

List of all Abstracts by ID

Below you find a complete listing of all abstracts sorted by id and a link to the full paper is available.

10 A New Formulation for A and E-Optimal Multi-Response Experiments

Ali Babapour Atashgah, *Amirkabir University of Technology Industrial Engineering De*
Abbas Seifi , *Amirkabir University of Technology IE Dep.*

Abstract:

Many real world experiments have multi-response characteristics. Optimal design of multi-response experiments is a challenging problem. In this paper, multi-response A and E-optimal design problems have been formulated as Semi-Definite Programming (SDP) models and solved efficiently. The new formulation allows adding some cost and other technological constraints. The SDP models generate optimal -exact designs for multi-response linear models in a general design space. The proposed formulations have been tested on several test problems and have proven to be very efficient. Numerical experiments show that the SDP formulations generate the multi-response optimal designs efficiently using an efficient interior-point solver.

11 Planning and executing organizational assessments using benchmarks of excellence

Ron Kenett, *KPA Ltd. and Univ. of Torino, Italy*

Yossi Raanan , *Business School, College of Management " Academic Studies , Rishon LeZion, Israel and KPA Ltd.*

Roberto Corradetti , *Dept. of Statistics, Univ. of Torino, Italy*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Achieving organizational excellence is a significant management challenge. In order to facilitate such efforts one needs an effective plan combining Best In Class accumulated experience with practical tools and methodologies.

This paper will describe how to combine the criteria of the US Malcolm Baldrige National Quality Award (MBNQA) with the framework spelled out by Jim Collins in his book "good to Great: why some companies make the leap... and others don't".

The approach includes three phases: planning, data collection and analysis. The objective is to design a tailored and effective road map for an organization on it's journey to excellence.

MBNQA provides 7 criteria for organizational excellence, Collins maps 6 steps over time that great companies were able to accomplish in order to achieve breakthrough results. Combining an assessment based on MBNQA with Collin's time line produces a surprisingly effective plan.

The methodology presented in this work involves statistical issues of experimental design, techniques related to surveys and interviews for data collection and specialized data analysis techniques.

Examples from implementation in a global multi-billion dollar company will be provided to demonstrate the approach.

Keywords: Big Q, Malcolm Baldrige National Quality Award, From Good to Great. Interview techniques, Planning organizational assessment, Organizational data analysis .

13 How to Improve an Organisation

Mike Holmes,

Abstract:

This presentation will explore how organisations gear up to improve. Most have no formal policies or procedures and approach improvement along cottage industry lines. A cottage industry approach leads to cottage industry scale improvement. In this presentation, we will explain the UIMPROVE approach, how to set up for industrial scale improvement and the role of data and statistical support in this.

14 Clusters Detection in Regression Models Applied to a Pollution Risk Evaluation Problem. The L2 Approach.

Ennio Davide Isaia, *Dept. Statistics & Applied Mathematics*

Alessandra Durio , *Dept. Statistics & Applied Mathematics*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Purpose of this paper is to investigate on the use of L_2 distance as a theoretical and practical estimation tool for parametric regression models.

This approach is particularly helpful in all those situations involving the study of large data sets, handling large samples with a consistent numbers of outliers, situations in which maximum likelihood regression models are usually unstable.

We shall also see how L_2 criterion may be applied in fitting mixture regression models and how it allows to detect clusters of data.

After explaining the use of the methods with some simulated examples, we shall point out main results of an industrial case study.

Firms operating in the field of pollution contamination risk of electrical transformers usually run chemical analysis on the oil of the transformer themselves in order to prevent and mitigate the risks of fire and of electric shocks.

To verify that their methods of assigning risk's values are independent of specific characteristics of the transformers (e.g. age, voltage, fluid quantity, ...) we resort to L_2 criterion to investigate on the relation between risk's values.

15 Six Sigma implementation in a UK Manufacturing SME: A Case Study

Jiju Antony, *Centre for Research in Six Sigma and Process Improvement*

Maneesh Kumar , *Centre for Research in Six Sigma and Process Improvement*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Does Size matter? Is Six Sigma only for large organisation? Does Six Sigma require a strong infrastructure? What about its application in Small and Medium-Sized Enterprises (SMEs)? These are some of the questions that are being encountered in recent years within Six Sigma community. Large organisations have been reaping benefits from successful deployment of Six Sigma, a business strategy that aims to identify and eliminate causes of mistakes or defects in business processes by focusing on process outputs that are of critical importance to customers. The ability to manufacture product or deliver services to its customer with only 3.4 defects per million opportunities yields a Six Sigma process. Since its inception at Motorola in mid 1980s, Six Sigma has sailed from manufacturing sector to service sector and transactional processes, generating revenues to organisations in billions. Though this business strategy has been applied to many large organisations, still very few cases are reported of its successful implementation in SMEs. The reason being quoted as resource constraints (financial, human, and technical) for its deployment; requires strong infrastructure; the present model not suitable for SMEs, and so on.

Do the aforementioned reasons really count? The answer to this is presented in this paper in the form of a case study as how Six Sigma was successfully deployed in a UK manufacturing SME and valuable lessons learned from its application are shared to encourage small businesses to buy-in faith in this business strategy. The research was carried out with an objective of assessing the status of Six Sigma in SME, challenges and barriers the company faced in its deployment. Both Survey and semi-structured interview were used as the research methodology to achieve the research objectives. Data analysis was carried out using the latest version of SPSS (13.0) and Microsoft excel. The results are primarily based on descriptive statistics. The findings from the study revealed that uncompromising and undying commitment from the top level management is critical to the success of Six Sigma. The study also identified the stumbling blocks encountered during Six Sigma implementation. Authors of the article are in consensus with the finding of the study: deploying Six Sigma in SME does not require heavy organisational infrastructure, i.e. only a black belt with few green and white belts can resolve their mundane problems. The leading role of academic institution in facilitating the implementation of Six Sigma in SMEs needs a serious thought. The article concludes with authors presenting their viewpoints on the role of academic institution in bridging the existing gap in the theory and knowledge of Six Sigma application in SMEs.

16 Bayesian networks for enterprise risk assessment

Concetto Bonafede, *University of Pavia*

Paolo Giudici , *University of Pavia*

Abstract:

The risk to according to different typologies of activity and priority can assume diverse values, meanings and it can be classified in different ways. In general the risk is measured in terms of probability combination of an event (frequency) and of its consequence (impact). To estimate the frequency and the impact (severity) are used or the historical data (quantitative data) or the expert opinions (qualitative data), either together. Moreover qualitative data must be shifted in numerical values to be used in the model. In the case of the enterprise risk assessment the considered risks are, for instance, that strategic, operational, legal and of image, which many times are difficult to be quantified. So in most cases only qualitative data, gathered by scorecard approach, are available for the risk analysis. The Bayesian Network is a useful tool to integrate different information and in particular to study the risk's joint distribution by using data collected from experts. In this paper we want to show a possible approach for finding the conditional probability table in the particular case in which only marginal correlations between nodes and prior probabilities of the node state are available, and when the variables have only two states.

17 Controlling Correlated Processes of Poisson Counts

Christian Weiß, *University of Würzburg*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

In context of statistical quality control, processes of count data arise in many different situations. In manufacturing industry, for instance, the number of defects or nonconformities of a unit of a production process is of interest, while in service industry the number of complaints of customers within a certain period of time is an important quality characteristic. The marginal distribution of such count processes can often be modelled by a Poisson distribution. If the process is even serially independent in its in-control state, then a number of control schemes, like c -, u -, Q -, EWMA and CUSUM charts, have been proposed in literature to monitor and control the process.

Unfortunately, count processes arising in manufacturing or service industry often show autocorrelation. In this article, we propose the class of integer-valued ARMA (INARMA) models, originally introduced by McKenzie (1985), to be well-suited to model the autocorrelation structure of Poissonian process arising in context of statistical quality control. Basic principles and a short review of important members of this broad family of models are provided, and we pay our attention to one of these members, namely the INAR(1) model, which is of particular relevance for quality control. Important statistical properties of these models are reviewed. Based on these results, we suggest four approaches to control such count processes, which are assumed to follow a stationary Poisson INAR(1) model in the state of statistical control. A comparison of the run length performance of these four control schemes is done, both in the state of control and in several out-of-control states.

18 A Variable Sample Size S2-EWMA Control Chart for Monitoring the Process Variance

Philippe CASTAGLIOLA, *Université de Nantes & IRCCyN UMR CNRS 6597*

Giovanni CELANO , *University of Catania, Dipartimento di Ingegneria Industriale e Meccanica*

Sergio FICHERA , *University of Catania, Dipartimento di Ingegneria Industriale e Meccanica*

Abstract:

In this paper the statistical performance of a VSS (Variable Sampling Size) S2-EWMA (Exponentially Weighted Moving Average) control chart designed to monitor the process variance is investigated. For the investigated chart, the sampling size can assume two different values. A statistically optimal design strategy based on the ARL (Average Run Length), defined as the average number of samples before the control chart signals an "out-of-control" condition, is presented and the statistical performance of the VSS S2-EWMA chart is assessed through a comparison with other control charts used to monitor the variance. The obtained results show how the possibility of varying the sampling size significantly improves the performance of both the FSSI (Fixed Size and Sampling Interval) S2-EWMA and the VSI (Variable Sampling Interval) S2-EWMA control charts.

19 Aspects of Experimental Design in the Allocation-Based Conjoint Analysis Model

Roberto Furlan, *Dept. of Statistics and Applied Math., Univ. Torino, Italy*

Roberto Corradetti , *Department of Statistics and Applied Mathematics 'Diego de castro', University of Torino, Italy*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Nowadays, pharmaceutical manufacturers need deeper and deeper market information they can rely on to make the right decisions and to identify the most promising opportunities. They can receive great benefits from understanding physicians' preferences and opinions, as these are the key people in prescribing medical treatments. Consequently, Conjoint Analysis represents a remarkable help for pharmaceutical companies during the product development stage of new drugs, and if properly conducted it also allows the estimation of product sales and market shares. This paper considers a Conjoint Analysis allocation-based model, particularly suitable for such projects. In particular, it focuses the attention on the design of experiment aspects, including the main limits affecting the design. A real world application regarding schizophrenia treatment is presented to better illustrate the allocation-based conjoint framework and design aspects.

20 Latent Class Factor Models for Market Segmentation: an Application to Pharmaceutical Products

Francesca Bassi, *Statistics Department, university of Padova*

Abstract:

Market segmentation is an essential element of marketing in industrialised countries. Goods and services can no longer be sold without recognising the heterogeneity of customers' needs. Segmentation is a grouping task for which a large variety of methods are available, including loglinear models, clustering methods and mixture models. Latent class (LC) analysis attempts to explain the observed association between the factors that make up a multiway contingency table by introducing unobservable underlying classes (clusters). The LC approach to clustering is model-based: the fundamental assumption is that of local independence: objects in the same latent class share a common joint probability distribution among the observed variables. LC clustering may be viewed as a probabilistic variant of K-means clustering. As such, LC clustering provides a way not only to formalise the K-means approach in terms of a statistical model, but also to extend it in several directions. Magidson and Vermunt (2001) propose an extension of the traditional LC approach, called LC factor model, which involves increasing the number of latent variables rather than the number of latent classes. The basic LC factor model, which contains R mutually independent, dichotomous latent variables, has exactly the same number of parameters as a LC cluster model with R+1 classes. The LC factor model is applied to identify segments in the pharmaceutical market. To propose the appropriate drug to the appropriate doctor, pharmaceutical industries cannot rely solely on sensations expressed by their agents, specific analyses are necessary. sector is characterised by a high level of competitiveness, more limited economic budgets than years ago and expensive sales and promotion activities. In this context, it is very important to understand which factors influence doctors in prescribing medicines, so to design appropriate marketing strategies.

21 Detecting changes in process measurement - what else can we do?

Martin Gibson,

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

This presentation will be a brief introduction to Change Point Analysis - a supplementary technique to I-MR & CUSUM charts - in analysing historical data. Benefits and disadvantages will be discussed based on real data.

22 Issues in the Integration of Statistical Process Control and Automatic Control

Alessandro Di Bucchianico, *Eindhoven University of Technology, Department of Mathematic*

Abstract:

Classical Statistical Process Control (SPC) assumes that observations are independent. However, in many industrial processors devices are implemented that automatically try to keep process characteristics on target. Standard control charts cannot be used here, since automatic control heavily distorts the independence assumption. Apart from this technical point, there is also an important methodological issue. Automatic control (APC) and SPC have different philosophies, since they are based on different models. APC is based on the assumption that processes continually wander, and hence must be adjusted continually. SPC, however, is based on the assumption that when so-called special causes are not present, the process does not wander and thus needs to be left alone in order to avoid increasing process variance (cf. Deming's famous funnel experiment). We will give an overview of approaches in the literature to reconcile these two approaches, with special emphasis on the following issues. Since SPC and APC have different philosophies, they also have performance measures. We will discuss some basic SPC-APC configurations and the implications on appropriate performance

measures. Connected to this is the development of specialized control charts for specific out-of-control situations caused by automatic controllers. If time permits, we will illustrate some issues in a stylized case study, where we also show the potential of modelling processes using Petri nets.

