IIQP NEWSLETTER

Spring 2002

Institute for Improvement in Quality and Productivity

University of Waterloo

Inside...

3 Business and Industrial Statistics Section

10 Computer Experiments

11 Call for Papers

Product Monitoring vs. Product Control

G. Dennis Beecroft

Dennis is the Managing Director of the IIQP. He has extensive work experience both in industry and at the University of Waterloo. He works with many companies on their quality issues.

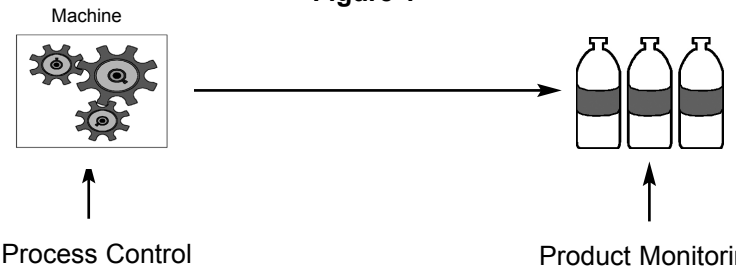
G. Dennis Beecroft

The recent release of the ISO 9001:2000 continues to underline the value of looking at all work, in fact all business, as a process or series of interconnected processes. This concept is not new and is well understood by organizations in their quest for improved quality of the products that they provide to their customers. In the automotive quality management system standard QS-9000 (now ISO/TS 16949), the test and inspection plan, called the control plan, has two columns to record the characteristics to be measured - one for product characteristics and the other for process characteristics.

However, most of what is being measured is characteristics of the product produced. For example, let us consider the product - a molded plastic pop bottle. The product characteristics being measured might be such things as average wall thickness, bottle diameter at various points and perhaps the cap threads. These characteristics are often statistically monitored over time. Based on the results of the measurement of these "product parameters", the "processes" that produce these products are defined in terms of "stability" and "capability".

This statistical monitoring of the product is commonly termed SPC or Statistical Process Control. Would it not be more appropriately called "SPM" or Statistical Product Monitoring? In statistical monitoring of the product, the data measured is after the product has been produced. The product is either acceptable or unacceptable. No level of monitoring at this point in time will have any impact on the actual quality of the product being produced. With this being the case, this inspection or appraisal activity is "non-value added".

Figure 1



to page 2... "Product Monitoring vs. Product Control"

Published in the Spring, Fall and Winter, the *IIQP Newsletter* is the official newsletter of the **Institute for Improvement in Quality and Productivity** at the University of Waterloo. It is available free of charge.

Editor
Jennifer Gaunt

Editorial Board
Bovas Abraham
G. Dennis Beecroft
Jennifer Gaunt
David Matthews

Copy Editor
Bev Rodgers

Contributors
Bovas Abraham
G. Dennis Beecroft
William Welch

Letters to the Editor
We welcome your comments. The editor reserves the right to edit all submissions.

IIQP
University of Waterloo
200 University Ave. W.
Waterloo, ON N2L 3G1 Canada
Tel. (519) 888-4593
Fax. (519) 746-5524
Web. www.iiqp.uwaterloo.ca

Please Circulate and Recycle

Product Monitoring vs. Product Control

(continued from page 1)

G. Dennis Beecroft

Let us now contrast this non-value added activities approach with that of measuring "process parameters" that affect the product characteristics. In the example of the molded plastic pop bottle, the pressure and temperature of the molding equipment might be critical process parameters that affect the quality of the plastic pop bottle. These parameters could be measured statistically over time and then adjusted as necessary to prevent unacceptable bottles being produced. It would be most appropriate in this case to term the statistical monitoring as "SPC" or Statistical Process Control since the "process" is being controlled by the measurement of key "process parameters". This preventive approach is "value added" as the process can be adjusted thus impacting the quality of the bottles being produced.

