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Book Reviews

Books for review are to be sent to the Book Review Editor Gösta Forsman, Department of Mathematics, University of Linköping, S-581 83 Linköping, Sweden.

Dehnad, K. (Ed.), Quality Control, Robust Design, and the Taguchi Method. Wadsworth & Brooks/Cole Advanced Books and Software, Pacific Grove, CA, 1989. ISBN 0-534-09048-6, xxiv + 309pp. $42.95.

The book is a compilation of published and unpublished papers written by associates of the Quality Theory and Technology Department of AT&T Bell Labs during the 1980s. It represents a unique blend of philosophy, methods, and applications that Dr. Genichi Taguchi brought to AT&T Bell Labs during his visits in the early 1980s.

The effort is a judicious blend of concepts that emphasize the Taguchi philosophy. The approach taken by the editor (Khosrow Dehnad) attempts to encompass a great number of ideas and philosophies of Dr. Genichi Taguchi. Dehnad has chosen to include chapters containing some of the more controversial aspects supported by Taguchi including the concept of accumulation analysis. Much of the motivation and resultant philosophy is developed directly from that of Taguchi and appears in his books Taguchi (1986) and Taguchi and Wu (1980). However, unlike Taguchi's work the book is easily read with few typographical errors, translation errors, or grammatical mistakes. Of equal importance to the readability and comprehension of the book is the glossary. The editor has conveniently located a glossary of terms unique to the ideas of Taguchi at the beginning of the book. The glossary is an absolute must for first time readers of Taguchi material.

The examples discussed are all derived from AT&T applications of the Taguchi philosophy and as a result are from the electronics field. The applications section is a nice touch as books of this level seldom contain such a section. It is refreshing to see applied statistical books taking this form. On the other hand, the book may have benefited from external applications and thought. Examples outside the electronics industry would certainly have extended the scope of the book.

Several of the papers have been published elsewhere (as suitably acknowledged by the authors and the editor), however, in more than one case very informative and provocative Discussions/Response also appeared with the original manuscript. These additional readings have not been included. Although some of these additional readings do not support the philosophy fostered in the book, for completeness, they should have been included.

The editor has divided the book into three parts, with Part One – Overview – being a selection of papers outlining the general philosophies and motivation for Taguchi's work as seen both by Taguchi and as interpreted by the respective authors. Part Two – Case Studies – provides five case studies illustrating application of the philosophy of Taguchi, and Part Three – Methodology – includes papers dealing with specific proposed methodology considered unique to Taguchi philosophy and the evolution of some of the ideas promoted by Taguchi.

Specific Comments

Part One – Overview

1. *Taguchi's Quality Philosophy: An Analysis and Commentary,* Raghu N. Kackar
This article originally appeared in the Journal of Quality Technology (Kackar 1986) and provides a brief overview of several Taguchi ideas in the area of robust design, loss functions, tolerances, and targets. Examples and figures are essentially those offered by Taguchi in his various manuscripts.

2. *Macro-Quality with Micro-Money,* Lewis E. Katz and Madhav S. Phadke
This article represents a very brief discussion of robust design. It contains some very strong statements regarding the "traditional approaches" used in quality assurance. Statements such as "The traditional method of studying a large number of variables has been to review them one at a time" only serves to alienate an entire group of quality practitioners that have been using other experimental designs for several years. Further statements such as "The robust design concept does not eliminate experiments – it simply makes the selection of the variable settings and the production tolerances much more efficient, saving time and costs" is an example of good start but suggests guaranteed success from experimentation which is not always the case!

3. *Quality Engineering Using Design of Experiments,* M.S. Phadke
This article was presented at the American Statistical Association's 1982 Joint Statistical Meetings. Much of the material discussed in this section appears elsewhere in the text with the exception of an introduction to Taguchi's linear graphs.

4. *Off-Line Quality Control, Parameter Design, and the Taguchi Method,* Raghu N. Kackar
Represents a reasonably comprehensive introduction to several of Taguchi's ideas now being discussed by practitioners. A good set of Discussions (Box 1985; Easterling 1985; Freund 1985; Lucas 1985; Pignatiello and Ramberg 1985) and Response (Kackar 1985a) appeared with the original manuscript (Kackar 1985) and are highly recommended as complementary readings.