23 Short introduction to measurement uncertainty

Birger Madsen, *Novo Nordisk*

Abstract:

This presentation will give a short introduction to the topic of measurement uncertainty, in particular to the approach in the GUM (Guide to the Expression of Uncertainty in Measurement). The various steps in determining the uncertainty of measurement are introduced:

1. Specification of the measurand
 2. Identify uncertainty sources
 3. Quantifying uncertainty
 4. Calculating the combined uncertainty
 5. Reporting uncertainty.
-

24 Simulation in uncertainty budgets

Birger Madsen, *Novo Nordisk*

Abstract:

This poster presents the results of using Monte Carlo simulation for determining the uncertainty of measurement in uncertainty budgets.

The steps in determining the uncertainty of measurement according to the GUM (Guide to the Expression of Uncertainty in Measurement) are:

1. Specification of the measurand
2. Identify uncertainty sources
3. Quantifying uncertainty
4. Calculating the combined uncertainty
5. Reporting uncertainty.

This is traditionally viewed as a "bottom up" approach. The usual tool is the uncertainty budget. In this tool, step no. 4 is done using linear approximations and the central limit theorem. However, these approximations and distribution assumptions can be avoided by using Monte Carlo simulation. In this way the actual distribution of the measurand is used rather than a hypothesised normal distribution. In this poster 6 different uncertainty budgets are presented along with the results of using simulation in order to calculate the combined uncertainty. The main conclusions are:

- Traditional approach usually overestimates combined uncertainty.
 - The resulting distribution will seldom be a normal distribution.
 - 100.000 cases seems adequate for doing the simulation.
-

25 Generic Six Sigma projects in healthcare

Ronald Does, *IBIS UvA*

Jaap van den Heuvel , *Canisius Wilhelmina Hospital Nijmegen*

Henk de Koning , *IBIS UvA*

Thijs Vermaat , *IBIS UvA*

Abstract:

Six Sigma is increasingly applied to a wide variety of non-manufacturing operations. In former ENBIS conferences, we discussed the implementation of Six Sigma in healthcare focusing on the decision making process. In this lecture we focus on the selection of Six Sigma projects in healthcare. It turns out that based on our experiences in several hospitals we may distinguish some generic projects. For these projects we work out

the first three steps of the Six Sigma Breakthrough Cookbook. These three steps correspond with the Measure phase in the DMAIC methodology.

26 SPC in practice, control charts with runs rules, and EWMA

Sven Knoth, *Advanced Mask Technology Center (AMTC) Dresden*

Abstract:

Apparently, there is no common understanding of the term SPC between academia, industry, and public organizations. This complicates the deployment of SPC procedures such as control charts in practice and their discussion on the interface of the mentioned parties. E. g., one common pattern I met in practice is that sophisticated control charts usually consist of mysterious runs rules (e. g., Western Electric). In academia, runs rules charts are more or less outdated (with good reasons). Additionally, quality circles summarize under SPC a lot of statistical/descriptive methods that allow to model and improve productive processes including control algorithms usually covered under the phrase EPC (engineering process control). In this talk, I want to illustrate some of these confusions. Second, Bill Woodall's excellent and provocative paper in 2000 together with it's discussion showed that the situation is not clarified yet and more discussion is needed. Eventually, the ISO document 11462 (the SPC one) does not really help in this situation. And the ENBIS community (the intersection of ENBIS and the related ISO TC is certainly not empty) could or should be the right group to clarify this.

Woodall, W. H. (2000), "Controversies and Contradictions in Statistical Process Control," *Journal of Quality Technology*, 32, 341-378.

27 An experimental set-up for destructive Gauge R&R assuming patterned object variation

Frank van der Meulen, *IBIS UvA*

Henk de Koning , *IBIS UvA*

Jeroen de Mast , *IBIS UvA*

Abstract:

The standard method to assess a measurement system's precision is a gauge repeatability and reproducibility (gauge R&R) study (Burdick, Borror and Montgomery (2003)). It exploits replications to estimate variance components that are interpreted as measurement spread. For some measurements it is not feasible to obtain replications, for example because objects are destroyed when they are measured, or because the object being measured changes over time. Such measurements are called destructive. De Mast and Trip (2005) give a precise definition of the problem of gauge R&R studies for destructive measurements. This problem has been a persistent problem in quality engineering and results in an overestimation of the gauge R&R. One possible solution suggested by De Mast and Trip is to replace replications with measurements of multiple objects. Subsequently these measurements are modelled by a fixed pattern. We consider an example in which the gauge R&R design is given by a Latio-square design. The resulting model is an unbalanced linear mixed model. For this model we estimate the variance components by two standard estimation methods: maximum likelihood and restricted maximum likelihood. The numerical optimization is performed by an implementation of the EM-algorithm. The approach is illustrated with the analysis of a real-data example.

28 Inventory policies and statistical model assumptions

Wiebke Haupt, *Department of Statistics, University of Dortmund*

Sonja Kuhnt , *Department of Statistics, University of Dortmund*

Abstract:

Inventory management involves decisions on the optimal stock level while considering costs and service levels: On one hand, high stock levels cause high costs and a reduction to a sensible level is worthwhile. On the other hand, stock levels must provide a certain desired service level and therefore should not be too low. Finding the "optimal" stock level is often automated due to the large number of items in stock. Inventory policies offer instructions on how to calculate the stock level. They are based on inventory models and distributional assumptions. The validity of distributional assumptions can, of course, not be checked for any item in stock, and so a new, nonparametric inventory policy is proposed. We investigate its performance and other inventory policies in situations of valid and violated model assumptions in a single item, single level setting. The investigated models and the related policies cover i.i.d. demand distributions and autoregressive moving average models. The policies are applied to simulated and real life data with a high proportion of zero demand periods. Their performance is compared by the achieved service levels.

29 How hospitals choose a quality management system: Relevant criteria in large Spanish hospitals

Marta Sangüesa, *University of Navarra*

Ricardo Mateo , *University of Navarra*

Laura Ilzarbe , *Tecnun - University of Navarra*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

This article examines the selection criteria used by hospital managers when choosing a quality management system (QMS): ISO 9001, Joint Commission (JC), EFQM, or a combination of them. Furthermore, this study provides a view of how extensive the use of QMS is in the main Spanish hospitals. Between December 2004 and March 2005, a questionnaire was sent to every Spanish hospital > 400 beds. Of the 101 hospitals that met the conditions of research, 42 responded to the survey: a response index of 41.58% (95% reliability and maximum margin of error of 11.6%). We have deduced the selection criteria from a contents analysis of the models. We have confirmed two hypotheses: firstly, that there are 16 relevant selection criteria for hospitals when deciding on a QMS; and secondly, that they choose QMS on the basis of the priority they attribute to given selection criteria. The data leads us to the conclusion that the implementation of QMS in Spanish hospitals is quite extensive: 71.4% use ISO 9001; 11.9% JC, and 69% EFQM. The combined use of the ISO 9001 and EFQM (47.6%) has also been noted. 15 of the 16 criteria have been shown to be relevant, and no new criteria have been discovered.

30 A STUDY ON THE CONTRIBUTION OF QUALITY FUNCTION DEPLOYMENT (QFD) TO SIX SIGMA DEVELOPMENT MODEL (DMAIC)

ERALP DOGU, *Dokuz Eylül Univeristy Department of Statistics/Izmir TURKEY*

ALI RIZA FIRUZAN* , *Dokuz Eylül Univeristy Department of Statistics/Izmir TURKEY*

Abstract:

A STUDY ON THE CONTRIBUTION OF QUALITY FUNCTION DEPLOYMENT (QFD) TO SIX SIGMA DEVELOPMENT MODEL (DMAIC)

ABSTRACT

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Key words: Quality Function Deployment (QFD), Six Sigma, Customer Focus, Six Sigma Project Selection, DMAIC

Quality Function Deployment (QFD) is a well-known quality improvement technique for customer focused design of the products, services or the processes. QFD simply focuses on "what" the customer wants and "how" the organization will achieve this aim.

QFD is a required method in many Six Sigma programs. Six Sigma is rich in statistical tools to provide the accuracy necessary to achieve 3.4 DPMO levels of quality.

In this study, vital role of QFD in improving the understanding of the voice of the customer, capturing customer priorities, and translating them into Six Sigma DMAIC directives are involved by statistical perspective. A case study is held in a plant in Turkey to determine the following Six Sigma projects for a switch and socket series by using the knowledge provided by QFD process.

JEL Classification: L 15

References

Breyfogle III, Forrest W 1999. Implementing Six Sigma: Smarter Solutions Using Statistical Methods. John Wiley & Sons, Inc

Chen, S.C.& Chen K.S.& Hsia T.C. 2005 "Promoting Customer Satisfactions by Applying Six Sigma: An Example from the Automotive Industry" Quality Management Journal Vol 12, No 4, 2005, 21-33 www.asq.org

Cohen, Lou 1995. Quality Function Deployment How to Make QFD Work for You. Addison Wesley Longman.

Ferguson, Ian 2005 "The Essential Need For QFD in the Measurement Based Strategy of Six Sigma".

Proceedings of International Symposium on Quality Function Deployment. Kusadasi TURKEY
 Fundin, Anders P. "Use Customer Feedback to Choose Six Sigma Projects" Six Sigma Forum Magazine February 2004, 13-17 www.asq.org
 Harrington, H. James and McNellis, Tom "Six Sigma for Internet Application Development" Software Quality Professional Vol 4 No:1/2001, 7-18 www.asq.org
 Mazur, Glenn 2003 "QFD in Support of Design for Six Sigma (DFSS)." Proceedings of 8th International Conference on ISO and TQM. Montreal CANADA www.mazur.net
 Mazur, Glenn 2003 "Voice of the Customer (Define): QFD to Define Value." Proceedings of 57th American Quality Congress. Kansas City USA www.mazur.net
 Mazur, Glenn 2005 "QFD in North America: 2005 Update, Twenty-One Years of Practical Application". Proceedings of International Symposium on Quality Function Deployment. Kusadasi TURKEY
 Pyzek, Thomas 2003. The Six Sigma Handbook: A complete Guide for Green Belts, Black Belts, and Managers at All Levels. McGraw Hill
 Zultner, Richard E 2005, "The Essential Role of QFD in Design for Six Sigma-Modern QFD for Modern TQM". Proceedings of International Symposium on Quality Function Deployment. Kusadasi TURKEY

31 The Tale of the Wounded Rat. Obtaining and Explaining Data for a "Go & No Go" Decision in a Pharmaceutical Development Project. A Case Story

Antje Christensen, *Novo Nordisk A/S*

*Karin Lund Nielsen , *Novo Nordisk A/S*

*Peter Ravn Brinck , *Novo Nordisk A/S*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

In the pharmaceutical industry, only about one out of seven development projects ever results in a product in the market. In the face of high late stage development costs, efficient "go & no go" decisions at an early development stage are important. Obtaining the right data to form the basis for these decisions, and making the message within the data accessible for decision makers who are not specialists in the field generating the data, are major responsibilities in project management.

The talk covers a case story of a "go-no go" decision in a pharmaceutical development project. The project is briefly explained, as is the experiment producing the data that formed the basis for the decision. The pivotal slides from the presentation to the decision making body are included.

In the second part of the talk, some aspects of the data presentation are examined. The decision making process is broken down into steps, and the role of data generation and presentation is pinpointed.

32 Accuracy of measurement of the composition of LNG shipments

Peter J. Zemroch, *Shell Global Solutions*

Arie D. Penning , *Shell Global Solutions*

Abstract:

The value of LNG shipments depends both on volume and chemical composition. Gas chromatography (GC) is used to determine composition when custody is transferred. Following the current ISO 8943 standard, gasified LNG is continuously collected in a sampling dome during loading and duplicate subsamples are subsequently analysed off-line. In an alternative scheme, samples are taken and analysed on-line at regular intervals during loading and the results averaged. This paper investigates and compares the uncertainties in the two schemes. The major sources of uncertainty are sampling error, errors associated with the LNG sample vaporizers, and measurement error in the GC analyser(s). Sampling and vaporization errors cannot be quantified exactly but their orders of magnitude have been estimated from real, historical data under a number of simplifying assumptions. GC-measurement error can be estimated from published precision data.

