossary and Tables for Statistical Quality Control* builds on the success of previous editions. Terms are still alphabetized as in previous editions; however, the editors have added a glossary of symbols, adding to the usefulness of this book.

With the common use of computers to analyze data, the editors shifted the focus on this reference from being a manual of definitions, charts and formulas to one for selecting the correct method of analysis. Many of the statistical formulas found in previous editions have been removed, and a large number of new references have been added to aid the reader in finding the actual statistical formulas as needed.

Several enhancements make this edition a must have for the quality professional – even if you have previous editions. The editors have rewritten many definitions to enhance understanding of the terms to people outside the quality profession too. Combining this with the removal of formulas makes this edition clearer and easier to use.

Even though formulas have been removed, the editors included basic diagrams to help the reader understand basic tools for presenting data. Within the definitions, key terms are italicized to indicate their definitions are also included in this reference. Finally, the book has exposed tabs that help the reader locate terms and definitions more quickly.

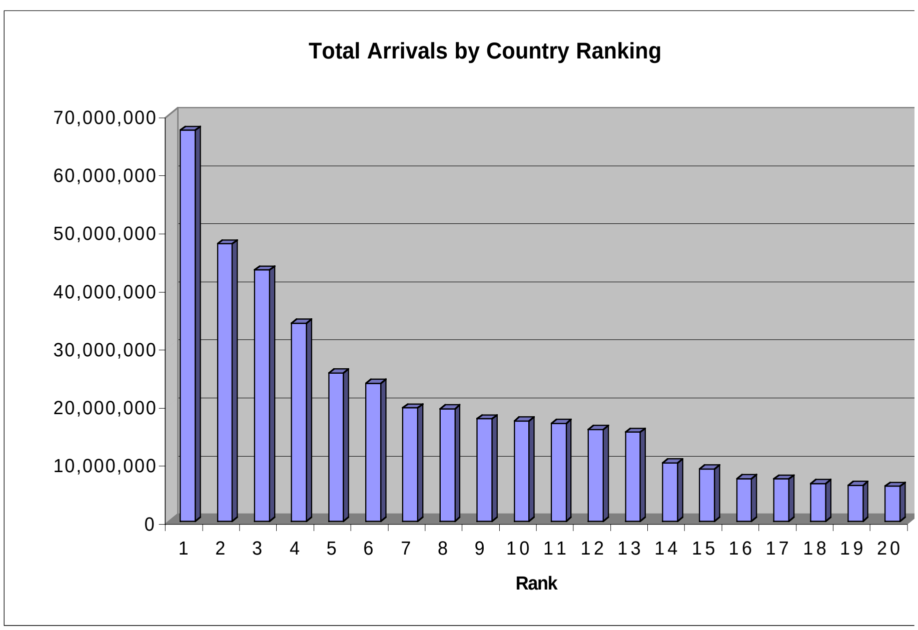
If you are looking for a reference filled with all the mathematical equations needed to perform statistical analysis, then this is not the edition for you. The fourth edition of this reference book is for a person looking for a good source of information to perform his or her daily work.

Gene Placzkowski
SC Johnson Wax
Racine, WI

Data Matters

TOP 20 TOURIST DESTINATIONS (1997)

Rank	Country	Arrivals
1	France	67,310,000
2	United States	47,752,000
3	Spain	43,252,000
4	Italy	34,087,000
5	United Kingdom	25,515,000
6	China	23,770,000
7	Poland	19,520,000
8	Mexico	19,351,000
9	Canada	17,636,000
10	Hungary	17,248,000
11	Czech Republic	16,830,000
12	Germany	15,837,000
13	Russia	15,350,000
14	Greece	10,070,000
15	Turkey	9,040,000
16	Ukraine	7,356,000
17	Thailand	7,294,000
18	Singapore	6,531,000
19	Malaysia	6,211,000
20	Belgium	6,037,000



http://www.nationmaster.com

49th Annual Fall Technical Conference

Statistics: The Gateway to Improved Quality

PROGRAM

We invite you to attend to the 49th Fall Technical Conference held this year in St Louis, Missouri. This conference is the premier forum to discuss topics at the interface of statistics and quality. The theme of this year's conference is the **"Statistics: The Gateway to Quality."** The goal is to engage researchers and practitioners in a dialogue that leads to more effective use of statistics to improve quality. The conference will serve to bring innovations in statistical methodologies and quality tools to the forefront.