5. *Quality Engineering Through Design Optimization,* G. Taguchi and M.S. Phadke
The editor indicates that this article first appeared as Taguchi and Phadke (1984) and alone is an interesting paper. The article outlines a systematic approach to a general quality problem and also discusses an optimization strategy for a particular process.

Part Two – Case Studies

6. *Off-Line Quality Control in Integrated Circuit Fabrication Using Experimental Design,* M.S. Phadke, Raghu N. Kackar, D.V. Speeney, and M.J. Grieco

7. *Optimizing the Wave Soldering Process,* K.M. Lin and Raghu N. Kackar

8. *Robust Design: A Cost Effective Method for Improving Manufacturing Processes,* Raghu N. Kackar and Anne Shoemaker

9. *Tuning Computer Systems for Maximum Performance: A Statistical Approach,* William A. Nazaret and William Klinger

10. *Design Optimization Case Study,* M.S. Phadke

Part Two – Case Studies – signals a major difference between this book and most other statistics books in that five case studies that discuss and highlight concepts introduced in Part One are presented. Each study represents a success story from AT&T and all read like consulting reports. The case studies are a prominent part of the book and should not be missed as they are instrumental in establishing the techniques previously discussed. The electronic nature of the case studies is a marginal distraction and only slightly affects readability.

Part Three – Methodology

11. *Testing In Industrial Experiments With Ordered Categorical Data,* Vijayan N. Nair
Again, the book would have benefited from inclusion of additional Comments (Agresti 1986; Box and Jones 1986; Hamada and Wu 1986; McCullagh 1986) and Response (Nair 1986a) that appeared with the original article. (Reviewer's Note: a recent article (Hamada and Wu 1990), associated Discussions, and Response is also a suggested reading).

12. *Performance Measures Independent of Adjustment: An Explanation and Extension of Taguchi's Signal-to-Noise Ratios,* Ramón León, Anne Shoemaker, and Raghu N. Kackar
See additional Comments (Boardman 1987; Easterling 1987; Box and Fung 1987; Dehnad 1987; Pignatiello and Ramberg 1987; Wu 1987) with Response (León, Shoemaker, and Kackar 1987a).

13. *A Geometric Interpretation of Taguchi's Signal to Noise Ratio,* Khosrow Dehnad

14. *A Data Analysis Strategy for Quality Engineering Experiments,* Vijay Nair and Daryl Pregibon
Chapters 11, 12, and 13 represent research papers that extend the general ideas promoted by Taguchi. They are distinctly more theoretical than the first ten chapters and initially may not appeal to the practitioner. However, as the practitioner becomes more comfortable with statistics and the ideas presented in earlier chapters, this section will be of some interest. Chapter 14, much like Chapter 10, outlines a systematic approach to implementation and can be easily read with the first ten chapters.

Overall the book represents a significant collection of papers expounding upon several ideas of Taguchi. Although some of the ideas are controversial the book is recommended for the practitioner's bookshelf.

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Groves, R.M., Survey Errors and Survey Costs. John Wiley & Sons, New York, 1989. ISBN 0-471-61171-9. xxi + 590pp., £47.

A strong argument can be made that the most important statistical innovation in this century was the development of the sample survey and its application to human populations and organizations. This versatile tool has given a considerable boost to the social sciences to the point that most empirical social science research is based on data obtained through sample surveys. It is even more important to the running of modern societies: Most of the information used by policy makers and public administrators on the workings of our societies is based on sample surveys. Indeed, were it not for essentially political reasons, sample surveys would have replaced the population census because the former can provide better information about a society in a more timely fashion.

Yet sample surveys are not perfect information gathering instruments. Groves's monograph provides its readers with an understanding of the sources of survey errors, an encyclopedic summary of our current knowledge about how these errors arise and how they vary, and, importantly, an agenda for increasing our knowledge about the best way to minimize errors (subject to time and resource constraints).