Measurement error and sample vaporizer variations make a larger contribution to the overall uncertainty in measured composition than discontinuous sampling error. Systematic variations between GC analysers make the biggest contribution with little benefit to be gained from increasing the normal sampling frequency in the on-line scheme.

The overall uncertainty in typical shipment data is very low in absolute terms for both schemes. The overall standard error is typically less than 0.35% related to the final energy calculation. The discontinuous on-line scheme is the more accurate. While on-line samples show larger variations (caused by the vaporizer) than those observed in dome samples, the effect is more than counterbalanced by the increased number of GC analyses.

33 use of IDEF as a suitable modeling tool in Six Sigma projects

* **Sarah Behdad**, *MSc student of Industrial Engineering Department, Tehran Pol*

Abstract:

The Six Sigma is one of the most popular approaches to ongoing process improvement efforts today, so it is extremely considered by managers who are responsible for planning and improving the processes. What is noticeable about Six Sigma is its emphasizing on measuring process and using statistical techniques to analyze the outcomes of the process, so it requires a well-understood process, but nearly none of the previous references about Six Sigma provide enough information for managers on how to model and analyze processes. Most of the references suggest developing a high level overview of the process called SIPOC diagram and then suggest the use of work flow diagrams if more detail information is needed. The fact is that Six Sigma works best with well-understood process and managers can use advantages of Six Sigma more by understanding the undertaken process. The purpose of this article is to introduce a modeling tool called IDEF as a complementary tool for extensive analysis of process. IDEF is known in system development efforts and is a set of notations are designed to model a process/enterprise from a defined viewpoint, such as a function viewpoint or an information viewpoint. This paper discusses the capabilities of IDEF and compares it with the previous tools such as SIPOC.

34 SUPPORT VECTOR MACHINES AND SOME OTHER REGULARIZATION METHODS IN STATISTICAL QUALITY CONTROL

Stelios Psarakis, *Department of Statistics, Athens University of Economics and*

***Javier M Moguerza**, *Department of Statistics and Operational Research, University Rey Juan Carlos, Spain*

***Alberto Muñoz**, *Department of Statistics, University Carlos III, Spain*

Abstract:

Support Vector Machines (SVMs) are powerful classification and regression procedures. SVMs arose in the early nineties as optimal margin classifiers in the context of Vapnik's Statistical Learning Theory. During the last few years SVMs have been successfully applied to real-world data analysis problems, usually providing improved results compared to other techniques. SVMs operate by minimizing an empirical risk in a well-posed and consistent way. A clear advantage of the Support Vector approach is that sparse solutions to classification and regression problems are usually obtained: only a few samples are involved in the determination of the classification or regression functions. This fact facilitates the application of SVMs to problems involving large amount of data, such as those within text processing or bioinformatics. Recently this methodology has been used within the Statistical Process Control (SPC) framework. In this work we give an overview of some applications of SVMs for SPC. In particular, we first describe some quality control examples, and then we focus on the use of SVMs for monitoring techniques applied to multivariate processes.

35 Split-plot Designs with Mirror Image Pairs as Sub-plots

John Tyssedal, *Department of Mathematical Sciences, NTNU*

Murat Kulahci, *Department of Informatics and Mathematical Modeling, DTU*

Søren Bisgaard, *Isenberg School of Management, University of Massachusetts at Amherst*

Abstract:

In this article we investigate two-level split-plot designs where the sub-plots consist of only two mirror image trials. Such designs are of practical use in process industries. Assuming third and higher order interactions negligible, we show that these designs divide the estimated effects into two orthogonal sub-spaces, separating sub-plot main effects and sub-plot by whole-plot interactions from the rest. Further we show how to construct split-plot designs that are of projectivity $P=3$ and 4. We also introduce a new class of split-plot designs with mirror image pairs constructed from non-geometric Plackett-Burman designs. The design properties of such designs are very appealing leaving effects of major interest free from full confounding.

36 Control charts as a tool for the fifth discipline

Vladimir Shper, *RESI*

Yuri Adler, *MIS&A, prof.*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

This paper presents a new look at the control charts. We consider this popular statistical tool as a tool for

system analysis within the frame of Senge's fifth discipline. The main archetypes introduced by P. Senge have been considered in succession and it was shown that it is possible to compare every archetype with corresponding control chart or run chart. We consider this approach as a way that may facilitate for many managers to reveal system archetypes in their daily life. Besides we suggest three new archetypes closely linked with Shewhart's idea of common and assignable causes of variation. These archetypes as it seems to us should become the subject of learning and training for every blue and white collar as well as for every worker and employee. In this way control charts devised by Shewhart as a statistical tool for analysis of process variability simultaneously turned out to be the simplest and the most practical tool for system analysis.

37 IS DOE REALLY USED?: A survey of Basque Industries

Martin Tanco, *Universidad de Navarra*

Elisabeth Viles , *Universidad de Navarra*

Laura Ilzarbe , *Universidad de Navarra*

Maria Jesus Alvarez , *Universidad de Navarra*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

A new survey is presented concerning the knowledge and use of Design of Experiments techniques (DOE) within industry in The Basque Country, a region recognized throughout Europe for its quality and prestige. The survey was carried out within manufacturing companies, yielding a response rate of 18%. Despite every effort by specialists in quality and statistics, DOE has yet to be applied as widely as it could and should be. Results show that 95% of industries undertake experimentation; most of them use one-factor-at-a-time (OFAT) strategies, and only 20% of those follow a pre-established statistical methodology. Moreover, only 20% of Basque manufacturing industries have applied DOE. Furthermore, results show that a lack of knowledge about general statistics is commonplace and only 33% of industries claim to be knowledgeable of DOE. In addition, although Taguchi methods are well known among industries, only 14% of them apply those methods

38 Cost-effective control charts for heavy-tailed distributions

András Zempléni, *Department of Probability Theory, Eötvös Loránd University,*

Csilla Hajas , *Department of Information Systems, Eötvös Loránd University, Budapest*

Katalin Szabó , *Department of Probability Theory, Eötvös Loránd University, Budapest*

Abstract:

In previous ENBIS conferences, [1], [2] we have presented work regarding the application of Markov Chains for cost-optimal design of SPC charts, designated as economic charts.

We modify such previous work in order to accommodate the general approach of Rahim and Costa [3], where all the cost elements are incorporated into the cash flow of the process in a unit time interval. We focus our research on the effect of the sampling distribution on the parameters of the economic charts, including the case, where the observations come from a heavy-tailed distribution. We apply the results to Hungarian teletraffic-data.

References

- [1] Zempleni, A., Hajas, Cs., Duarte, B. and Saraiva, P. "Optimal Cost Control Charts for Shift Detection", presented at the third European Network for Business and Industrial Statistics (ENBIS) conference, Barcelona, Spain (2003).
 [2] Zempleni, A., Hajas, Cs., Szabó, K., Duarte, B. and Saraiva, P. "Statistical Process Control: economic and multivariate", presented at the fifth European Network for Business and Industrial Statistics (ENBIS) conference, Newcastle (2005). [3] M.A. Rahim and A.F.B. Costa "Joint economic design of to Xbar and R charts under Weibull shock models". *Int. J. Prod. Res.*, 38, 2871-2889 (2000).

39 A statistical approach to understand the magic triangle of reliability, system cost and customer benefit in consumer driven engineering

Thomas Hochkirchen, *Ford Research Centre Aachen, Germany*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The design of any technical system requires the specification of durability requirements: What kind of stress is the system confronted with? A customer correlated engineering answer to questions like these is given

statistically, based on an assumed distribution of a measurable magnitude describing this stress. Given this distribution, durability targets can be formulated as percentile: only the worst 100%-q% of the customers are "allowed" to experience problems. There is an obvious trade-off, as the reliability target has a direct link to system cost. A second trade-off is the trade-off between system performance and the durability target: System tuning to increase performance and thus customer benefit will typically increase the stress the system will encounter and therefore as well have an impact on the reliability target. In combination, these trade-offs describe a magic triangle with the corner points of Customer Benefit (performance), System Reliability and System Cost. A change at either of these corners will automatically influence the other two. Any system specification has to take this magic triangle into account, and naturally the question arises how this can be done "optimally". This paper is meant as a pragmatic first step towards finding a good solution. The concepts and the way they are combined are illustrated using Micro-Hybrid vehicles, which combine two features in order to improve fuel economy and emissions:

1. The engine is automatically switched off when the vehicle is stationary and instantly restarted as soon as the driver wishes to drive off again "so there is no fuel used at idling.
2. Braking energy is recuperated via a regenerative braking control strategy.

Both features put additional stress on the vehicle: Engine and starter have to cope with an increased number of restarts, while the battery has to deal with increased charge throughput.

41 Efficient evaluation of batch homogeneity in pharmaceutical production

Stefanie Feiler, *AICOS Technologies AG, Basel*

*Philippe Solot, *AICOS Technologies AG, Basel*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

During the transfer from chemical to pharmaceutical production, the homogeneity of supplied batches is often of great importance for a trouble-free further processing. It is therefore essential for pharmaceutical companies to dispose of an appropriate statistical method and a software tool in order to easily verify the actually achieved homogeneity.

For the application considered, it turned out that an analysis of variance, which would be the standard statistical technique for homogeneity testing, is of little practical relevance as it often detects statistically significant differences, even if the overall homogeneity is more than sufficient for practical purposes. Therefore we proposed a method based on a precision limit R which is comparable to the reproducibility limit used in interlaboratory studies. R is estimated using a nested linear model. Here some care has to be taken not to get a too conservative limit.

Based on these considerations, it is possible to calculate the sample size needed for testing depending on a given acceptable homogeneity level HC and the maximum tolerated consumer/producer risks. Another aspect useful in practice is to determine these risks in dependence of the ratio HC/R for various sample sizes. If HC is unknown, the theory can be used to identify a homogeneity limit based on acceptable consumer/producer risks.

We first address the statistical methodology and then show in which software form it has been made available to the practitioners. Finally, we discuss the advantages provided by the integrated routine use of the tool in a large pharmaceutical company.

43 Would Shewhart have developed the same SPC-rules today?

Paul Banens, *CQM*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Control Charts are basic methods for process control and process improvement. The origin goes back more than 80 years to Shewhart. He developed the famous rules to calculate the Control Limits. Although the method is well known and applied to all kinds of processes, some typical problems arise over and over again.

Sometimes the Control Limits are apparently too small (batch processes) and sometimes apparently too broad (fixed profiles). We found ways around it and called these situations "special cases".

In this presentation I will explain that I prefer to see these "special cases" as "standard" for today's processes according the basic assumptions of Shewhart. The standard method (Shewart) of calculation of the Control Limits is only applicable for few of our today's processes making these processes the "special cases" of today. So we should change our default way of calculating the Control Limits.

44 Statistical tools for dealing with complex data-massive problems: a key for practical relevance

Alberto Ferrer, *Department of Applied Statistics, Operations Research and Qu*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Are we (statisticians) relevant for our (potential) clients? Are we "paper" driven or "problem" driven? Are we working in collaboration with other scientists? Do we adapt the problems to the scenario required for the techniques we know or vice versa? Great statisticians as Pearson, Gosset, Fisher, Box, Shewhart, Tukey also ask themselves those questions. Advance manufacturing and high-technology enterprises produce large amounts of highly complex databases. High competitiveness has lead to such enterprises to invest in improvement methodologies to reduce costs and increase client satisfaction. Six Sigma and Process Analytical Technology (PAT) are good examples of this. Both emphasize the use of statistical techniques as a key ingredient for success. The problem is that most of the well-sounded statistical techniques are not appropriate in these data-massive environments. In this talk multivariate statistical techniques based on projection to latent structures: bilinear models like Principal Component Analysis (PCA) or Partial Least Squares Regression (PLS); or multiway models like Tucker-3 or N-PLS, are introduced as powerful tools for converting data to information used for process understanding and process improvement in these new environments. Several examples from different processes (petrochemical, steel, wastewater treatment, image analysis, proteomics) are outlined.