You will have the opportunity to meet informally and exchange views with speakers and colleagues during breaks and the always-friendly hospitality suite. Four awards sponsored by ASQ divisions will be presented at the conference. On Thursday afternoon, at the W.J.Youden Memorial Address, the Hunter Award will be presented to a person who demonstrated creative development and application of statistical techniques to problem solving in the quality field.

PRE & POST CONFERENCE SHORT COURSES

Two short courses will be offered on Wednesday, October 15th and two on Saturday, October 22nd from 8:30 a.m. to 5:30 p.m. The fee for each course includes coffee breaks and lunch. Registration is limited.

Better Industrial and Scientific Experiments by James M. Lucas ($250) – Wednesday, October 19th

You will learn how to run better industrial experiments for quality and process improvement or scientific experiments to answer important questions (hypotheses) from a world-class experimenter. We emphasize experiments using industrial or scientific equipment such as production machinery. We show how to carry out the best experiments when there are hard-to-change and easy-to-change factors. We use the fact that many experiments using equipment are inherently split-plot experiments in our examples; we tell how to design and analyze split-plot experiments. Because resources are always limited we also discuss how to run the lowest cost experiment. This course is designed for people who have run an experiment or who have taken a previous course on Experimental Design. All course participants should e-mail a description of a current experimental design problem to JamesM.Lucas@worldnet.att.net; the course examples will be built on the problems of the participants.

Statistical Engineering by Stefan Steiner ($250) – Wednesday, October 19th

Statistical Engineering (SE) is an algorithm and a collection of data-based strategies and tools designed to improve the performance of high to medium volume manufacturing processes. The key step of the algorithm is the appropriate selection and efficient application of one of seven variation reduction approaches: fix the obvious using knowledge of a dominant cause of variation; desensitize the process to variation in a dominant cause; feedforward control based on a dominant cause; feedback control; make the process robust; 100% automated inspection; move the process center closer to target.

In most applications of SE we recommend searching for a dominant cause of variation. SE promotes an efficient search for this cause using the method of elimination and special statistical tools. SE is widely used in the automotive sector by both OEMs and their suppliers. Because of its algorithmic structure and specialized purpose, it is easy to fit SE into Six Sigma and other Continuous Improvement systems. This course will change how you think about process improvement.

Generalized Linear Models in Industry by Timothy J. Robinson and Christine Anderson-Cook ($250) – Saturday, October 22nd

Non-normal data is common in industrial experiments. Popular examples include success/failure responses, responses involving time to failure, responses resulting in counts, and many others. Generalized linear models offer a powerful tool for the modeling of such data and advances in software have made the utilization of generalized linear models tangible for the practitioner. The purpose of this course is to provide instruction on the use of generalized linear models and to illustrate their use via examples from industry. Specific topics include the connection of generalized linear models to approaches utilized in linear regression analyses, logistic regression, Poisson regression and over dispersion. Emphasis will be on the application of generalized linear models. The attendees should be at least somewhat familiar with regression analysis and matrix algebra as it is used in the underpinnings of linear models. The text Generalized Linear Models with Applications in Engineering and the Sciences by Myers, Montgomery, and Vining (2002) will serve as the reference for the course and the text will be available for purchase on the day of the course. Examples will be illustrated using SAS and SAS JMP. The notes, examples, and SAS code utilized in the course will be provided to all participants.