There is much to be learned from Groves's painstaking volume. Especially valuable is his classification of survey errors, a brief summary of which follows:

To conduct a sample survey requires a bundle of associated skills, unfortunately not all at the same level of scientific development. Sampling theory and its practical applications are undoubtedly the best developed tools in the sample survey bundle: Sampling statisticians know how to design samples and how to calculate the associated sampling errors. Ingenious approaches have been invented to deal with seemingly intransigent sampling problems, e.g., sampling homeless persons in urban areas or nomadic tribes in a sparsely settled area. Although we know how to conceptualize and even calculate them, sampling errors are not the only error problems with which we have to deal in understanding and evaluating sample surveys.

Most of the remaining items in the tool kit do not have the same base of developed theory and are served more by craftlore than by well-articulated theory. First, all sample designs require a sampling frame, an exhaustive list of the entities to be sampled. Every sampling frame suffers to a greater or lesser degree from omissions of sampling units: For example, a sampling frame based on residential telephone numbers necessarily omits persons and households that do not have telephones. For many telephone surveys, the non-coverage of persons in households without telephones may be acceptable especially in the light of economic benefits. In other surveys, omission of that group may be a serious flaw. In short, non-coverage errors in principle can be minimized, usually by increasing the funds allocated for the survey.

Second, every sample design carried out in the field comes up against the fact that some of the entities designated to be in the sample – persons, households, government units, firms, etc. – cannot be reached and some will refuse to be interviewed or to fill out the survey forms, a combined proportion that ranges in the United States from 5% in the best of government sponsored surveys to 25–30% in the typical surveys run by the major academic and commercial survey research centers to 50% or more in the less rigorous surveys conducted by market research firms operating on stringent budgets. We have only incomplete understanding of why some surveys have high and others have low response rates. Sponsorship does play a role as well as the subject matter of the survey. We also know that non-response rates can be reduced by intensive efforts in the field consisting of repeated attempted contacts with those not reached and persuasive efforts to convert those who have refused to cooperation. Craftlore concerning non-response is far from perfect but constitutes a body of knowledge that does provide guidelines.

Third, designing survey schedules and questionnaires is perhaps the least well developed part of the sample survey tool kit. Psychometrics and, to a lesser degree, econometrics have provided a theoretical framework for understanding survey instruments, *after* they have been used but provide little guidance at the design stage. Writing survey instruments is still largely an art form because of the almost complete absence of a theory of response. A few generalizations are established: The responses of individuals (or organizations) are affected by the survey delivery mode, i.e., by telephone, mail, or face to face interviews. We also know that interviewers affect responses but in ways that are difficult to generalize. Even more important are the effects of questionnaire or schedule wordings: Seemingly slight wording changes can produce large shifts in responses. Save for a few ingenious experimental efforts from which it is difficult to generalize, we know little about how wording changes affect responses.

An especially valuable effort in Groves's volume arises from his tying his discussion of survey errors to survey costs. For many sources of error, it is possible to reduce the size and direction of the errors by increasing the funds allocated. In a world of infinite resources, it would be possible to reduce errors as much as one wanted. In the real world of limited resources, the sponsor of sample surveys needs to know how much error reduction can be obtained by each additional increment. Groves provides some answers by developing functions which relate error reduction to costs.

This volume is an extremely valuable contribution to survey methodology. It has many virtues: First, it provides a framework in which survey errors can be segregated by sources. Second, Groves has skillfully synthesized existing knowledge, bringing together in an easily accessible form empirical knowledge from a variety of sources. Third, he has managed to integrate into a common framework the contributions of several disciplines. For example, the work of psychometricians and cognitive psychologists is made relevant to the research of econometricians as well as the field experience of sociologists. Finally but not least, Groves has managed to present all this in a style that is accessible to a wide variety of readers ranging from survey specialists to policy makers.

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Harvey, A.C. Forecasting, Structural Time Series Models and the Kalman Filter. Cambridge University Press: Cambridge 1989. ISBN 0-521-3296-4. 554pp., £55.