45 Multivariate approach for start-ups and transition periods analysis and steady state identification in batch processes

***Daniel Aguado**, *Department of Hydraulic Engineering and Environment. Technic*

Alberto Ferrer , *Department of Applied Statistics, Operations Research and Quality. Technical University of Valencia*

*Aurora Seco , *Department of Chemical Engineering. University of Valencia*

*José Ferrer , *Department of Hydraulic Engineering and Environment. Technical University of Valencia*

Abstract:

Historical data from a laboratory-scale sequencing batch reactor (SBR) operated for enhanced biological phosphorus removal from wastewaters have been systematically analysed to study the start-up of the process and to detect when the steady-state is reached. Steady state identification is important in our system to trigger an extensive sampling and data collection aimed at characterizing its performance. For this purpose, we propose the combination of two methodologies: Nomikos and MacGregor (1995) for batch process data analysis and Brown and Rhinehart (2000) for steady-state identification. The proposed approach takes advantage of the inexpensive and on-line data collected from the 5 electronic sensors installed in the SBR: electric conductivity, oxidation-reduction potential, dissolved oxygen concentration, pH and temperature. Furthermore, the compression and visualization abilities of the projection to latent structures techniques are fully exploited for tracking the evolution of the collected variables trajectories during the start-up of the process, providing useful information for process understanding. In this study, the three-way data from the SBR process was unfolded batch-wise since the focus was on analysing the differences among batches. The results demonstrate that the proposed approach can be efficiently used to detect when the process is at steady-state, to monitor the overall process evolution and also to isolate the causes of changes in the process using contribution plots.

46 Robust Design Methodology - A Gap between Principles and Tools?

Torben Hasenkamp, *Division of Quality Sciences, Chalmers University of Technol*

Ida Gremyr , *Division of Quality Sciences, Chalmers University of Technology*

Abstract:

Even though Robust Design Methodology (RDM) is an often occurring concept in literature there are few applications in Swedish industry. Strange to say, many organisations struggle with understanding and counteracting the same kinds of issues that can be addressed with RDM. Companies indicate a lack of support in the use of tools applicable " thus indicating the need for a better structured framework that aligns the application of tools with RDM and its principles. So far, literature has placed a focus on statistical techniques used to create robust designs while the principles underlying RDM and practical applications have been less emphasized. Certain practices can support such an alignment by acting as intermediates between principles and tools. In this paper a two-week problem solving case in a Swedish, medium-sized company working with RDM is the object of investigation. The case is documented and it is analyzed how Design of Experiments is applied

with respect to RDM and its underlying principles. The results show that there is a gap between principles and tools, which could be bridged by practices that may affect the way tools are utilized and facilitate their alignment with the methodology. Examples of such practices can be to explore and utilize transfer functions, develop P-diagrams and to appreciate the quadratic loss function.

Key Words: Robust Design Methodology, Design of Experiments, Noise Factors, Control Factors

47 Multivariate statistical sensitivity analysis of a computer model for pharmaceutical industry market and innovation dynamics

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*Franco Malerba, *CESPRI, Bocconi University, Milan, Italy*

*Luigi Orsenigo, *Department of Engineering, University of Brescia and CESPRI, Bocconi University, Milan, Italy*

Michele Pezzoni, *Department of Engineering, University of Brescia, Italy*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Statistical sensitivity analysis is a useful technique to analyze multivariate stochastic computer model in order to better understand the cause and effect relationships between input parameters and output observations. This paper is based on a pre-existent formal evolutionary economic model that simulates the main aspects of the market and the innovation processes that take place inside the pharmaceutical industry. It belongs to the family of "History-Friendly" models. Our purpose is to reveal the critical input parameters concerning R&D costs, research opportunities, regulatory regime, demand and firm's features in the mechanisms of innovation and market dynamics through the use of multivariate statistical sensitivity analysis. This preliminary work represents a first step in the introduction of a complete analysis with a mixed linear model.

48 Physical Models for the Prediction and Prevention of Dynamic Disturbances in BTA Deep-Hole-Drilling

Nils Raabe, *University of Dortmund*

Oliver Webber, *Department of Machining Technology Dortmund*

Dirk Enk, *Department of Machining Technology Dortmund*

Claus Weihs, *University of Dortmund*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

One serious problem in deep-hole drilling is the formation of two different types of dynamic disturbance called spiralling and chatter. For each disturbance type a model is presented. Both Models have in common that they are discretized analogous models of the boring bar and so directly contain the physical parameters of the process. As spiralling can be explained by the convergence of bending eigenfrequencies with multiples of the rotational frequency, the corresponding model describes the bending oscillations of the bar. In combination with Statistical Process Control, this model will help to early predict crucial situations and to derive intervention strategies. In contrast to this, chatter occurs in the shape of self-excited torsional vibrations. As shown in earlier work this self-excitation can be early predicted by using Multivariate Control Charts. The corresponding model mimics the torsional oscillations and is able to reproduce the regenerative effect. As it contains the adjustable process parameters rotational frequency and feed, the effect of different intervention strategies can be investigated with this model.

49 Enlightening research: Exploring a biochemical system by analysing multivariate data from designed experiments

Frøydis Bjerke, *Matforsk AS*

*Hanne Larsen, *Matforsk AS*

*Siri Geiner, *University of Life Sciences, Norway*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Exposure to light induces photo-oxidation in dairy products, causing undesired off-taste. Hence, for the dairy

industry and retailers, knowledge of lighting conditions and light-protecting packaging is important, to maintain freshness of products during shelf storage in shops. A designed experiment in four factors: illumination source (tube type), type of packaging, distance to illumination source, and exposure time was performed, and the resulting oxidation of low fat sour cream was measured by fluorescence (emission spectrum, 300 – 800 nm). Hence, the experiment have highly correlated multiple responses, and at certain wavelength ranges these are expected to relate to specific chemical constituents in the products, like riboflavin and chlorophyll. In addition, emission spectra from the illumination sources themselves were obtained. The presentation emphasises the statistical (multivariate) analyses and graphing techniques applied, e.g. 50-50 MANOVA, in order to increase understanding of the underlying mechanisms of oxidation by exposure to light. The main objective is to present and interpret complex and comprehensive data results to researchers and practitioners in an informative way.

50 Quantification and analysis of the distribution of reliability test durations

Nikolaus Haselgruber,

Klaus Denkmayr , *NA*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The reliability as well as the durability of a component usually is demonstrated based on a validation program which is a heterogeneous collective of tests. Each single test time has to be scaled correctly in terms of equivalent mileage – using an acceleration factor dependent on certain damage modes – before applying life time analysis methods. The distribution of equivalent mileages often is skewed and the reliability target time is equal to a high quantile of that distribution which plays an important role if the hazard rate of the life time distribution is not constant over time. This paper suggests a description of the distribution of test times as a basis for the application of a statistical test which decides about the acceptance of the validation program due to a given target and zero failures, i.e. right-censored test times. The advantage of the method already has been confirmed in several practical applications in the automotive industry.

51 Explaining Correlations by Plotting Orthogonal Contrasts

Øyvind Langsrud, *MATFORSK, Norwegian Food Research Institute.*

Abstract:

A new plot that helps understanding the relationship between two response variables in a designed experiment is described. Instead of plotting the observed values directly, we make a scatter plot of orthogonal contrasts that are derived from the general linear model. This new plot contains the same correlation information as the ordinary scatter plot of original observations. Therefore, one can interpret how the effects of the various design variables contribute to the correlation coefficient. This idea is also useful in more general cases. When original observations are plotted in some way, we can always make a corresponding plot of orthogonal contrasts. The discussion starts by considering a fractional factorial design where the sensory quality of baguettes was studied. In this case the correlation between two response variables can be illustrated by plotting the estimated effects of one response against the estimated effects of another response.

An example from sausage production is used to illustrate a more general situation where orthogonal contrasts are derived from a response surface model. In addition to illustrating the correlation between two responses, the concept of plotting orthogonal contrasts is extended to partial least squares regression and to principal component analysis.

52 Can we run a company as a designed experiment?

Chris McCollin, *Department of Computing and Informatics, Nottingham Trent Un*

John Disney , *Department of Strategic Management and Marketing, Nottingham Business School, Nottingham Trent University*

Michael Brown , *Department of Strategic Management and Marketing, Nottingham Business School, Nottingham Trent University*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The reason for posing the question is twofold. Designed experiments can be used to optimise process/product outputs and planning experiments are well developed and help to understand the causes of variation within a system. Measurement within processes is also now well-defined in terms of Six Sigma metrics. Thus the idea of monitoring company effectiveness over time in a planned way is already the goal of any Six Sigma programme.

The paper addresses aspects of change management tools such as the Kano model, Quality Function Deployment and Servqual and how a designed experiment approach could be developed for a company. Problems and recommendations are discussed with respect to case studies of companies who attempted change without the approach and then are addressed in the context of whether a designed experiment approach may work.

53 Sequential multivariate optimization by means of the expected improvement criterion

Nadine Henkenjohann, *University of Dortmund*

Abstract:

For the optimization of complex production processes, classical methods of DoE are not appealing because they require an intolerably large number of design points. To improve the efficiency a sequential approach which combines the use of stochastic process models with the expected improvement criterion can be used. The appealing property of the expected improvement criterion is that it allows a balancing search. The user can define the weighting between a local and global search. Whereas searching more locally means giving more weight to regions with optimal prediction, searching more globally the uncertainty of the model prediction is given more weight. Since this approach yields very good results with respect to accuracy and efficiency it is desirable to generalize this approach to the more practice relevant situation of multivariate data. Hence, in this contribution a multivariate expected improvement criterion is proposed which is based on desirability functions. The calculation of this criterion requires derivation of the multivariate distribution of the desirabilities. When using either only one-sided desirability functions or only two-sided desirability functions the exact multivariate distribution could be derived. When a mixture of one and two-sided desirability functions is considered, an approximation based on the doubly-truncated multivariate normal distribution is proposed. The efficiency of this approach is shown by a two-dimensional simulation study.

54 On the comparison of run orders of unreplicated $2^{(k-p)}$ designs in the presence of a time trend

Joachim Kunert, *Fachbereich Statistik, Universität Dortmund, Germany*

*Kayode Adekeye , *Department of Maths and Statistics, Kwara State Polytechnics Ilorin, Nigeria*

Abstract:

The response from a factorial experiment carried out in a time sequence may be affected by uncontrollable variables that are highly correlated with the time in which they occur. In such a situation, one possibility is to randomize the run order of the experiment. Another possibility is to use a systematic run order that is robust against time trends. Since randomized run orders make the time trend part of the error, it can be hoped that systematic run orders will be more effective to identify truly active factors. In this paper, a simulation study is used to compare the performances of the randomized and the systematic run orders. The response from an experiment where we have observed a strong time trend is used to demonstrate the influence of a realistic time trend on the run orders under consideration. The performance of the run orders is then measured by taking the probabilities of false rejection and the probabilities of detection of active contrasts. Our results show that the randomized run order managed to keep the nominal level, while the systematic did not. Additionally, when there were active factors, then the systematic run orders did not achieve more power than did the randomized run order.

References

de León G, Grima P, Tort-Martorell X (2003) Experimental order in factorial design. Paper presented at the 3rd ENBIS-Conference in Barcelona, 21â€"22 August, 2003 (Abstract at: http://www.enbis.org/barcelonaconference/abstracts.html_114)

Kunert J and Adekeye K (2006) On the comparison of run orders of unreplicated $2^{(k-p)}$ designs in the presence of a time trend. *Metrika*, to appear.

55 Robustification of Sheet Metal Spinning Process

Paul Schmelzer, *Institute of Forming Technology and Lightweight Construction*

*Simone Jock , *Department of Statistics, University of Dortmund*

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*Matthias Kleiner , *Institute of Forming Technology and Lightweight Construction, University of Dortmund*

*Joachim Kunert , *Department of Statistics, University of Dortmund*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Sheet metal spinning is an interesting and flexible metal forming technology for the efficient production of rotation-symmetric sheet metal parts. But the manufacturing process is sensitive to changes of noise factors (like e.g. varying material batches) that affect the process adversely. These factors often cause unacceptable deterioration of quality and consequently necessitate new process settings. The challenge is to make the process less sensitive to such noise factor changes. To overcome the problem firstly all relevant noise factors must be identified. Furthermore it is crucial to find a way to reproduce the noise factor changes even though they are by definition not controllable. Thereafter the main goal is to find process parameters or parameter settings that enable to make the process robust against noise factors. First experiments have been run using the conventional robustification methods including Taguchi's ideas and orthogonal arrays to robustify the process. The results showed that the classical approach cannot be utilised due to special characteristics of the parameter space. Hence, the methods have to be adapted for our purpose. As a first approach for problem solving space-filling designs are integrated in the robustification process. Finally the results shall be generalized to be applicable to different materials and workpiece geometries. The presentation will comprise the latest results of the research work.