Optimal Design of Industrial Experiments by Peter Goos ($250) – Saturday, October 22nd

Experimenters are often faced with practical difficulties when running standard experimental designs like factorial designs or central composite designs. These difficulties – which include, for example, the limited availability of time, restrictions on the levels of the experimental variables and the simultaneous presence of qualitative, quantitative and/or mixture variables in the study – make it hard to design the experiment. However, a tailor-made experimental design for these situations can be constructed using the optimal design approach. This course will give an example-based overview of the basic concepts in optimal design theory and of the ways in which optimal experimental designs can be constructed. In addition to the strengths of the approach, weaknesses, dangers and pitfalls will be discussed and solutions for them will be given. Finally, an overview of available software will be provided and recent developments in the area such as the construction of variance dispersion graphs and the design of experiments involving hard-to-change factors will receive attention.

COUNCIL MEETINGS

On Wednesday, October 19th, the Chemical & Process Industries Division and the Statistics Division of ASQ, will hold a council meeting from 7:30 to 9:30 p.m. These open meetings are an opportunity for those who wish to become involved in the activities of the societies to become better informed.

HOSPITALITY SUITE

The Fall Technical Conference and the officers of the sponsoring organizations host a hospitality suite every year. We welcome new faces and new perspectives on division operations as well as share technical insights with colleagues, in a friendly, informal atmosphere. Please come to meet us in St. Louis!

AREA ATTRACTIONS

St. Louis is the gateway to the west. Here are a few of the attractions near by:

- Anheuser-Busch Brewery
- Gateway Arch & Museum of Westward Expansion
- Grants Farm
- Missouri Botanical Gardens
- St. Louis Science Center
- St. Louis Zoo (free)
- Six Flags over Mid-America
- Bowling Hall of Fame & Museum
- Cahokia Mounds
- The Museum of Transportation
- Old Cathedral

Please see the concierge desk or the front desk for directions and information on local attractions.

ACCOMMODATIONS

A block of rooms has been made available at the Hilton St. Louis Airport. Conference rates are $99 plus tax for a Single Room. These rates apply for October 18 through 21 based on availability. The guest room block will be held until October 5. Reservations can the hotel directly at 314-426-5500 or 1-800-HILTONS. Be sure to mention the ASQ Fall Technical Conference to receive the special conference rate. Check-in time is 3:00 p.m. and check out time is 12 noon. There is a $3 per day parking fee in the hotel lot.

CANCELLATIONS AND REFUNDS

We encourage attendees to enroll by September 16 to ensure availability. To encourage early registrations, we will promptly refund the entire registration fee minus meal costs if you cancel after September 25.

TRAVEL INFORMATION

Located conveniently at the St. Louis International Airport, the Hilton is perfectly accessible to any part of our city. Take the Metrolink from the Airport to Downtown for Shopping, Dining and Sight Seeing. Complimentary Transportation is available to Riverboat Casinos.