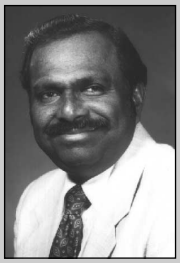
While this concept is well understood by most organizations, very little measurement of "process parameters" is being done. The main reason is that the "product characteristics" are more easily determined than "process parameters". In many cases the customer specifies the product characteristics as their requirements. Process characteristics or parameters are much more difficult to determine, then measure and control. Process parameters are particularly difficult to determine where people, rather than machines, perform most of the work being done in producing a product. In most cases these important process characteristics can only be determined through experimentation. This experimentation can be very time consuming and costly. It often also requires the production of unacceptable product to verify the process parameters.

In summary, while "process control" is more efficient and cost effective than "product monitoring", it requires much more effort and cost to determine the process characteristics that affect the product quality. However, the effort will pay for itself in the long term. By producing only acceptable product through process monitoring and control costly, inefficient, non-value added inspection activities could be eliminated. ◆

Business and Industrial Statistics Section of the Statistical Society of Canada

Bovas Abraham

Bovas is the Director of the IIQP and has been a consultant with the Institute since its inception. His main areas of interest include Quality Improvement, and the management and implementation of statistical procedures.



Bovas Abraham

The Statistical Society of Canada (SSC) has three active sections: the Bio-statistics section, the Survey Methods section, and the Business and Industrial Statistics Section (BISS).The Business and Industrial Statistics Section was created at the 2000 annual meeting of the SSC. It has about 60 members across Canada. The overall objective of the section is to focus on the interests of members working in business and industrial areas. The section organizes invited and contributed paper sessions at the SSC annual meetings as well as pre-conference short courses and workshops. The section also aims to promote the involvement of academic statisticians and students in the solution of practical problems in business and industry. It also attempts to develop linkages among statisticians working in various applied areas and academia. During last year, we developed a set of the regulations for this Section.

During the 2001 annual meeting in Burnaby, British Columbia, BISS organized a special invited session, a workshop, and two invited sessions. Prof. William Meeker of Iowa State University was the speaker in the special invited session and he presented a paper on 'Accelerated Testing: A Method for Obtaining Reliability Information Quickly'. Prof. Hugh Chipman from the University of Waterloo offered a day-long workshop on 'Data Mining'. The other invited sessions were 'Innovative Applications of Statistics in Business' organized by Martin Putterman of University of British Columbia and 'Statistics in Industry' organized by Randy Sitter of Simon Fraser University.

For the 2002 annual meeting BISS is planning a one-day workshop on 'Design and Analysis of Computer Experiments' and Prof. William Welch, University of Waterloo is the workshop leader. We are also planning a special invited session and the speaker is Prof. John MacGregor, McMaster University who will speak on 'The Changing Nature of Data and Its implications for Applied Statistics'. In addition there will be two invited sessions 'Split Plot Experiments in Industry', organized by Prof. John Brewster of the University of Manitoba and 'Statistics in Finance and Marketing' organized by Dr. Alison Burnham of GE Capital. There is also another invited session jointly organized by BISS and the Survey Methods Section. Thus, BISS has an exciting program organized for the next SSC annual meeting, May 26-29, 2002, at McMaster University in Hamilton, Ontario, Canada. For details for this conference, visit www.ssc.ca.

The IIQP has been a big supporter of BISS and Bovas Abraham, Director of IIQP, was the founding president and continues to be the president. Several IIQP members have been actively involved in BISS activities (workshop leaders, invited speakers, etc) from the very beginning. The IIQP maintains the website for BISS.

I take this opportunity to invite you to join BISS and get involved in its activities. The executive committee is interested in hearing suggestions and ideas from people in industry and business as to how BISS can be more effective in promoting links between academia and industry and business. We would also like to hear about themes for future workshops, and invited sessions and about potential speakers from industry and business.

It is important for us to be informed of activities similar to those of BISS. We like to foster links with other groups and organizations in Canada or elsewhere who have similar interests. We already have links with the Statistics in Business and Industry committee of the International Statistical Institute. If you know of other groups similar to BISS, please let us know.