This is an impressive book detailing a subject that has not previously been presented in book form. The developments in this area owe a lot to Harvey, whose work in this field dates back to the early 80s.

The book is intended for teaching purposes and contains a number of exercises. A knowledge of linear algebra and calculus is presupposed. Without basic training in statistics covering at least maximum likelihood and least squares estimation in regression models, this book will prove difficult to read.

The basic building block for the book is a structural form for a time series model. This structural model can be seen as a modernization of the classic trend plus seasonal dummies models. The modernization and the concept of a structural form stem from the more flexible and explicit modelling of the trend, seasonal, as well as irregular components. In Harvey's terminology, the autoregressive-moving average (ARMA) models popularized by Box and Jenkins are reduced form models. The structure concept refers to the pattern in the data and it should not be interpreted as the econometricians' structural form.

The book consists of nine chapters. After the Introduction, Chapter 2 is devoted to the class of structural time series models. They are introduced as being, for instance, extensions to primarily exponentially weighted moving averages. A distinguishing feature is the emphasis on the stochastic specification, enabling the use of the statistical technique. For the seasonal component, both trigonometric and seasonal effect specifications are given. The relationships to ARMA and other model types are also discussed.

The structural form time series models and ARMA models have a corresponding state space representation. In Chapter 3 the form is introduced and some of its basic characteristics, such as minimal realization, observability, and controllability, are briefly discussed. Based on this, a fairly complete treatise on the Kalman filter follows with both its theoretical and practical properties summarized. The maximum likelihood estimator based on prediction errors from the state space form are given. Examples and numerical algorithms are discussed.

The Chapter 4 contains the details of estimation in both the time and frequency domains. Computationally the latter has advantages, even if the time domain techniques should not be overwhelmingly time consuming on a modern PC. The identifiability of structural time series models is discussed.

Chapter 5 considers various tests. A particular effort is devoted to likelihood ratio, Wald, and Lagrange multiplier tests when some of the parameters lie on the boundary of the parameter space.

The model class is extended in various directions in Chapter 6. Mention can be made of interesting new applications of count data models. In addition, growth and exponentially distributed dependent variables are considered.

The implications of introducing explanatory variables into the structural time series model, for estimation, testing, and so on, are given in Chapter 7.

In Chapter 8, extensions to multivariate models, as, e.g., seemingly unrelated regressions and dynamic factor analysis, are analyzed. Chapter 9 is devoted to continuous time models.

In summary, this book is important, offering in one context a real alternative approach to ARMA-type models. A program package for PC's is also available. The book contains a great number of illustrative models that frequently reappear. While these highlight specific issues, they also tend to hide basic ideas besides adding pages. For teaching purposes at an advanced undergraduate level it is advisible to emphasize a selected number of central issues, possibly illustrated with one or two empirical examples.

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Healy, M.J.R., GLIM: An Introduction. Oxford University Press, Oxford, 1989. ISBN 0-19-852225-8, ix + 130pp, £10.95

The class of generalized linear models, introduced by Nelder and Welderburn in 1972, provides a very powerful extension to standard linear regression models. The enhanced class includes as special cases techniques such as regression, analysis of variance, the log linear modelling of contingency tables, logistic regression, and probit analysis. It therefore encompasses a considerable proportion of the most commonly used statistical methodology.

The statistical package GLIM, first released commercially in 1974, is designed specifically to fit generalized linear models and now has versions available for most mainframes and micro-computers. Despite its wide applicability and availability, however, the package has not been utilised to the extent that it ought to be. The main reasons for this are its command language, which can be very off-putting to beginners, and the lack of any suitable introductory text. Until recently the only available documentation has been the package's reference manual which, like most such manuals, is useful to experienced users but not very helpful to novices.

Healy's book aims to fill this gap, providing an introduction to the facilities and command language of GLIM without attempting an exhaustive coverage of its capabilities. The book assumes a readership with knowledge of statistics up to the level of multiple regression, but apparently requires less computing expertise since it describes very basic operations such as pressing the return button after each instruction. It would seem to be aimed at users of statistics, possibly with prior experience of a basic statistics package, rather than at statisticians per se. Within these limits it is an excellent book, completely fulfilling its stated purpose and giving sufficient guidance to bring readers to a level at which they should be able to cope with a more advanced text if necessary. The book is complementary to two other recent texts by Aitken et al. (1989), which takes a more mathematically orientated approach to statistical modelling with GLIM, and McCullagh and Nelder (1989), which concentrates on the theory of generalized linear modelling.

