H.-J. LENZ
P.-TH. WILRICH
Editors

Frontiers in Statistical Quality Control

8

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With 92 Figures
and 93 Tables

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Editorial

The VIIIth International Workshop on "Intelligent Statistical Quality Control" took place in Warsaw, Poland, and was hosted by Professor Dr. Olgierd Hryniewicz, Systems Research Institute of the Polish Academy of Sciences and Warsaw School of Information Technology, Warsaw, Poland. The workshop itself was jointly organized by Professor Dr. O. Hryniewicz, Professor Dr. H.-J. Lenz, Professor Dr. P.-T. Wilrich, Dr. P. Grzegorzewski, Edyta Mrówka and Maciej Romaniuk.

The workshop papers integrated in this volume are divided into three main parts: Part 1: "General Aspects of SQC Methodology", Part 2: "On-line Control" with subchapters "Sampling Plans", "Control Charts" and "Monitoring", and Part 3: "Off-line Control" including Data Analysis, Calibration and Experimental Design.

In Part 1 **"General Aspects of SQC Methodology"** ***von Collani and Palcat*** analyze "How Some ISO-Standards Complicate Quality Improvement". They compare the aims of ISO-Standards for QC with the aims of continuous quality improvement. Due to a lack of compatibility different QC procedures are proposed.

In Part 2 **"On-line Control"** there are fifteen papers. It starts with two papers on **"Sampling Plans"**. ***Hryniewicz*** considers "Optimal Two-Stage Sequential Sampling Plans by Attributes". Acceptance sampling by attributes requires large samples when the fraction of nonconforming items in sampled lots or processes is very low. Wald's sequential sampling plans have been designed in order to meet this situation. Hryniewicz proposes restricted, curtailed sequential sampling plans for attributes. The plans fulfil pre-specified statistical requirements for risks, while offering minimal sampling efforts. ***Palcat*** reviews three-class sampling plans useful for legal metrology studies in his paper entitled "Three-Class Sampling Plans - A Review with Applications". He reviews the key features of the three-class sampling plan theory and discusses some applications, where such plans would be effective for QC. The author examines applications, which are specific to the field of legal metrology. He closes with case studies where isolated lots are common and currently used methods are problematic.

Control Charting has been an integral part of On-line Control, and there is evidence that this will continue. Therefore almost one half of the papers focus on **"Control Charts"**. ***Bodnar and Schmid*** in "CUSUM Control Schemes for Multivariate Time Series" extend multivariate CUSUM charts to VARMA processes with Gaussian noise superimposed. They consider both modified control charts and residuals charts. By an extensive Monte Carlo study they compare them with the multivariate EWMA chart (Kramer and Schmid 1997). ***Knoth*** pays special attention to the correct design goal when control charts are run. His paper is entitled "The Art of Evaluating Monitoring Schemes – How to Measure the Performance of Control Charts". The author asks for caution when using the "the minimal out-of-control ARL" as a design criterion of monitoring schemes and advocates the "minimal steady-state ARL" from the viewpoint of features of the steady-state delay distribution. ***Morais and Pacheco*** present some striking examples of joint (μ, σ)-schemes in "Misleading Signals in Joint Schemes for μ and σ". They show that the occurrence of misleading signals should alert the quality staff on the shop floor, and the practioneers should be bothered. ***Mrówka and Grzegorzewski*** contribute to a new design of control

charts with a paper on "The Fréchet Control Charts". They suggest the Fréchet distance for simultaneously monitoring of process level and spread. Their new chart behaves comparable to classic control charts if changes either in process level or in process spread only are observed. However, it is much better than a combined ($\overline{x}$ - s)-chart if simultaneous disturbances of the process level and spread happen. In their paper entitled "Reconsidering Control Charts in Japan" ***Nishina, Kuzuya and Ishii*** study the role of causality and its relation to goals as target functions of control charting. Machine capability improvements due to advanced production technology have resulted in variance reduction within subgroups. They note that part of the variance between subgroups can be included into the variance due to chances. In a case study they show that a measurement characteristic specified by a related Standard is not necessarily appropriate for the control characteristic. ***Pokropp, Seidel, Begun, Heidenreich and Sever*** monitor police activities in "Control Charts for the Number of Children Injured in Traffic Accidents". They specify a generalised linear model (GLM) with Poisson counts. Parameter estimation is based on data, which represents the daily number of injuries. Seasonal effects are considered. Control limits are computed by Monte-Carlo simulation of the underlying mixing distributions in order to detect deviations from the police target values for various periods of interest. ***Reynolds jr. and Stoumbos*** take a look at process deviations and follow up the rational subgroup concept in "A New Perspective on the Fundamental Concept of Rational Subgroups". Control charts are usually based on a sampling interval of fixed length. They investigate the question whether it is better or not to use sample sizes $n = 1$ or $n > 1$ and to select either concentrated or dispersed sampling. A tandem chart to control μ and σ is investigated. They conclude that the best overall performance is obtained by taking samples of $n = 1$ and using an EWMA or CUSUM chart combination. The Shewhart chart combination with the best overall performance is based on $n > 1$. ***Saniga, McWilliams, Davis and Lucas*** investigate "Economic Advantages of CUSUM Control Charts for Variables". Their view on an economic CUSUM design is more general than the scope of earlier publications on this topic. ARLs are calculated using the Luceno and Puig-Pey (2002) algorithm in combination with a Nelder Mead search procedure. The policy decision of choosing a CUSUM chart or a Shewhart chart is addressed. ***Suzuki, Harada and Ojima*** present a study on "Choice of Control Interval for Controlling Assembly Processes". Time series models are used for effective process control of specific assembly processes, especially, if the number of products is high. Influential factors like the control interval or the dead time of the assembly process are considered. ***Yasui, Ojima and Suzuki*** in "Generalisation of the Run Rules for the Shewhart Control Charts" extend Shewart's 3-sigma rule and propose two new rules based on sequences of observations. The performance of such modifications is evaluated under several out-of-control scenarios.