56 Multiscale Statistical Process Control of Continuous Processes

Marco Reis, *Department of Chemical Engineering, University of Coimbra*
Bhavik Bakshi , *Department of Chemical Engineering, Ohio State University*
Pedro Saraiva , *Department of Chemical Engineering, University of Coimbra*

Abstract:

We present an approach for conducting multiscale statistical process control (MSSPC) based upon a library of basis functions provided by wavelet packets. The proposed approach explores the improved ability of wavelet packets in extracting features with arbitrary locations and having different localizations in the time-frequency domain, in order to improve the detection performances achieved with wavelet-based MSSPC. Such an approach is tested using artificial simulated signals, with its average run length (ARL) performance being compared against other SPC methodologies. Furthermore, behaviour under real world situations of application is also assessed, covering several industrial case studies, with the construction of ROC curves for the several methods tested (receiver operating characteristic curves). Both univariate and multivariate situations are covered. The ARL results for a step perturbation show that the proposed methodology steadily presents an interesting performance for all shift magnitudes, without significantly changing its relative scores as happen with current methods. For artificial disturbances with features more localized in time/frequency domain, multiscale methods outperform their single scale counterparts. In the examples with industrial data sets, where the disturbances present more complex patterns, multiscale approaches also provide the best results, in particular regarding the range of low false alarms operation, where process monitoring methods are aimed to run.

57 Analysis of Means; An under-used alternative to Analysis of Variance which is simple, illustrative and well suited for industrial improvements

Oystein Evandt, *ISRU, University of Newcastle upon Tyne, UK*
Shirley Coleman , *ISRU, University of Newcastle upon Tyne, UK*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Analysis of means (ANOM) is a family of multiple comparisons procedures for means. ANOM is similar to one way Analysis of Variance (ANOVA) because it involves testing the null hypothesis that all groups of data in question come from distributions having equal means. The user of ANOVA will either conclude that there is not sufficient evidence to reject that all means are equal, or conclude that at least one of the means differs from the others. With ANOM however, it will be concluded whether or not one or more specified means differ from the average of all of the means, above or below, under the restriction that the chosen overall significance level is not violated. This is often useful in practice. The graphical nature of ANOM eases the task of conveying the analysis results to people with little statistical background, whether they are end users of the analysis results or members of a team of mixed specialists. Whether a specific mean differs from the average of all of the means, is decided by means of a chart resembling a control chart, called an ANOM chart. The limits on the chart against which the group averages are compared for making such decisions, are called decision limits. The computation of decision limits is made easy by userfriendly tables. Furthermore, MINITAB as well as SAS has good facilities for ANOM. The effects of fixed factors in designed experiments can be analysed using ANOM. Means of groups of observational data can also be compared, as well as rates and proportions related to Poisson and binomial data respectively. The ANOM methodology is exemplified with case studies from industry and business. Plots

made by MINITAB are used for illustrations.

58 Out of Control or in Weak Statistical Control?

Bo Bergman, *Quality Sciences, Chalmers University of Technology*

Alexander Chakhunashvili, *Quality Sciences, Chalmers University of Technology*

Abstract:

While traditional control charts based on three-sigma control limits are usually effective enough to detect out of control state(s) of a process, in certain situations it requires more than just a control chart to single out special cause variation from common cause variation. Walter A. Shewhart, being aware of this problem, proposed a second criterion (first criterion being the control chart itself) to detect assignable causes of variation in such situations. However, the second criterion does not solve the problem completely as it appears to be rather restrictive.

In this paper, we present an illustration originated in a Six Sigma Black Belt project at an automotive parts supplier where we develop further Shewhart's second criterion, now incorporating a two tailed F-test, to accommodate a broader range of industrial situations. We also reason upon these situations referring to them as processes in weak statistical control.

59 A Conceptualistic Pragmatic Approach to Bayesian Reliability Analysis

Bo Bergman, *Quality Sciences, Chalmers University of Technology*

Abstract:

Some years ago Richard E. Barlow wrote an interesting book on Reliability Engineering, Barlow (1998). He took a very serious subjectivist approach based upon basic, natural judgements from which engineering decisions, based on Bayesian Belief Nets, could be built. He also included in the book an interesting section on the Total Time on Test (TTT-) plotting technique. However, the inclusion of the TTT-plotting technique was not very well argued for within the subjectivist framework. In this paper I will give an extension to the usual Bayesian (subjectivist) framework naturally including techniques (like the TTT-plotting above) challenging the judgements whereupon statistical inference and subsequent decisions are built. The starting point will be in the knowledge theory developed by C I Lewis. Lewis called himself a conceptualistic pragmatist to differentiate himself from the earlier pragmatists like Peirce, James and Dewey. His ideas, emphasising that we always use our prior conceptions to interpret the sensuously given to build our experience, was an important source of inspiration to Shewhart and subsequently to Deming and to the learning approach, the PDSA- cycle, which permeate the current quality movement. These ideas seem very similar to the Bayesian thoughts. However, Lewis challenges us to always reflect on our prior understanding, and, if felt necessary, make changes. In Lewis theory, learning is not only incremental as in Bayesian theory, dramatic shifts might occur. This will be the starting point of this paper.

60 Quality Control of Food Products using Image Analysis and Statistical Tools

Ana Pereira, *Department of Chemical Engineering, University of Coimbra*

Pedro Saraiva, *Department of Chemical Engineering, University of Coimbra*

Marco Reis, *Department of Chemical Engineering, University of Coimbra*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

This presentation reports results regarding the application of an online color imaging system for quality control in an industrial food production line. The studies carried out regard developments in Quality Control for cereals manufacturing, in particular, the coating homogeneous of cereal flakes in close collaboration with Nestlé Portugal S.A.. Most cereal flakes are typically produced by coating the base product with a colored and flavored coating. Coating plays an important role in the final taste and appearance of the cereal and consequently in its consumer acceptance and valuation. Nowadays the assessment of quality is done through a classification into a finite number of classes (Acceptable, Non Acceptable and Standard) by a panel of experts belonging to the Quality Control and Production. We believe that this process can be improved by the use of on-line image analysis techniques, with the following advantage: accuracy, consistency and resource allocation. By using an RGB camera and a lighting system, images are acquired and sent to a computer that performs classification. This methodology includes a preliminary classification phase where standard information regarding the three prototypes is defined and used to set the statistical parameter limits for the different quality classes. Then, product samples are analyzed using image analysis (pixel-oriented multivariate analysis of multichannel images) and statistical tools are applied in order to come up with the appropriate product quality classes. Our

results indicate that it is indeed possible to classify different samples of flakes according to the classes previously defined by a panel of experts.

61 A review of process capability index calculation methods

Thomas Wagner, *Infinion Quality Management*

Abstract:

Process capability indices are one of the most important quality indicators for process monitoring and improvement. Various methods for index calculation are in use. The goal of this paper is to give an overview of the most important methods and to point out the weaknesses of these approaches. It will be shown that the physical process must be understood to find an appropriate sampling method, to be able to evaluate the stability and to use an adequate capability calculation method.

62 Individual Control Charts based on Pseudo Values

Elsayed Dr.Elamir, *Department of Management and Marketing- College of Business*

Abstract:

When monitoring a process it is important to quickly detect changes in its dispersion. It is also important to search for special causes that may result in a smaller process dispersion. Control charts for individual measurements are often used when production volume is too low to justify rational subgrouping or when automated inspection equipment is used to measure every unit produced. A problem that arises with such charts is how to detect changes in the process variation, since there is only one measurement available. Shewhart control charts, individual and moving range, for individuals are commonly used in these situations. However, the moving range chart may present some serious shortcomings. Although the individual observations may be independent, the moving range statistics are correlated. This correlation affects the interpretation of patterns on the control chart as well as the ability of the chart to quickly detect changes in dispersion. Also, since there is no lower limit on the moving range chart, it is not possible to monitor for decreases in the process dispersion. In this article, we propose control charts based on pseudo values for the individual observations which are suitable for monitoring process location and dispersion when subgrouping is not possible or not suitable. Control limits are derived and we use simulated average run length to compare the performance of Shewhart control charts and proposed control charts. An example is given which illustrates how to use and benefits of the proposed charts.

63 A new algorithms for identification effects in two-level factorial designs and Taguchi-s orthogonal arrays

Zorica Veljkovic, *Dpt. Industrial Engineering, Fct. Mechanical Engineering, Be*

Slobodan Radojevic , Dpt. Industrial Engineering, Fct. Mechanical Engineering, Belgrade University

Abstract:

Factor allocation and alias structures are developed in 1950-ies, and for Taguchi-s orthogonal $L_n(2^k)$ arrays was proofed that they are fractional factorial designs. For higher level factorial designs, since they are not fully developed in matrix form, factor allocation in full and fractional designs are yet to be fully created. Therefore this paper discuss method for identifying factorial effects by column number, starting from columns containing basic factors (main effect in full factorial designs), through factor interactions, using defined mathematical rules. On that basis, algorithm for constructing and algorithm for identification of allocation nonbasic (additional) factors, defining relations of generators and alias structure are developed. Algorithm represents interlude for similar methods and algorithms for identification factor allocation and identification of alias structure in full and fractional factorial designs, in matrix form (transformed and not transformed Taguchi's orthogonal arrays).

64 A SPLIT-PLOT DESIGN FOR A NUMERICAL CONTROL MACHINE

Rossella Berni, *Department of Statistics- University of Florence*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

This work follows a previous study where a numerical control machine is analysed in order to improve the

precision of the measurement for a general dental implant. In this paper, taking care of the previous results, we plan a split-plot design in order to determine the best arrangement of point-sets for three circumferences to define a frustum of cone. The design involves three factors: the drift speed, the measurement speed and the factor of interest, called "circle-point". This last factor is defined as a factor having four levels where each level is a combination of point-sets. Our attention is focused on determining the best arrangement of point-sets, considering the two speed factors, in order to improve both the accuracy of the measurement and, simultaneously, the measuring time for every single dental implant. More precisely, drift speed and measurement speed are considered as classification factors and are inserted in the whole-plots, while the third factor "circle-point" is a sub-plot factor. The design and the optimisation are evaluated according to more response variables, the specific dimension variables measured by the feeler pin when it is in touch with the dental implant by means of a measuring head.

65 A Weighted Ordinal Logistic Regression for Conjoint Analysis and Kansei Engineering Experiments

Stefano Barone, *University of Palermo*

*Alberto Lombardo , *University of Palermo*

*Pietro Tarantino , *University of Naples Federico II*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Customer need for emotional satisfaction is increasingly considered by product/service designers. While several existing methods support the translation of customer requirements into technical specifications, researchers are now working to develop methods aimed at integrating affective aspects into product design. Kansei Engineering is a design philosophy that considers customer perceptions and emotions through a multi-disciplinary approach. Conjoint Analysis is a statistical tool that can be used for implementing a Kansei Engineering study. This article presents a new methodology for conducting a Kansei Engineering study in very early development phases. This methodology uses two new procedures. The first one is aimed at calculating attribute importance weights by using respondent choice time in controlled interviews. The second procedure consists in the introduction of such weights in an ordinal logistic regression model. By using the proposed methodology it is possible to better identify the product/service attributes able to induce specific emotions and feelings in the customer. An application of the method to the design of mobile phones is presented.

Keywords: Kansei Engineering, Conjoint Analysis, Attribute Rating, Ordinal Logistic Regression. Importance Weights.

66 Variability Analysis and Management

Jan Myszewski, *Chair of Entrepreneurship at Wyższa Szkoła Przedsiębiorczości*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The text outlines concepts related to variability and provides a scheme of processing information on set of factors influencing the performance of a system. Techniques useful in variability analysis are described with particular reference to their role in quality and process control. The scheme of variability structure identification described in the paper and entitled Variability Analysis generalises classical approaches to variability control established by W. Shewhart and W.E. Deming using the methods of mathematical statistics. It subsumes many well-known paradigms of management such as those of Kaizen, Re-engineering, System of Profound Knowledge and applications of statistical techniques such as Histograms and ANOVA in system management. Possible applications of the scheme cover any system or process subjected to management. Measures of variability also provide assessments of quality of such management. Variability Analysis highlights the role of teamwork in quality management and provides hints for the methodology of teaching statistical methods for system and process control. Key words: management system, quality control, statistical methods, variability management,

67 Data Mining: Which Method comes out with the best Model? A confrontation between Regressions, Decisions Trees and Neural Networks.