The chapters of the book alternate between describing GLIM utilities and describing the fitting of particular models, starting with the very simplest. This enables the GLIM novice to produce results at an early stage without having to learn an excessive amount of detail. More complex aspects of GLIM are introduced gradually as needed for specific models, thus ensuring an understanding of their relevance to statistical analysis. Chapter 1 is concerned with data input and display, including histograms and two-dimensional plots, while Chapter 2 describes the fitting of simple linear models for continuous variables only. Chapter 3, calculations, deals with the numeric facilities of GLIM including arithmetic and data transformation, random number generation, and sorting. Chapter 4, data in tables, is concerned with analysis of variance while Chapter 5 describes the available tabulation facilities. Chapter 6, models with factors and variables as predictors, deals with analysis of covariance and Chapter 7 is concerned with data in the form of counts. Chapter 8, files and text, considers input and output while Chapter 9, macros, describes the extent to which GLIM can be used as a high level programming language in which to write short programs. Chapter 10, miscellanea, briefly considers a number of predominantly computational topics such as convergence, and three appendices give lists and details of the GLIM commands.

On the whole the writing style is lucid and the book very readable. The use of special symbols to mark passages appropriate only to the latest version of GLIM, and the insertion of references directly into the text, both tend to interrupt the flow of the text and proved irritating at times. While the former device may be necessary if the book is not to be restricted to a subset of GLIM users, the latter is not and the book would benefit by having a separate reference list. The one flaw in the book, if indeed it is a flaw, is its brevity. The description of GLIM and its facilities is extremely well done, but other aspects of the modelling process are not covered in such great detail. This is most apparent in two situations. Firstly, most of the modelling chapters contain brief descriptions of techniques and these are often very basic. Secondly, there is a tendency to gloss over the question of problems arising in the analysis, examples being the problem of model selection and colinearity in Chapter 2 and the problem of aliasing in Chapter 4.

Since, however, the book is intended as an introduction to GLIM and not to statistical modelling, it could be argued that extending these areas would not enhance its usefulness. A final deficiency is the lack of any supplementary material or problems for the reader to work with, apart from those examples directly used in the text.

In summary, Healy has written an excellent and much needed introduction to the GLIM package. Supplemented by additional material on methodology it would form an ideal basis for service courses on generalized linear modelling and GLIM.

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Keats, J.B. and Hubele, N.F. (Eds.), Statistical Process Control in Automated Manufacturing. Marcel Dekker, Inc., New York, 1989. ISBN 0-8247-7889-8. xv + 294pp., $69.75.

One of the most important goals in manufacturing is to continually improve the quality of the products while at the same time reduce the manufacturing cost. To keep the manufacturing cost low, the traditional statistical process control (SPC) procedures make decisions about the status of a manufacturing system based on samples of products (usually small samples) taken from the manufacturing line. With the increasing availability of inexpensive computers and automated data acquiring systems, it is possible to take measurement from every product and this will give rise to data that are correlated. Multiple measurements may be taken from every product and the data become multivariate. In addition to the statistical information, classification information such as part number, date produced, and the operator in charge may also be gathered. It is easy to collect a huge amount of manufacturing information in an automated manufacturing system.

It is apparent that new procedures are needed to handle the multivariate correlated statistical information. This entails resolving the management of the huge amount of manufacturing information and addressing the combined use of the statistical and classification information in improving the quality of products. Procedures presented in this monograph for handling manufacturing information generated from an automated manufacturing system include time series modeling (including Kalman filter), control charting procedures, keeping statistical databases, expert systems, and real-time machine control. Key issues and implementation strategies in an automated manufacturing setting are also addressed. It must be noted that sampling must still be used in many manufacturing systems which involve destructive testing. Knowledge of time series modeling (Box and Jenkins 1976) and statistical process control is essential for a good understanding of this monograph. This monograph is an important step in the right direction for continual research of suitable and effective procedures for use in automated manufacturing systems. There are twelve papers in this research monograph. Seven of these were presented at the "Statistical Process Control: Keeping Pace with Automated Manufacturing, a National Symposium," held at Arizona State University on November 6–7, 1986. The main contributions of each paper are highlighted below.