For more details about the BISS visit: www.iiqp.uwaterloo.ca/BISS.

Current Executives

President
Bovas Abraham, University of Waterloo
babraham@uwaterloo.ca

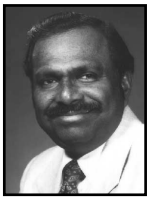
President-Elect
John Brewster, University of Manitoba
brewstr@cc.umanitoba.ca

Secretary
Roman Viveros, McMaster University:
rviveros@mcmail.cis.mcmaster.ca

Treasurer
Julie Zhou, University of Victoria
jzhou@math.uvic.ca ◆

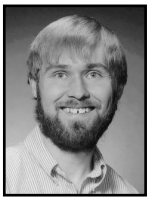
Upcoming Courses

Meet some of our Course Instructors ....



Bovas Abraham
Director, IIQP

G. Dennis Beecroft
Managing Director, IIQP



Hugh Chipman
Consultant, IIQP

Jock MacKay
Consultant, IIQP

Stefan Steiner
Consultant, IIQP

Gary Waller
Associate Provost, Academic and Student Affairs, UW

Cost of Quality for Continuous Improvement

TWO DAY COURSE

Course Description

Cost of Quality (COQ) is an excellent continuous improvement (CI) management tool. COQ can be used effectively to identify, prioritize and then track CI projects by breaking down quality costs into four standard categories: prevention, appraisal, internal failure, and external failure.

You Will Learn

- To Categorize Elements of COQ
- Select and Track Projects
- Choose Vendors and Price Products Using COQ
- Use Cost of Quality for CI in QS-9000 and ISO 9000

Target Audience

- Financial Officers
- Quality Managers and Professionals
- Continuous Improvement Team Leaders

Course Dates

June 5-6, 2002
November 14-15, 2002

Cost

$790 (+GST)

Cost Includes: tuition, course notes, handouts, lunches, coffee and refreshments.

Advanced Data Mining

ONE DAY COURSE

Course Description

More and more companies have enormous databases which may contain undiscovered but useful information. Data Mining is the search for this information using statistical models and computational techniques. This one day course will illustrate the state of the art, using real data from direct marketing, drug discovery and industrial control problems.

You Will Learn

- What is Data Mining?
- Methods for Preprocessing Data
- Graphical Exploration of Data
- Classification and Regression Techniques
- Clustering

Applications in the Course Include

- Direct Marketing
- Drug Discovery
- Process Monitoring with High Dimensional, High-Volume Data

Course Dates

June 18, 2002
September 27, 2002

Cost

$395 (+GST)

Cost Includes: tuition, course notes, handouts, lunch, coffee and refreshments.

Design of Experiments

TWO DAY COURSE

Course Description

A designed experiment is a special type of process study that involves changing one or more process characteristics to investigate their effects.

Design of Experiments (DOE) is one of the continuous improvement tools in Six Sigma and ISO 9001:2000. This two day course will teach you how to effectively use this key methodology to improve quality and reduce costs.

This course will provide you with the right tools to understand, plan and execute an experiment. You will also gain the experience in deciding if experimentation is a good approach to your particular problem(s).

You Will Learn

- What is an Experiment?
- Experiments vs. Other Data Based Approaches
- Complete Factorial Experiments - looking at several factors simultaneously
- Fractional Factorial Designs - efficient ways to look at many factors
- Taguchi's Robust Designs to Reduce Variation
- Implementation - Planning and Executing Experiments

Course Dates

June 25-26, 2002
November 7-8, 2002

Cost

$790 (+GST)

Cost Includes: tuition, course notes, handouts, lunches, coffee and refreshments.

Effective Problem Solving

TWO DAY COURSE

Course Description

Effective Problem Solving involves a disciplined methodology and the use of appropriate tools. This workshop teaches a 5-step problem solving model - define problem, containment, determine root cause, implement solution and verification of solution, and tools to be used at the various steps within the problem solving process.