49th Annual Fall Technical Conference, St. Louis, MO

Thursday, October 20, 2005

7:30	Registration Desk Opens		
8:00-9:00	**WELCOME / PLENARY SESSION** **Speaker: Roger Hoerl, *General Electric Global Research*** **Welcome: Statistics and Quality: What's After Six Sigma?**		
Session 1	**A.** **LOGARITHMIC SPC**	**B.** **ROBUST PARAMETER DESIGN**	**C.** **BUSINESS PROCESS MODELING**
9:15-10:00	**An SPC Control Chart Procedure Based on Censored Lognormal Observations** Uwe Koehn *Koehn Statistical Consulting LLC* **Moderator:** Daksha Chokshi *Pratt and Whitney*	**Process Optimization through Robust Parameter Design in the Presence of Categorical Noise Variables** Timothy J. Robinson, *University of Wyoming* W. A. Brenneman W. R. Myers, *The Procter & Gamble Company* **Moderator:** Douglas Hlavacek *Ecolab*	**Business Process Characterization Using Categorical Data Models** Cathy Lawson *General Dynamics* Douglas Montgomery *Arizona State University* **Moderator:** Mark Kiel *United States Steel*
10:00-10:30	BREAK		
Session 2	**A.** **MULTIVARIATE SPC**	**B.** **TOPICS IN DOE**	**C.** **SIX SIGMA**
10:30-12:00	**Using Nonparametric Methods to Lower False Alarm Rates in Multivariate Statistical Process Control** Luis A Beltran Linda Malone *University of Central Florida*	**Bayesian Analysis of Data from Split-Plot Designs** Steven G. Gilmour *University of London* Peter Goos *Universiteit Antwerpen*	**Six Sigma beyond the Factory Floor** Ron Snee *Tunnell Consulting*
	Statistical Monitoring of Dose-Response Quality Profiles from High-Throughput Screening James D. Williams *General Electric* Jeffrey B. Birch, William H. Woodall, *Virginia Tech* **Moderator:** Julia O'Neill *Merck & Co., Inc.*	**Adapting Second Order Designs for Specific Needs: A Case Study** James R. Simpson. *FAMU-FSU* Drew Landman *Old Dominion University* Rupert Giroux *FAMU-FSU* **Moderator:** Jonathan Andell *Andell Associates*	**Some Trends in Six Sigma Education** Douglas Montgomery *Arizona State University* **Moderator:** Roger Hoerl, Martha *General Electric Global Research*
12:15-1:45	**LUNCHEON** **Speaker: Bob Moore of the National Park Service** **Topic: "The Gateway Arch: An Architectural Dream"** **Presiding: Julia O'Neill, Merck & Co., Inc., ASQ-CPID Chair**		
Session 3	**A.** **TECHNOMETRICS**	**B.** **DOE FOR COMPUTER SIMULATION**	**C.** **COMMON MISTAKES IN STATISICAL APPLICATIONS**
2:00-3:30	**Control Charts and the Efficient Allocation of Sampling Resources** Marion R Reynolds, Jr. *Virginia Tech* Zachary G. Stoumbos *Rutgers University*	**Application of Design of Experiments in Computer Simulation Studies** Shu Yamada Hiroe Tsubaki *University of Tsukuba*	**Common Mistakes When Using SPC (and What to do About Them)** Douglas Fair *InfinityQS International, Inc.*
	The Inertial Properties of Quality Control Charts William H. Woodall *Virginia Tech* Mahmoud A. Mahmoud *Cairo University* **Moderator:** William Notz *The Ohio State University*	**Computer Experimental Designs to Achieve Multiple Objectives** Leslie M. Moore *Los Alamos National Laboratory* **Moderator:** Dennis Lin *Penn State University*	**Common Practitioner Mistakes in Data Analysis** Scott M. Kowalski *Minitab, Inc.* **Moderator:** Joseph Pigeon *Villanova University*
4:00-5:00	**Presentation of WILLIAM G. HUNTER AWARD** **W. J. YOUDEN MEMORIAL ADDRESS** **Speaker: Soren Bisgaard, University of Massachusetts** **Topic: "The Future of Quality Technology"** **Presiding: Mark Kiel, United States Steel, ASQ-STAT Past Chair**		