With the availability of inexpensive data-gathering systems in an automated manufacturing setting, Keats discusses the effects of the avalanche of statistical information on the role and goal of SPC procedures. Keats also gives a review of the traditional SPC control procedures, feedforward and feedback control schemes. However, it is not clear from the paper how one can adapt the use of these traditional SPC procedures in an automated manufacturing system.

Contreras gives a general idea of an on-line statistical process control system (OLSPCS) by describing the objectives and desirable characteristics of an OLSPCS. Both the managerial and technical problems in implementing an OLSPCS are discussed. In contrast with the "bottom-up" and "top-down" implementation strategies, Contreras presents a "middle-out" implementation strategy which is based on small incremental changes and reviews with respect to a master plan.

Concerned with the presence of autocorrelation and systematic time series effects which could yield misleading information regarding the state of statistical control by traditional control charts, Alwan and Roberts propose modeling systematic nonrandom causes by autoregressive integrated moving average (ARIMA) models. A chart of fitted values based on a fitted time series model is constructed for detecting common causes (systematic, nonrandom causes) and a second chart based on the residuals from the fitted model is constructed for detecting special or assignable causes.

The procedure developed by Montgomery and Friedman is similar to that developed by Alwan and Roberts. Time series models are used to fit the data to produce uncorrelated residuals. However, Montgomery and Friedman suggested plotting the residuals only for the detection of changes in the original signal.

The simple exponential smoothing model and exponential with trend model are demonstrated by Kirkendall to be special cases of the Kalman filter. Explicit relationships between the parameters of these models and the Kalman filter are given.

An extension of the iid (independent and identically distributed) model is considered by Crowder with the process mean allowed to wander over time. This turns out to be a special case of the Kalman filter. Using results from Bayesian Kalman filter theory, the posterior process mean is expressed as an EWMA (exponentially weighted moving average) with the smoothing constant depending on some unknown variances, which can be estimated using an MLE (maximum likelihood) approach. A control chart procedure based on the box and the whisker plot of the posterior distribution of the process mean is developed.

Hubele gives a multivariate extension of the narrow-limit gaging procedure. In a univariate narrow-limit gaging procedure, narrow gage limits are specified within the specification limits. The interval between the narrow gage limits is coded green, the intervals outside the specification limits are coded red and the intervals outside the narrow gage limits but within the specification limits are coded yellow. This is just like a Shewhart chart with an out-of-control region, warning region, and in-control region. The yellow regions are indicators of potential problems. For a two-dimensional case, two ellipses with probabilities 0.86 and 0.999 respectively are drawn, and nine subregions are specified based on the intersection of straight lines formed by $\mu_1 \pm 2\sigma_{11}$, $\mu_1 \pm 4.5\sigma_{11}$, $\mu_2 \pm 2\sigma_{22}$, and $\mu_2 \pm 4.5\sigma_{22}$. No explanation is given for the choice of the numbers 2 and 4.5. A set of rules is also given without explanation for adjusting the parameters μ_1, μ_2, σ_{11}, and σ_{22} depending on the positions of two consecutive observations in the nine regions within the two ellipses. This procedure might lead to an over-adjustment of the process. A far more important issue remains unanswered: How does one actually adjust the unknown process means and variances? Many references are missing from Hubele's paper.