You Will Learn

- How to Correctly Define the Problem
- Understand Work as a Process
- Identify Different Types of Problems
- Define Processes Using Process Maps
- Learn the 5-Step Problem Solving Model
- Practice the Use of Problem Solving Tools

Who Should Attend

- Quality Managers and Professionals
- Quality Improvement Team Members

Course Dates

June 12-13, 2002
November 21-22, 2002

Cost

$790 (+GST)

Cost Includes: tuition, course notes, handouts, lunches, coffee and refreshments.

Training Effectiveness

ONE DAY COURSE

Course Description

Training Effectiveness is a requirement for ISO 9001 Quality System Requirements under Element Training. This introductory workshop is based on the Kirkpatrick Model.

You Will Learn

- Options and Recommendations for Developing Evaluations
- Procedures for Measuring Effectiveness
- Roadblocks to Effective Evaluation
- How to Evaluate at the Four Levels (Reaction, Learning, Behaviour and Results) and Pros and Cons of Different Approaches

Who Should Attend

- Human Resources Personnel
- Training Professionals
- Management Leaders
- Quality Professionals

Course Dates

June 20, 2002
October 10, 2002

Cost

$395 (+GST)

Cost Includes: tuition, course notes, handouts, lunch, coffee and refreshments.

Understanding Six Sigma

ONE DAY COURSE

Course Description

Six Sigma is an improvement system which is seen as a business strategy to gain the knowledge needed to obtain better quality products and services faster and cheaper. More and more companies are trying to implement this system. This one day course is mainly oriented to people from small to medium companies who are contemplating about undertaking a six sigma initiative. This course will provide an overview of the Six Sigma system.

You Will Learn

- What is Six Sigma?
- DMAIC Process
- Statistical Thinking
- Variation Reduction
- Six Sigma and Process Capability
- Statistical Tools in Six Sigma
- Training in Six Sigma

Course Date

November 14, 2002

Cost

$395 (+GST)

Cost Includes: tuition, course notes, handouts, lunch, coffee and refreshments.

Statistical Process Control

ONLINE COURSE

Course Description

This new course is equivalent to a 2 day (14 hours) short course on Statistical Process Control (SPC). This online course is developed for people involved in process control and improvement activities. It will provide an understanding of the basic concepts of Variation, Stability, Capability, etc.

Course Contents

- Understanding Variation
- Charts for X-Bar and R
- Charts for Individuals
- Sampling for Charts
- Process Capability
- Charts for Attribute Data

For More Details Visit:

http://www.iiqp.uwaterloo.ca/SPC

Registration Information

Use the online form to register. Once the form and payment is received a user name and password is issued via e-mail.

Course Available Until

December 20, 2002

Cost

$295 (+GST)

Statistical Engineering

TWO DAY COURSE

Course Description

Statistical Engineering is a combination of statistical strategies and tools carefully selected to efficiently solve chronic problems in high volume manufacturing. Statistical Engineering attempts to exploit observational data from your existing process to “home in” on the root cause of problems.

This two day course covers the guiding strategies and tools you need to effectively apply this exciting methodology to improve quality and reduce costs. This course is a requirement for our new Statistical Engineering certification program, and is also a good compliment to the Design of Experiments two day course.

You Will Learn

- Guiding Principles of Statistical Engineering
- Structured Problem Solving Strategy - diagnostic and remedial journeys
- Progressive Search and Families of Variation
- Clue Generation Methods - using observational data to efficiently guide improvement efforts

Course Date

January 15-16, 2003

Cost

$790 (+GST)

Cost Includes: tuition, course notes, handouts, lunches, coffee and refreshments.

Third Edition

ISO 9001:2000

An Updating Overview

ONE DAY COURSE

Course Description

This course is designed for organizations who are already registered to ISO 9000 and need to know more information on the updated edition.