49th Annual Fall Technical Conference, St. Louis, MO

Friday, October 21, 2005

7:30	Registration Desk Opens		
Session 4	A. JOURNAL OF QUALITY TECHNOLOGY	B. RESPONSE SURFACE METHODOLOGY	C. GRAPHICAL METHODS
8:00-9:30	**A Dual-Response Approach to Robust Parameter Design for a Generalized Linear Model** William R. Myers *William A. Brenneman* *The Procter & Gamble Company* Raymond H. Myers, *Virginia Tech*	**Comparison of Global Characterization Techniques in Response Surfaces** Francisco Ortiz Jr. Simpson, James R. *FAMU-FSU* Drew Landman *Old Dominion University*	**Using a Pareto Chart to Select Effects for a Two-Level Factorial DOE** Pat Whitcomb *Stat-Ease, Inc.*
	Analysis of Performance Measures in Experimental Designs Using the Jackknife Asokan Mulayath Variyath Bovas Abraham Jiahua Chen *University of Waterloo* **Moderator:** Joe Sullivan *Mississippi State University*	**Response Surface Design Evaluation Using Mean Square Error Criteria** Christine Anderson-Cook *Los Alamos National Lab* Connie M. Borror *University of Illinois* **Moderator:** Malcolm Hazel *Consumers Union*	**Extreme Makeover: Data Edition** Julia C. O'Neill Lori B. Pfahler *Merck & Co., Inc.* **Moderator:** Martha Gardner *General Electric Global Research*
9:30-10:00	BREAK		
Session 5	A. MEASUREMENT SYSTEMS	B. RELIABILITY	C. PROCESS ANALYTICAL TECHNOLOGY
10:00-11:30	**Two-Dimensional Guidelines for Measurement System Indices** T. Kevin White *Voridian*	**The Analysis and Comparison of Start-up Demonstration Tests** Michelle L. Depoy Smith William S. Griffith *University of Kentucky*	**Engineering a Proactive Decision System for Pharmaceutical Quality** Ajaz S. Hussain *Food and Drug Administration*
	On the Comparison of Two Measurement Devices Joseph G. Voelkel *Rochester Institute of Technology* Bruce E. Siskowski, *Reichert Inc*	**An Early Detection Test for the Compatibility of Two Software Environments** Daniel R. Jeske Qi Zhang *University of California, Riverside*	**Multivariate Calibration for Analysis of Content and Coating Uniformity in Pharmaceutical Tablets** John F. Kauffman John A. Spencer *Food and Drug Administration*
	Generalizing Gage R&R Summaries Beyond Two-Way Crossed Models Annie Dudley Zangi Nicole Hill Jones *SAS Institute, Inc.* **Moderator:** Will Guthrie, *National Institute of Standards and Technology*	**Meeting Challenges in New Product Development Phases Using Accelerated Life Testing** Sarath Jayatilleka *Maytag Appliances* O. Geoffrey Okogbaa *University of South Florida* **Moderator:** Leslie M. Moore *Los Alamos National Laboratory*	**Application of PAT for Development of a Pharmaceutical Unit Operation** Steven M. Short Carl A. Anderson James K. Drennen III Robert P. Cogdill Zhenqi Shj, *Duquesne University* **Moderator:** Huiquan Wu *Food and Drug Administration*
11:45-1:15	**LUNCHEON** **Speaker: Sallie Keller-McNulty, Dean of the School of Engineering at Rice University, ASA President-Elect** **Topic: "Reliability Reloaded"** **Presiding: Joanne Wendelberger, Los Alamos National Laboratory, ASA-SPES Chair**		
Session 6	A. SCREENING DOE	B. MULTIVARIATE REGRESSION	C. MEASUREMENT SYSTEM ANALYSIS
1:30-3:00	**Using Fractional Factorial Split-Plots: Minimum Aberration or Optimum Blocking** James M. Lucas *J. M. Lucas and Associates* Frank Anbari *George Washington University*	**Evolutionary Algorithms in Multicollinearity Situations: A Case Study with Stabilizing Transformations** Flor A Castillo Carlos M. Villa, *The Dow Chemical Company*	**Bayesian Models for the Characterization of Reference Materials** Will Guthrie *National Institute of Standards and Technology*
	Sequential Supersaturated Designs for Efficient Screening Angela M. Jugan David Drain *University of Missouri – Rolla* **Moderator:** Geoffrey Vining *Virginia Tech*	**Hierarchical Monitoring of Defect Rates Using Process Data** David R. Forrest *Virginia Inst. of Marine Science* Christina M. Mastrangelo *University of Washington* **Moderator:** Alex Georgiev *Kautex Textron, Inc.*	**Open Source Excel Tools for Statistical Analysis for Complex Measurements** Hung-kung Liu Will Guthrie John Lu Juan Soto *National Institute of Standards and Technology* **Bayesian 3D Reconstruction of Chemical Composition from 2D Electron Microscopy** Donald Malec, *National Institute of Standards and Technology* **Moderator:** Erika Abbas *E Ink Corporation*