Andrea Ahlemeyer-Stubbe, *Ahlemeyer-Stubbe, Business Intelligence Marketing and More*

Birger S Madsen , *Novo Nordisk A/S*

Abstract:

The talk gives the audience on one hand an overview about the advantages and disadvantages of each method in general; on the other hand we plan to show on practical datasets which helps best esp. under aspects of later usage of the predication results. We like to discuss the difference between being the best model under statistical- and the practical aspects

68 A Control Scheme For Developing Processes

Seiichi Yasui, *Industrial Administration, Tokyo University of Science*

Yoshikazu Ojima , *Industrial Administration, Tokyo University of Science*

Tomomichi Suzuki , *Industrial Administration, Tokyo University of Science*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Usually, control charts are applied for controlling and/or monitoring processes in matured level. However, we can find processes are not in matured level when the processes are started. We call such processes in initial state as 'developing processes' in this paper. We propose a control chart method for developing processes for detecting several kinds of outlying situations, and for categorizing outlying situations. The method contains four types of control charts; they are traditional s chart, trimmed s chart, x-bar chart and x-median chart. Outlying situations are categorized by combining the charts with traditional statistics and the charts with robust statistics. The outlying situation is categorized into the process problem and the measurement problem. Furthermore our control chart method discriminates whether the problems are accidental or systematical. In theoretical background, the contaminated data and the statistical model for the balanced nested experiments is reasonable as the model of developing processes. The variance components and the probability of the occurrence of specific irregularities exponentially decrease. The control limits are robust and based on EWMA (exponentially weighted moving average) of usual Shewhart control limits. A recommended practice for categorizing outlying situations is provided.

69 Robust Estimation of Loss Ratio for Korean Automobile Insurance

Kang Sup Lee, *Department of Mathematics Education, Dankook University*

Young Ja Kim , *Department of Statistics, Dankook University*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Some data containing large scale loss prohibited us from making good estimation. To overcome the problem, we use Huber's M-estimator and median to estimate the loss ratio for Korean automobile insurance. As the results, we have $c=1.5$ as suitable tuning constant in Huber's M-estimates, median is another alternative, and the number of claim is the best weight value of the exposure unit in credibility.

70 Development of a modified C-POSSUM predictor equation for predicting morbidity after laparoscopic colectomy

Pavel Jahoda, *Technical University of Ostrava, Department of Applied Mathe*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The purpose of this study is to compare the original POSSUM and newly developed risk-adjusted morbidity after laparoscopic colectomy (LAC). Original POSSUM morbidity was calculated using the Physiological and Operative Severity Score for enUmeration of Mortality and morbidity (POSSUM) equation ([1]). The aim of the paper is to develop a dedicated Colorectal Physiological and Operative Severity Score for enUmeration of Mortality and morbidity (C-POSSUM) equation for predicting operative morbidity using logistic regression analysis, and to compare its performance with the original POSSUM equation described by Copeland [1]. All patients who underwent LAC performed by a single surgeon from the beginning of 2001 up to end of 2004 were analyzed. The observed mortality rates were compared with those predicted by the POSSUM scoring system. Then new C-POSSUM model based on logistic regression analysis was generated and newly compared with observed mortality. Finally we will conclude that C-POSSUM provides more accurate method predicting the morbidity. [1] Copeland GP, Jones D, Walters M.: POSSUM: a scoring system for surgical audit. British Journal of Surgery 1991, 78: 355-360

71 Robust Parameter Design for Multiple Responses

Sonja Kuhnt, *Department of Statistics, University of Dortmund*

Abstract:

The development of high-quality products or production processes can often be greatly improved by statistically planned and analysed experiments. Existing methods for the analysis and optimisation of multiple responses so far require some kind of weighting, for instance in terms of costs or desirability. Particularly at the design stage, such information is hardly available. Kuhnt and Erdbrügge (2004) present an alternative strategy using loss functions. The effect of different weights assigned to the individual responses is displayed by predicted response means and variances in so-called joint optimisation plots. Here we propose and discuss possible choices of weighting sequences for more than two responses.

References:

Kuhnt, Erdbrügge (2004): A Strategy of Robust Parameter Design for Multiple Responses. *Statistical Modelling* 4, 249-264.

72 Design of performance measurement system

Michal Tkac, *Department of Economic Informatics and Mathematics, Faculty*

**Katarina Kicakova, Department of Economic Informatics and Mathematics, Faculty of Business Economics in Kosice, University of Economics in Bratislava, Slovakia*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Performance measurement system is what motivates employee's behavior. It is not the company's objectives, but performance measures bound to rewards. Therefore, if a company's performance measurement system does not cope with its goals, it will be useless. However, organizations do not usually use any specific method for designing their performance measurement systems and they lack rational linkage between goal setting and performance measurement. The aim of this paper is to apply axiomatic design method used in Design for Six Sigma for creating a performance measurement system of educative process. Axiomatic design should ensure avoiding a coupled design and keeping low complexity of the design. Such design of a performance measurement system will provide compliance of performance measures with objectives set in the area of staff training.

73 Using Control-Charts to drive the process improvement in a company

Winfried Theis, *MSR Consulting*

Falk Hayo Sanders, *MSR Consulting*

Abstract:

After implementing an enormously improved process at one of our clients the question arose, how to transform this improvement into a steady process and drive the company to even more improvements. The first step was to implement a regular meeting of all parties involved in the process and make the success visible within the working area. Within these meetings all aspects of the highly complex process with many sub-processes are discussed and improvements are searched for. A statistician of course thinks first about a control chart to ensure the steadiness of the process. Since no true "in-control" process can be achieved because of the highly complex structure of the problem at hand it has to be assumed (and further observation does manifest this) that we have an in-control state.

For the second task a special interpretation was asked for:

Since the target shall be increased the upper control limit of a CUSUM chart triggers a control box which allows to increment the target-value. Such an increment then triggers a re-calculation of the necessary parameters. We present an EXCEL-Tool which implements this idea and our experiences with this idea.

74 LEAN in education and training

Johan Batsleer, *AMELIOR*

Abstract:

Nowadays, companies have to strive for excellence if they hope to survive in the long run. Beating the competition is the most important prerequisite in order to make it through today's difficult market situation. There are plenty of models that help to achieve excellence. Six Sigma is one the systems that can help with this

ambition.

Others seek refuge in the principles of Lean Manufacturing to reach the highest levels of excellence. The Toyota Production system, which is 50 years old, has become legendary and was the basis of Lean Manufacturing.

"Lean" is a structured way of eliminating losses. It is a system that deletes all unnecessary activities, which must lead to a leaner production.

Nowadays we see that the 'LEAN-thinking' also perfectly can be used in administrative processes. Mapping the value stream, measuring added-value and attacking losses bring organisation in the right mindset that huge opportunities still can be found.

Why not use these fantastic tools in education and training?

Could we also go for a wave of 'LEAN-thinking'?

Today it is all a matter of being better, being cheaper and being faster - or the QCD-isme (Quality, Cost and Delivery).

So why not using the principles of the Toyota Production System to make sure that we deliver excellent quality, combined with pull-systems.

The change in mindset although is huge. The principle should be: It's all about learning, and not about educating.

In this lecture, some lean-principles will be discussed within an area of education and training.

75 Two-stage modelling in electrical load forecasting, with application to customer management by power distribution utilities

Daniele Amberti, *University of Turin and O.R.S. s.r.l.*

*Antonio Pievatolo , *IMATI-CNR*

*Fabrizio Ruggeri , *IMATI-CNR*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

New EU regulations are gradually introducing competition in the electricity market. In view of this, power distribution utilities need medium term hourly load forecasting tools. We propose an integrated approach to load forecasting which employs unsupervised and supervised classification methods, time series and regression modelling. Since hourly time series of electrical load data result from the combination of patterns at different time resolutions, we model the patterns at different resolutions separately:

on the logarithmic scale, the total daily load is modelled as an ARIMA model, including exogenous variables for the day types and the season; the load profile is modelled as a percentage of the total daily load and independently of it, by introducing 23 parameters for each day type. The day type classification plays a very important role on the model adequacy, which is used to determine the best number of classes in a model-based fashion.

76 Applying Bayesian Networks to Clinical Risk Management in Haemodialysis

Chiara Cornalba, *Department of Computer Science and Systems, University of Pa*

Abstract:

Adverse events in health care organizations (HCOs) are more than a serious concern. Over the last few years the awareness of this problem has raised and different organizational solutions have been tried. This paper is aimed at proposing risk management as the basic methodological approach to deal with adverse events by the HCOs. The method is described both at a theoretical and empirical level, thanks to its application to a haemodialysis department. We focus on the problem of managing clinical risks, in terms of events that influence the risk of hospitalization and mortality and their expected costs. Using fault tree heuristic guidelines we have developed a novel graphical representation of uncertainty about the occurrences of these top events. Our multi-state coherent system is based on discrete Bayesian Networks (BNs): different dialysis domain aspects are defined through specific "reliability block diagram", such as haemodialysis department and patient performances, dialysis quality indexes. The prototype comprehends an incident reporting system, which was developed and applied to collect failure data (more than 10000 dialysis during 4 years data collection). Prior selection and inference techniques are applied to BNs to estimate patients' and department's clinical risk profile. Furthermore, they are augmented with decisional nodes and scenario analysis to complete the risk management process: health care decision makers analyse diagnostic and therapeutic practices, evaluate the reliability in therapeutic and governance strategic decisions and prevent adverse events that influence the patients' risks. The ultimate goal is to improve patients' outcome and, consequently, service supply quality in HCOs.

77 How to Measure Six Sigma Project Benefits

Michal Tkac, *Department of Economic Informatics and Mathematics, Faculty*

**Stefan Lyocsa, Department of Economic Informatics and Mathematics, Faculty of Business Administration in Kosice, University of Economics in Bratislava, Slovakia*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The paper deals with different approaches to measure six sigma project benefits in early six sigma project planning phase. The aim of this paper is to show, how to specify estimated six sigma project benefits in special cases. We would like to present an approach, for gaining support from executives for launching a six sigma project.

78 On Using Six Sigma Methodology for Software Quality Assurance

Grigore ALBEANU, *UNESCO IT Chair at University of Oradea*

Poul Thyregod, Technical University of Denmark, IMM

Henrik Madsen, Technical University of Denmark, IMM

Florin Popentiu-Vladicescu, University of Oradea

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The Six Sigma methodology is an alternative to TQM for obtaining: manufacturing defect reduction, cycle time reduction, cost reduction, inventory reduction, product development and launching, labor reduction, increased usage of resources, product sales improvement, capacity improvements, and delivery improvements. Six Sigma is based on a measurement strategy focused on customer satisfaction & financial benefits through variance reduction and continuous process improvement. Six Sigma uses two methodologies named "DMAIC" (Define, Measure, Analyze, Improve, Control) and "DFSS" (Design For Six Sigma). This paper describes the usage of the Six Sigma methodology for software quality assurance and how a mixed Six Sigma and CMMI can be applied to increase the capability and maturity level of the software department. The experience is reported for some small and medium-sized software projects.

79 ON APPLICATION OF NONMARKOVIAN STOCHASTIC MODELS FOR SYSTEM REPAIR SERVICE POLICIES

Lidia Filus, *Mathematics, Northeastern Illinois University, USA*

Jerzy Filus, Mathematics & Comp. Sci. Dept., Oakton College, USA

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

An "extended Weibullian" stochastic process is constructed and applied as a model for reliability of systems with repair. The process (which entries are considered to be times between successive failures) is defined by a common pattern for sequences of new n -variate pdfs of corresponding r . vectors (as n grows to infinity). New, relatively simple, description of underlying stochastic dependencies between the modeled times between failures allows to relax the usual Markovianity assumption, while analytical tractability is still preserved (!). For these reasons a gain in predictions accuracy when the new models are to be applied is anticipated.

80 Visual Six Sigma: Making Data Analysis Lean

Ian Cox,

Malcolm Moore, NA

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Statistical analysis methods are extensively used throughout Six Sigma, unfortunately many of the methods are alien to mainstream thinking. Projects requiring extensive use of statistical methods can suffer from long project cycles, higher project costs and frequent push back. Typical comments include:

- “Too much time is spent worrying about the correct application of the method rather than focusing on what the data is telling us.”
- “Our guys run a mile rather than use statistics.”
- “Our managers glaze over when stats methods and results are presented.”
- “Training overhead is huge and we forget how to use most of what we are taught.”
- “Prescribed problem solving approaches curb creativity.”
- “We need to manage data diversity and problem context.”

This presentation will examine visual approaches that make data analysis intuitive and lean, delivering knowledge that is readily understood and embraced at all levels. Attendees will see Visual Six Sigma in Action via a brief Call Centre Case Study.

81 Six sigma measures as a part of process mapping.

Adam Jednoróg, *CAMT, Wroclaw Univeristy of Technology*

Hieronim Rudnicki , *Sauer-Danfoss Sp. z o.o. Wroclaw*

Zbigniew Sierzchula , *CAMT, Wroclaw Univeristy of Technology*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

There are many ways of process mapping but very rarely process maps include information about quality. Six Sigma advocates measures like First Pass Yield, Throughput Yield and Rolled Throughout Yield as measures directly connected with productivity. Very little literature was devoted to these measures. The aim of this paper is to characterize them, show conditions under which First Pass Yield as much easier available than Throughput Yield can substitute it. The necessary conditions for collecting the data are described. Finally the case study showing the analysis of real process map is presented. It is also described what conclusions form the process map analysis could be drawn and how they could help in putting the corrective action in the right direction. The integration of Six Sigma measures with Lean Manufacturing measures is also proposed.