The Third Edition ISO 9001:2000 has made several changes creating a more user friendly standard. It has simplified its language, reduced the required documentation, and made several changes based on customer and user feedback. This edition will be easier to implement, use and upgrade from the previous editions.

In this updating course, find out about the changes and how it impacts your organization and your registration status.

You Will Learn

- Background on 2000 Edition
- Overview of Changes
- Impact on Current Quality System
- Transition Guidance
- Review of Critical Changes
- How to Implement Changes
- Changes to Auditing

Course Dates

June 17, 2002

November 12, 2002

Cost

$395 (+GST)

Cost Includes: tuition, course notes, handouts, lunch, coffee and refreshments.

Forecasting in Quality / Productivity Improvement

TWO DAY COURSE

Course Description

Forecasting plays a central role in business decision making: decisions about investments, resource allocations, schedules and inventory levels. This course gives an overview of useful quantitative forecasting tools and it also covers regression/time series models that incorporate into the forecasts any additional information such as sales promotions and price reductions. Computer software implementing these procedures are demonstrated, and participants have the opportunity to practice their new skills with their own data sets.

Course Contents

- Sales forecasting and inventory control
- Quantitative and qualitative forecast approaches
- Exponential smoothing forecast procedures
- Autoregressive models for forecasting
- Forecast models for incorporating the effects of promotions
- Forecast evaluation and forecast tracking
- Case studies
- Discussion of computer software
- Hands-on computer lab to practice new skills

Target Audience

- People in marketing, operations management, logistics and inventory control, etc.
  Brand managers.

Course Date

September 30-October 1, 2002

Cost

$790 (+GST)

Cost Includes: tuition, course notes, handouts, lunches, coffee and refreshments.

How Do I Register?

REGISTRATION INFO

You may register online or contact the Institute at the address below.

Institute for Improvement in Quality and Productivity
200 University Ave. W.
University of Waterloo
Waterloo, Ontario N2L 3G1
Tel. (519) 888-4593
Fax. (519) 746-5524
E-Mail. iiqp@math.uwaterloo.ca
Web. www.iiqp.uwaterloo.ca/Courses

More Information

- All IIQP courses can be tailored to suit specific needs or applications and presented within your company. Such courses are often developed by modifying or combining existing courses, depending on the request.
- Instructors are University of Waterloo faculty and IIQP staff who are professionals with extensive industrial training and consulting experience.
- Refund of fees will be made only if notice of cancellation is received at least 10 working days prior to the start of the course. Substitution of participants from the same organization is permitted.
- Please add GST to all course fees
  (GST#: R119 2606 85)

Name: _____

Position/Company: _____

Address: _____

City: _____

Postal Code: Zip: _____

Tel: _____

Fax: _____

E-Mail: _____

Please Specifiy Course(s) and Date(s):

_____

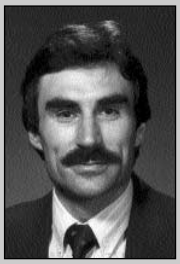
_____

☐ Bill Later ☐ Cheque / Money Order Enclosed

Computer Experiments

William Welch

William Welch is a member of the IIQP whose interests include design of experiments and discovery of pharmaceutical drugs. He has consulted with companies such as AT&T, GlaxoSmithKline, GM and Intel.



William Welch

Increasingly, engineers are using computer models to design and improve products and processes. In automotive engineering, a good example is crash testing. Because of time and dollar constraints, physical crashes can be carried out for only a very limited number of vehicles. Engineers supplement the physical data with predictions from computer models, especially when choosing amongst many potential vehicle designs.

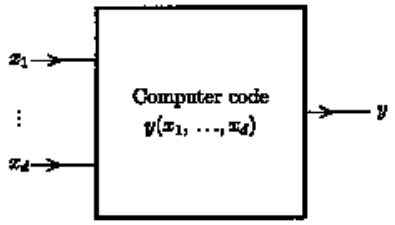
In general, a computer model is just a (large) amount of computer code that converts various input variables into one or more output variables, as shown in Figure 1. In a quality-improvement context, the inputs, $x_1,\ldots, x_d$, are variables describing the engineering design, and the output, y, is a measure of design performance.