A new control charting procedure is developed by Coleman. The underlying distribution function first has to be estimated and then the observations are transformed into approximate uniform variates $\{U_i\}$ using the estimated distribution function. A control chart procedure is then developed based on the magnitude of the quantity $p_{n,k}^{\text{low}} = \Pr(\pi_{i=n-k+1}^{n} U_i < R)$ for some fixed k and R. A small value of $p_{n,k}^{\text{low}}$ indicates that one or some of the $\{U_i, i = n - k + 1, \ldots, n\}$ are too small and gives an indication of an out-of-control mode. The value of $p_{n,k}^{\text{high}}$ is similarly defined. One useful feature of Coleman's procedure is the glyph plot which is constructed based on the values of $\{p_{n,k}^{\text{low}}\}$.

These glyph plots show more clearly than the Shewhart chart any shift or trend in the process mean. My main concerns with Coleman's procedure include the following: (1) With the probability integral transformation, one is no longer working with the parent distribution. As Coleman notes when he talks about using sample means in $\bar{X}$ chart "The parent distribution is a 'signature' of the process, and ideally should be familiar to those who are trying to control the process," (2) Based on a simulation study, Coleman claims that the performance of his procedure is comparable to that of a CUSUM chart. However, I remain unconvinced due to the fact that the charts that Coleman uses for comparison do not have the same in-control average run length (the difference is substantial), and (3) The use of the glyph plot as an on-line SPC tool for making a decision as to whether a process is in control or not is not suitable for two reasons: (i) an overhead of observations is needed before a glyph plot can be constructed and (ii) any pattern due to an out-of-control mode may not become obvious until many sample points later and this is not desirable in SPC. Coleman's glyph plot is more suitable as a tool for the study of past data. As a final note, Coleman seems to think that the CUSUM chart cannot be used for any arbitrary distribution even if the in-control distribution can be characterized (see pages 155 and 179). As long as the in-control distribution can be adequately characterized, the ARL properties of a CUSUM chart may be studied either using the integral equation procedure (continuous case) developed by Page (1954) or the Markov chain procedure (both discrete and continuous cases) described by Brook and Evans (1972). In short, the CUSUM chart can be used for any arbitrary distribution as long as the in-control distribution can be characterized.

The goals, benefits, and desirable characteristics of manufacturing databases for automated manufacturing systems are discussed by Ghosh. A general model containing categorical and statistical attributes is emphasized.

Gidwani claims that PICON (process intelligent control) is the first expert system tool (an integrated hardware/software environment) specifically designed for building on-line real-time systems. On-line real-time means that the system is capable of communicating with a data acquisition system to access information as required during the decision making process. An overview of PICON is given.

LeClair and Park describe the development of an expert system that is able to understand aggregate (fused) data from multiple sources (sensors), and hence the name sensor fusion. The basic rationale behind a sensor fusion system is that combining input from several sources will produce a more reliable perception of the targeted environment as compared to separate evaluation of input from each source.

The quality of a finished workpiece in metal-cutting operations depends to a large extent on the relative position between the cutting tool and the workpiece, which in turn depends on machine tool geometric error, thermal effect, and static loading. Donmez describes the application of a deterministic methodology to develop a real-time control system to a CNC (computer numerical control) machine tool for compensation of machine tool geometric and thermally induced errors. Significant accuracy enhancement is achieved on the machine parts produced.

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Syski, R., Random Processes, A First Look. Second Edition, Revised and Expanded. Marcel Dekker, New York and Basel, 1989. ISBN 0-8247-8028-0. xxii + 413pp., $49.75 (in U.S.A. and Canada), $59.50 (in all other countries).

This book is (assuming a knowledge of calculus) an introduction to probability theory with an emphasis on stochastic processes (Markovian, renewal, branching, and birth and death processes). It is the second revised and expanded edition with a new chapter on maximum likelihood estimation including such estimation in connection with Poisson and birth and death processes. This new chapter also has a section on probabilistic modelling.

The book is written in a lively, entertaining, and challenging style. The chapters are called "Easy Life and Good Times," "Be Discreet with Discrete," "To Renew or Not to Renew," "Markovian Dance," and "Inference from Interference." The first edition of the book has been very well received by reviewers and users and the second edition can be even more highly recommended as a challenging, easily read introduction to probability theory and stochastic processes. The book should be especially suitable for self-study. An extra bonus is the rich collections of good exercises after each chapter.

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