82 DoE - How to choose the right approach?

Michal Baranowicz, *Wroclaw Univeristy of Technology*

Monika Olejnik , *Wroclaw Univeristy of Technology*

Adam Jednorog , *Wroclaw Univeristy of Technology*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Six Sigma cookbook offers a Black Belt a lot of different tools, methods and techniques. One of the most powerful tools is Design of Experiments. Every Black Belt during realization of each project can get stuck in the moment when he is left with some variables which can be potentially significant for previously defined problem. Design of Experiments is the best way to help in this kind of situations. There are a few approaches to DoE that can be used. It is critical for a successful project, to select the right type of this unquestionably effective tool. In this article authors attempt to establish some basic criteria for right Design of Experiments strategy selection.

83 Measuring ISO 9000 effects on a company quality performance

Debora D'Avino, *Department of Aeronautical Engineering, University of Naples*

*Pasquale Erto , *Department of Aeronautical Engineering, University of Naples Federico II*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Over the last decade, ISO 9000 certification effects on a company quality performance have been the subject of many articles. Usually, these articles are anecdotal and descriptive: some highlight the negative aspects of registration; others underline the positive consequences; the remainder consider both negative and positive aspects. The greater part of these works use case study methodology based on interviews and questionnaires addressed to quality managers about their experience with the ISO 9000 certification. Obviously, the answers

are often questioned being not "objective data". In particular, has been noted that the answers are biased since the respondents are more likely interested to give positive opinion about the job which they are engaged in. In conclusion, apart from personal opinion, there is a surprising lack of effective "measure" of the link between the ISO 9000 practices and outcomes. After the certification "explosion", time has come to approach the problem scientifically. To this end, on the base of our past experience in the technological innovation control, we propose a methodology centred on flexible S-curve model aimed to measure the ISO 9000 certification effects on a company performance.

85 Statistical evaluation of test stands' measurement ability on the basis of testers' readings variability in Sauer-Danfoss Wroclaw.

Hieronim Rudnicki, *Sauer-Danfoss sp.zo.o Wroclaw*

Janusz Blonski , *Sauer-Danfoss sp.zo.o Wroclaw*

Abstract:

Test stands perform an essential function in the quality evaluation of steering units produced in Sauer-Danfoss Wroclaw. To control the measurement ability of test stands, testers (gold units) are used. The article applies basic statistic methods to define the character of testers' reading variability and to identify factors that have an effect on testers' variability.

As a project result the measurement ability of a test stand was determined. Implementation of SPC cards were made to identify special and common causes and to take appropriate corrective actions.

Implementation of double testers made it possible to distinguish between the test stand and tester as source of disturbance. In this way the number of ungrounded service works and stops in the testing processes are limited. Continuous statistical control of test stands guarantee correctness of performed tests.

86 Allocating factors to orthogonal arrays in split plot designs

Goro Watanabe, *Tokyo University of Science graduate school, science-and-en*

Tomomichi Suzuki , *NA*

Takahiro Togashi , *NA*

Seiichi Yasui , *NA*

Yoshikazu Ojima , *NA*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

In experimental design, there are various situations. The number of experiment increases when we take up many factors. To avoid such cases, we use fractional factorial experiments. Linear graphs and orthogonal arrays are convenient for the designs of fractional factorial experiments. In linear graphs, a factor allocated to a column is shown by a "point", and the two factor interaction is shown by a "line" between the two "point" . In other cases, when there are hard-to-change factors, randomization may become difficult. In such cases, we use split plot designs. Split plot designs are very efficient in cost and time, but the analysis method is rather complicated. In the past, there were not much paper concerning allocating factors and deriving linear graphs for split plot designs. In this paper, we investigate two cases. The first is an investigation of how to allocate factors for all the cases to orthogonal arrays. Here we show linear graphs according to the number of factors. We found designs when allocating factors is not possible with existing prepared linear graphs. The second is an investigation for the case of split plot design. Here we show allocating factors to the orthogonal arrays in split plot designs. We found linear graphs for split plot designs. We believe these linear graphs and orthogonal arrays become useful methods to actual experimenters.

87 Empirical modeling of uncertainty in vision systems for industrial robotic applications

Francesco Finazzi, *Department of Quantitative Methods - University of Milan-Bic*

*Alessandro Fasso' , *Department of Management and Information Technology - University of Bergamo*

*Davide Brugali , *Department of Management and Information Technology - University of Bergamo*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Many industrial robotic applications concern with a manipulator that pick up objects from a working area, being

their position in space estimated through a vision system. Although many methods have been developed for carry out that kind of estimates, not as much effort has been focused on the uncertainty related with them. Example of factors that can influence the uncertainty are calibration errors, image quality, particular setting of the algorithm used, particular physical features of the objects and environmental conditions. With such factors it is clear that try to find out a precise and deterministic model for the uncertainty can be a difficult task to perform.

In this paper, after analyzing the factors involved, we present an experimental methodology that allows to build an empirical model of the uncertainty and to identify the factors that actually influence it. The methodology is based on two statistical tools: Design of Experiment and Process Modeling.

Due to the many constraints on the experimental space, the high number of factors involved and their different nature, we direct our attention to the so called "optimal" designs. By comparing different models and criteria, we obtained a model which allowed us to reduce the error on the estimate of objects position.

88 Production Availability Evaluation of Special Test Case Using Stochastic Petri Nets

Monika Kochanicková, *Department of Computer Science, Palacky University, Olomouc,*

**Radim Bris , Department of Applied Mathematics, VSB-Technical University of Ostrava, Czech Republic*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

In this paper we present an approach using stochastic Petri nets as dynamic model for supporting a Monte Carlo simulation to the production availability evaluation of special test case of the European thematic network SAFERELNET (EU project number GTC2-2000-33043). Within this network it has been decided to design relevant simple test cases the aim of which being to point out the actual industrial problems encountered by reliability engineers; to bring to light the new problems arising at the present time; to provide a basis for comparing methods and tools; to identify the present time gaps between methods and tools available and actual needs. Our test case is extracted from an offshore actual installation and comprises a great number of the problems encountered when dealing with probabilistic studies related to production processes. Stochastic Petri nets provide a good framework to model the dynamic behavior of such complex systems. This presenting multi-component modeling approach take into consideration several complex processes like the corrective and preventive maintenance strategy, degradation of components, the resource allocation and different failures of simulate system.

90 Optimisation of a Tinzaparin Outcome Variable using Response Surface Methodology

Kathleen O'Sullivan, *Statistical Laboratory, University College Cork*

Sinead O'Neill , *Statistical Laboratory, University College Cork*

John O'Mullane , *Department of Computer Science, University College Cork*

Jian Huang , *Statistical Laboratory, University College Cork*

Martin Rea , *Wexport Ltd, Cork*

David Cadogan , *Wexport Ltd, Cork*

Abstract:

Tinzaparin, a low molecular weight heparin, is a drug widely used for the prevention and/or treatment of deep venous thrombosis. Tinzaparin is derived from Heparin by enzymatic depolymerisation using Heparinase. Two factors of this system were evaluated; process factors A and B. The aim of this study was to determine the combination of these two factors that optimises an outcome variable in the manufacture of Tinzaparin while satisfying the required specifications on other parameters. Response surface methodologies (RSM) are experimental procedures employed to identify factor settings that optimise a response. Specifically, a rotatable central composite design was used. Five levels of each factor were chosen with analysis of 22 experimental runs being performed. A second-order model was examined. This model permitted the evaluation of linear, quadratic and interactive terms of the factors on the response variable. Three-dimensional surface plots and contour plots were drawn for illustration. The specifications of the additional parameters were assessed by examining the relationship between the process factors A and B, and each of the parameters. Each model was evaluated in terms of the optimal factor settings and the required specifications. The analysis of the second-order model indicated that a linear-model provided a good fit to the data and that low levels of process factor A with high levels of process factor B produced optimal values of the outcome variable. However, the specifications on the additional parameters necessitated that these factors had to be constrained. This experimentation and analysis demonstrated that it was possible to reduce process factor A while increasing process factor B so as to optimise the outcome variable and maintain specification. Keywords: response surface

methodology, central composite design, optimization, enzymatic depolymerisation

91 Analysis of array CGH data: identification of genomic alteration regions

Jian Huang, *Statistical Laboratory, University College Cork, Ireland*

Kathleen OSullivan , *Statistical Laboratory, University College Cork, Ireland*

Sinead O'Neill , *Statistical Laboratory, University College Cork, Ireland*

Yudi Pawitan , *Department of Medical Epidemiology and Biostatistics, Karolinska Institutet, Sweden*

Abstract:

The DNA sequence copy number is the number of copies of DNA at a region of a genome. DNA copy number alterations are key genetic events in the development and progression of human cancer. Recently array Comparative Genomic Hybridization (aCGH) was developed to measure DNA copy numbers across a whole genome. Statistical methods for analyzing aCGH data are aimed at identifying regions of genomic alteration that are associated with clinical phenotypes such as survival. A standard approach to the problem is to individually test each region for the association on a "region-by-region" base. On the base of random effects modelling of a CGH data, we propose a smooth segmentation algorithm to analyze the copy-number variation of the genome, and a smooth t-test approach based on the smooth segmentation to identify significant alteration between two groups. Two strategies are considered:

1. Smoothing the raw data for each array followed by calculating the t statistics.
2. Calculating t statistics from unsmoothed data, followed by smoothing the t statistics.

The two smoothing strategies are compared on real data and simulation data. Comparison study of smooth segmentation with "discrete" segmentation methods such as the R package DNACopy and GLAD is also presented. Results show that both smooth and discrete segmentation aid identification of regions of genomic alteration. Strategy 1 performs better than Strategy 2 in terms of false discovery rate. Keywords: comparative genomic hybridization, segmentation, DNA copy number

92 Detecting Outlying Laboratories in Precision Experiments

Tomomichi Suzuki, *Department of Industrial Administration, Tokyo University of*

Seiichi Yasui , *Department of Industrial Administration, Tokyo University of Science*

Yoshikazu Ojima , *Department of Industrial Administration, Tokyo University of Science*

Ling Feng , *Department of Industrial Administration, Tokyo University of Science*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

One important aspect of statistical data is how they are measured and how accurate they are, especially if some decisions will be made based on the data in such fields as business, industry, trades, and so on. Therefore, evaluating the accuracy of the measurement methods are one of the statistical tasks, and it is performed through precision experiments. A precision experiment is a collaborative interlaboratory experiment in which the performance of the measurement of each laboratory is assessed using identical materials. Often, many levels of the material are investigated. The methods for evaluating accuracy for precision experiments are described in ISO 5725 series. The method considers detecting outlying laboratories and outlying data which are crucial to the final output of the evaluation of accuracy. The detection procedure is defined for each of the levels of the measured material, and it is performed independently for each of the levels. Since it is natural to suppose the measurement results are correlated among the levels in actual cases, there is a need for a methodology for detecting outlying laboratories considering the measurement from multiple levels. In this paper, we propose a new methodology to detect outlying laboratories. We also present tables with values which are necessary for testing whether a laboratory is outlying or not.

93 Process Capability Indices for One-sided Specification Intervals and Skew Distributions

Kerstin Vännman, *Department of Mathematics, Luleå University of Technology, S*

Malin Albing , *Department of Mathematics, Luleå University of Technology, Sweden*

Abstract:

The case when the specifications interval is one-sided is frequent in industry, but not well developed theoretically. Most of the published articles about process capability focus on the case when the specification interval is two-sided. Furthermore, usually the assumption of normality is necessary. However, a common practical situation is process capability analysis when the studied characteristic has a skew distribution with a long tail towards large values and an upper specification limit only exists. In such situations it is not uncommon that the smallest possible value of the characteristic is 0 and this also is the best value to obtain. As an example consider a surface polishing process, where the surface should be as smooth as possible and ideally should have the smoothness values of 0. It is not unusual in practice, in such a situation, to use a two-sided specification interval and put the lower specification limit equal to 0. However, this will imply that when the smoothness values are close to 0 the index value will be small, wrongly indicating a non-capable process. To overcome this kind of problem, we discuss some different ways to define process capability indices for situations with an upper specification limit and target value zero. Furthermore, we assume the studied characteristic to have a skew distribution with a long tail towards large values. We consider suitable decision procedures based on the estimated indices and investigate some of their statistical properties. Examples will be presented to illustrate the methods discussed.