Part 2 closes with three papers on "**Monitoring**". ***Andersson*** in her contribution to "Robust On-Line_Turning Point Detection. The Influence of Turning Point Characteristics" is interested in turning point problems of cyclical processes. She develops and evaluates the methodology for on-line detection of turning points in production processes by using an approximate ML estimation technique combined with a nonparametric approach. ***Iwersen and Melgaard*** in "Specification Setting for Drugs in the Pharmaceutical Industry" discuss the practical implications of setting and maintaining specifications for drugs in the pharmaceutical industry. These include statistical process control limits, release limits, shelf life limits and in-use limits. The challenge is to make the limits consistent and practical. The approach involves normal linear mixed models and the Arrhenius model, a kinetic model, which describes for example the temperature dependence on drug degradation. In "Monitoring a Sequencing Batch Reactor for the Treatment of Wastewater by a Combination of Multivariate Statistical Process Control and a Classification

Technique" ***Ruiz, Colomer amd Melendez*** combine multivariate SPC and a specially tailored classification technique in order to monitor a wastewater treatment plant.

Part 3 **"Off-line Control"** includes five papers. ***Göb*** discusses in "Data Mining and Statistical Control – A Review and Some Links" statistical quality control and its relation to very large (Terabytes) databases of operational databases sampled from industrial processes. He strongly advocates for adoption of techniques for handling and exploring large data sets, i.e. OLTP databases and (OLAP) data warehouses in industry. He reviews the links between data mining techniques and statistical quality control and sketches ways of reconciling these disciplines. ***Grzegorzewski and Mrówka*** consider the calibration problem in which the corresponding loss function is no more piecewise constant as in Ladany (2001). In their paper on "Optimal Process Calibration under Nonsymmetric Loss Function" they consider the problem of how to set up a manufacturing process in order to make it capable. They propose an optimal calibration method for such loss functions. The suggested calibration procedure depends on the process capability index C_p. ***Ojima, Yasui, Feng, Suzuki and Harada*** are concerned with "The Probability of the Occurrence of Negative Estimates in the Variance Components Estimation by Nested Precision Experiments". They apply a canonical form of generalised staggered nested designs, and the probability of the occurrence of negative LS estimates of variance components is evaluated. Some practical hints are derived for the necessary number of laboratories involved in such problems. ***Koyama*** in "Statistical Methods Applied to a Semiconductor Manufacturing Process" uses a $L_{16}(2^{15})$ orthogonal design and presents a semi-conductor factory scenario where new types of semiconductors are to be manufactured very shortly after the design. The lack of time causes small data sets as well as a lot of missing values. Finally, ***Vining and Kowalski*** in "An Overview of Composite Designs Run as Split-Plots" firstly summarise the results of Vining, Kowalski, and Montgomery (2004) and Vining, Parker, and Kowalski (2004). The authors secondly illustrate how to modify standard central composite designs and composite designs based on Plackett-Burman designs to accommodate the split-plot structure. The paper concludes with a walk through a fully worked-out example.

The impact of any workshop is mainly shaped by the quality of papers, which are presented at the meeting, revised later and finally submitted. We would like to express our deep gratitude to the following members of the scientific programme committee, who did an excellent job with respect to the recruiting of invited speakers as well as refereeing all the submitted papers:

Mr David Baillie, United Kingdom
Prof. Elart von Collani, Germany
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Prof. Hans-J. Lenz, Germany
Prof. Yoshikazu Ojima, Japan
Prof. Poul Thyregod, Denmark
Prof. Peter-Th. Wilrich, Germany
Prof. William H. Woodall, U.S.A.

We would like to close with our cordial thanks to Mrs. Angelika Wnuk, Institute of Production, Information Systems and Operations Research, Free University Berlin, who assisted us to clean up and to integrate WINWORD papers.

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On behalf of all participants, the editors would like to thank Professor Dr. Olgierd Hryniewicz and his staff for their superb hospitality, the perfect organisation, and the stimulating scientific atmosphere. We are happy and proud to announce that the International Workshop on Intelligent Statistical Quality Control will be continued in 2007.

Berlin, November 2005

Hans - J. Lenz
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PART 3: OFF-LINE CONTROL

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Part 1

General Aspects of SQC Methodology