STATISTICS DIVISION COMMITTEE ROSTER

Voting Members of STAT Council

2005-2006

Committee	Name	Division Position	ASQ Member #	E-mail address	Telephone
OFFICERS					
	Geoff Vining	Division Chair	85577	vining@vt.edu	540-231-5657
	Gordon Clark	Chair-Elect	1037887	clark.17@osu.edu	614-847-1394
	Daksha Chokshi	Treasurer		daksha.chokshi@pw.utc.com	561-796-8373
	Doug Hlavacek	Secretary	127270	douglas.hlavacek@ecolab.com	651-306-5833
STANDING					
Examining					
Chair	Howard Swartz	Examining Chair	26025	swartzhc@aaicorp.com	410-628-3278
Auditing					
Chair	Geoff Vining	Division Chair	85577	vining@vt.edu	540-231-5657
By-Laws					
Chair	Mark Kiel	Past Chair	617887	mhkiel@uss.com	219-888-3788
Nominating					
Chair	Mark Kiel	Past Chair	617887	mhkiel@uss.com	219-888-3788
Program					
Co-Chair	Doug Hlavacek	Secretary	127270	douglas.hlavacek@ecolab.com	651-306-5833
Co-Chair	Scott Kowalski	Vice Chair - Products & Services	1087689	skowalski@minitab.com	407-328-9609
Publications					
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Co-Chair	Scott Kowalski	Vice Chair - Products & Services	1087689	skowalski@minitab.com	407-328-9609
Voting Member	Brian Sersion	Newsletter Editor	63027969	sersiob@ucmail.uc.edu	513-556-4350
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Non-Voting Member	Rudy Kittlitz	Glossary & Tables Editor	18478	e300@overland.net	915-837-9937
Strategic Planning					
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CONSTITUTED					
Tactical Planning					
Chair	Gordon Clark	Chair-Elect	1037887	clark.17@osu.edu	614-847-1394
Promotions					
Co-Chair	Daksha Chokshi	Treasurer		daksha.chokshi@pw.utc.com	561-796-8373
Co-Chair	OPEN	Vice Chair - Outreach			
Non Member	Small Web Solutions	Web Master	Contact	jwebster@smallwebsolutions.com	219-988-3139
Membership Needs					
Co-Chair	Daksha Chokshi	Treasurer		daksha.chokshi@pw.utc.com	561-796-8373
Co-Chair	OPEN	Vice Chair - Outreach			
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Voting Member	Ed Schilling	Standards Chair	29108	egscta@rit.edu	585-475-6129
Voting Member	Harry Koval	Certification Chair	18974	hkoval@comcast.net	651-776-9503
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Chair	OPEN				
WCI Session Manager	OPEN				

STATISTICS DIVISION AMERICAN SOCIETY FOR QUALITY

ASQ

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The *ASQ Statistics Division Newsletter* is published quarterly by the Statistics Division of the American Society for Quality.

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This will change the address for all publications you receive from ASQ including the newsletter. You can also handle this by phone (414) 272-8575 or (800) 248-1946.

UPCOMING NEWSLETTER DEADLINES FOR SUBMISSIONS

Issue	Vol.	No.	Due Date
Winter 2005	24	2	Nov. 30, 2005
Spring 2006	24	3	Feb. 28, 2006

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Other Periodicals for Applied Statistics
http://www.asq.org/pub/jqt/