94 Modeling Dependencies in Operational Risk with Hybrid Bayesian Networks

Irina Starobinskaya, *Seminar of Financial Econometrics, University of Munich*

***Stefan Mittnik**, *Seminar of Financial Econometrics, University of Munich*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

This paper examines the problem of quantifying and modeling operational risk of financial institutions in the framework of the Advanced Measurement Approach framework as put forth in Basel II Accord. We argue that standard stochastic dependencies are not sufficient to model operational risk, since one also observes causal topological dependencies between risk classes. They arise, for example, from common information- or work-flows when a failure in an upstream process induces risk for downstream processes. The paper presents a model that explicitly captures both topological and stochastic dependencies between risk classes. We represent operational risk taxonomy by hybrid Bayesian networks (BNs) that are an intuitively compelling language for communicating causal relationships and external interventions. We demonstrate the use of hybrid BNs as a tool for depicting causal dependencies between frequencies (discrete nodes) and severities (continuous nodes) of risk events as well as for handling common underlying shocks. In the BN framework we consider nodes to represent reliability/frequency or severity of risk classes, while directed arcs represent causal relationships between these risk classes. The methodology is illustrated by a Monte-Carlo simulation for a set of risk processes with various levels of reliability/severity and various degrees of topological interdependence.

The results of our study show the substantial impact of topological dependencies on triggering the overall system breakdown. Moreover, they demonstrate that BNs help to explicitly and realistically account for dependencies and to visualize risk flows within an institution. Thus, they are a useful support for decision making in risk processes.

95 Almost Perfect Runs with Applications in Statistical Process Control

Sotiris Bersimis, *Department of Statistics and Insurance Science, University of*

Markos Koutras, *Department of Statistics and Insurance Science, University of Piraeus, Piraeus, Greece*

Abstract:

In the present work, we study a random variable T which describes the waiting time until the first appearance of an almost perfect success run, in a sequence of independent Bernoulli trials. The term almost perfect run is used to declare the appearance of a window of length at most k , which contains at least r successes (an alternative term that has been used in the literature for that is a scan statistic). The exact distribution of the waiting time variable T and its properties are investigated by the aid of a Markov chain embedding technique (for details see Balakrishnan and Koutras (2002) and Fu and Lou (2003)). The distribution of T has recently attracted the interest of many other researchers (see e.g. Han and Hirano (2003) and Chang et al (2003)), because of the fact that it arises quite naturally in various problems related to statistical process control and acceptance sampling. Some additional applications of the same waiting time random variable T in different areas such as DNA analysis and educational psychology are also illustrated.

ACKNOWLEDGEMENT

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96 Controlling the Quality of Bivariate Processes with Grouped Observations

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Abstract:

In Statistical Process Control, quite frequently the need is raised to deal with situations where the quality characteristics of interest are described by the aid of discrete random variables (attribute characteristics). Motivated by this fact, we explore a general class of models associated with possibly correlated discrete variables, which can be efficiently used for the investigation of bivariate processes involving grouped data. More specifically, we present a multi-step gauge control procedure for monitoring the stability of the bivariate parameter of interest when the observations are classified into one of several groups. The theoretical study is carried out by establishing a recurrence scheme for the tail probabilities of the run length distribution of the suggested control chart. Additional applications of the theoretical model to other areas such as acceptance sampling and destructive testing are also presented.

ACKNOWLEDGEMENT

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97 Assessing intra-batch uniformity of solid dosage units during process validation

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Tudor Oita, *Agilrom Scientific*

Abstract:

Uniformity of dosage units is the main goal of a pharmaceutical manufacturing process. The purpose of this study was to develop a practical approach to evaluate uniformity of dosage units during process validation studies. The 5.2. Supplement of Ph. Eur. (Official since 1 July 2005) brought a harmonized vision on dose content variability through general chapter 2.9.40 "Uniformity of dosage units". In this chapter dose content variability is controlled by establishing a limit on the Acceptance Value, a linear combination of standard deviation and the absolute mean deviation from the target. Starting from pharmacopoeial criteria, a validation approach was developed. A low probability of acceptance (5%) and an 85% coverage of 75-125% label claim was defined as limiting quality standard. Several testing plans using a different sample sizes for characterising a uni-dose solid oral dosage form batch using mass variation approach were provided. The proposed test plans have different levels of producer risk which allow the manufacturer to select the most appropriate plan for a particular product.

98 Operational Risks in Enterprise System Implementation

Ron Kenett, *KPA Ltd. and Univ. of Torino, Italy*

Eduardo Kuperman, *KPA Ltd.*

Yossi Raanan, *KPA Ltd.*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Enterprise System Implementation is a major impact initiative with process, technological and human resource dimensions. In ENBIS4, a paper by Buhl et al (Methods to Collect and Analyze Organizational Change Management Data. The BEST Approach) presented a methodology to map Cause-Event-Action-Outcome chains using a 3X9 reference framework

In this paper, we introduce aspects of operational risks to analyze this type of data and mitigate the impact of such chains.

Operational risks add a new dimension that can impact significantly enterprise system implementation such as introduction of ERP, PDM or CRM systems.

If we consider the implementation of enterprise systems using operational risks methodology, the decision on how to plan, carry out and monitor the implementation can change.

Partial Order Maps, used to present risks in several dimensions in a partial order context will be presented together with other relevant multivariate data analysis statistical methods.

99 SEQUENTIAL EXPERIMENTAL DESIGN FOR MULTIVARIATE GENERALIZED LINEAR MODELS

Hovav Dror, *Statistics & Operations Research, Tel Aviv University*

David Steinberg , *Statistics & Operations Research, Tel Aviv University*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

A one-stage experimental plan requires the researcher to fix in advance the factor settings at which data will be observed. Sequential experimental design allows updating and improving the experimental plan following the data already observed.

We consider the problem of choosing sequential plans when the response is modeled by a GLM. A common setting is "sensitivity testing" (also known as "dose-response" or "up and down"). In a typical experiment, a dose level is chosen at each step and success or failure of a treatment is recorded.

We suggest a new procedure for the sequential choice of observations and show it is superior in efficiency to commonly used procedures, such as the "Bruceton" test (Dixon and Mood, 1948), the Langlie (1965) test or Neyyer's (1994) procedure. The suggested procedure is based on a D-optimality criterion, and on a Bayesian approximation that exploits a discretization of the parameter space.

Perhaps more important than the improved efficiency, the suggested algorithm can be used in many situations where the former algorithms do not apply. These include extension from the fully sequential design to any partition of the experiment to blocks of observations, from a binary response to any GLM (including Poisson count models), and from the univariate case to the treatment of multiple predictors.

We present a comparison of results obtained with the new algorithm versus the "Bruceton" method on an actual sensitivity test conducted recently at an industrial plant. We also provide comprehensive comparison of techniques via a Monte-Carlo simulation.

100 On the use of principal component analysis for identifying and monitoring geometric profiles

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Massimo Pacella , *Dipartimento Ingegneria dell'Innovazione, Università degli Studi di Lecce (Italy)*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

In many industrial applications, quality of products or processes is related to profiles or curves. Recent literature pointed out that traditional control charting methods can not be applied in these cases and new approaches for profile monitoring are required. With reference to mechanical components, profiles and surfaces play a relevant role, testified by the high number of geometric specifications characterizing most of the technical drawings. In this framework, approaches for profile monitoring can be effectively adopted to quickly detect unusual patterns in the machined profiles. Most of the approaches for profile monitoring are based on combining classical regression to multivariate control charting. Regression is used to describe the profile by means of a relationship between a response variable and one or more explanatory variables or predictors. These predictors have to be properly chosen depending on the specific case faced. A different approach consists in using Principal Component Analysis (PCA) instead of regression to identify patterns in the profile data. However, the use of PCA has been limited to a visual aid in interpreting the systematic behavior underneath collected curves. In this paper, we deepen advantages related with the use of PCA in profile monitoring. In particular, we explore which type of profiles' features allows one to obtain interpretable principal components. We further compare performance of PCA control charting with the one attainable with traditional approaches for profile monitoring. Within the paper, a real case study related to roundness profiles of mechanical components is used as reference.

101 A model of random point processes with mutually dependent intensities

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[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

Poisson distribution, Poisson random processes and generalizations are widely used as a probabilistic tool for the modeling of occurrence of certain events in time. As the area of application of such models is very broad, from technical reliability analysis, through medical studies, biostatistics and survival analysis, to demography and social studies, there exist numerous different variants of these models. In the present contribution I consider a situation when more random point processes run in parallel, the evolvment and events of one influencing the intensity of others. The case is encountered typically when analyzing technological processes with mutually dependent events like failures and certain important marks, which can or cannot be controlled and

flag possible changes of failure intensity. The framework of counting (and marked point) processes is used for the analysis and also prediction of such a system behaviour. This framework allows to treat such cases via regression models for intensities and select a proper model form (multiplicative, additive) depending on what is more realistic. As it has been recognized, the performance of many complex processes from other areas (finance, business, sports) can be described in a similar way. Hence, after formulating the model and methodology, I will give an illustration by an example from sports, namely the development of the conditions and the intensity of score in the course of match.

102 A comparison of the Simes-Benjamini-Hochberg procedure with some Bayesian rules for multiple testing

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Jayanta K. Ghosh , *Department of Statistics, Purdue University, USA*

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Abstract:

Working with large data bases often requires simultaneous testing of many statistical hypotheses. There are many ways of assessing and controlling the error of such multiple testing procedures. The most traditional approach is to control the Family Wise Error Rate (FWER) or the False Discovery Rate (FDR). Procedures controlling FDR are usually less stringent than those controlling FWER and therefore they are often used in practical applications. One of the most popular testing procedures used to control FDR is the Simes-Benjamini-Hochberg procedure. In this presentation we consider the framework of sparse mixtures, which are used to describe the situation when the alternative hypotheses hold only for a small proportion (p) of simultaneously performed tests. Using simulations as well as theoretical observations we study false discovery rate (FDR), positive false discovery rate (pFDR), power and misclassification probability for the Simes-Benjamini-Hochberg (SBH) procedure, as well as for various Bayes and Parametric Empirical Bayes procedures. Our results confirm the observation of Genovese and Wasserman (2002) that the misclassification risk of the SBH procedure is close to optimal when p is relatively small. This property is shared by some of the considered Bayes testing rules, which in general perform better than the SBH procedure for large or moderate p 's.

[1] Genovese C. and Wasserman L. (2002) Operating characteristics and extensions of the false discovery rate procedure. *J. R. Statist. Soc. B*, 64, 499 - 517.

104 Discovering Six Sigma myths.

KamiL Torczewski, *Wrocław Univ. of Technology*

[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

After almost 20 years of Six Sigma practicing and developing, there is still a lot of misunderstanding with it. A lot of Six Sigma myths and legends exist in both business and academic world. In this article, author focuses on the most common misunderstandings about Six Sigma, and explains the real nature of this improvement programme.

110 Mathematical foundations for valuation of extra information

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[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

We consider a model of financial market with one stock with lognormal returns and one risk-free bond. There are two types of investors: regular traders (with knowledge described by some filtration $\mathcal{F}_{[0,t]}$) and insiders possessing from the beginning some extra information available to regular traders only at the end of or after the trading interval (this knowledge is described by filtration $\mathcal{F}_{[0,t]} \vee \sigma(G)$). Enlargement of filtration may substantially improve investor strategy allowing him to build portfolio with greater expected utility. We show how to use results of stochastic calculus of variations (Malliavin's calculus) to calculate investor's utility with and without an additional knowledge.

112 An expert system for computer aided selection of experimental designs

Jacek Pietraszek, *Cracow University of Technology, Institute of Computing Scie*

Zbigniew Polanski , *Cracow University of Technology*

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[Full Paper](#) and [Appendix \(if available\)](#)

Abstract:

The mathematical and interpretation complexity is the most important difficult blocking wide spread of the DOE methodology in industry environment. A small part of mentioned techniques was implemented, especially as a "black box" receipts without deeper understanding. Software companies released many software packages focused on computational aspects without deeper advisory.

Authors propose a dialog expert system based on rule-driven inference engine and a knowledge base as described in [4,5]. The knowledge base contains specially coded descriptions of typical experimental designs. A user interface is driven by embedded decision tree and set of questions is addressed to the user during session with system. An answer for every question determines one descriptive aspect of future selection process. When session ends all descriptive aspects are determines or "wild-carded" either. The complete set of these linguistic variables (knowledge database filter) is next transformed to the real relational database filter written in SQL. This query is sent to database engine and after filtering process all proposed experimental designs are displayed.

Recent version supports selection of two-level fractional, composite and latin squares designs. Current development is focused onto Taguchi robust designs, mixture designs and introducing fuzzy-logic into dialog. Authors are strongly interested in co-operation with other research centers and industry.