In principle, then, we could carry out "what-if" analyses, optimize y as a function of $x_1,\ldots, x_d$, and so on directly via the computer model, but there are a number of practical obstacles:

- The number of input variables (d) can be very large;
- These computer codes usually take a long time for a single run (one set of values for $x_1,\ldots, x_d$), maybe hours on a fast computer;
- The relationship between the inputs and the output is often complex.

In other words, we need to explore a high-dimensional input space and a complex function $y(x_1,\ldots, x_d)$ with relatively few runs of the code. For instance, we might have 10 input variables and be restricted to 100 runs. This suggests using the limited data to fit an approximation, and solve the engineering objective using the approximation. Statisticians are well accustomed to such ideas, e.g., the response surface methodology of Box and Draper. Thus, *computer experiments*, where the data come from a computer model, have some

Figure 1: A Computer Model



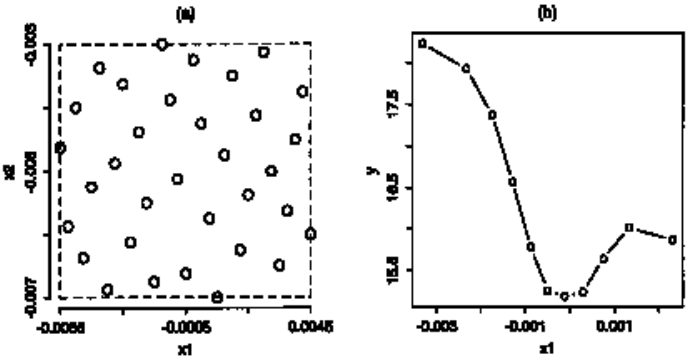
similarities with physical experiments.

Computer models present some unique challenges, however. First, these models are often deterministic. This does not mean that statistics is irrelevant! Even without random error, if you are asked to predict a function of 10 variables using data from only 100 runs there could be much uncertainty in your predictions, and dealing with uncertainty is a statistical concern. Secondly, the complexity often seen in the $y(x_1,\ldots, x_d)$ relationship, e.g., highly nonlinear effects, can make standard regression methods inaccurate.

For these reasons, statistical design and analysis tends to be rather different for computer experiments. For instance, Figure 2(a) shows the values of the first two input variables, x_1 and x_2, in a recent tolerance study involving an aircraft engine. The experimental plan has 33 runs and 33 levels for each input variable. With many levels, it is possible to estimate highly nonlinear effects. Indeed, such effects were present in the aircraft-engine study. A very flexible type of regression model was fit to the data and used to approximate the input-output relationship. Figure 2(b) is the estimated effect of x_1 on y from the approximating model; it suggests that x_1 has a large effect on y when $x_1 < 0$ but a much smaller effect when $x_1 > 0$. Visualization of the relationships in this way is very helpful to understanding. Here, manufacturing variation in x_1 leading to small values of x_1 will have much impact on the performance measure, y.

At the Statistical Society of Canada 2002 Annual Meeting in Hamilton, Jerry Sacks and I will be presenting a workshop overviewing these methods.◆

Figure 2: Aircraft-Engine Example
(a) Values of the first two variables in the experimental design of 33 runs; and
(b) Estimated effect of of x_1 on y.



INTERNATIONAL CONFERENCE ON QUALITY AND INNOVATION

Presented by the Institute for Improvement in Quality and Productivity

UNIVERSITY OF WATERLOO

Waterloo, Ontario, Canada

October 22-23, 2002 ◆ Waterloo Inn

call for papers

Quality and Innovation are key factors influencing strategic decisions in business, government and other organizations. In this rapidly changing economic environment, it is essential for organizations to respond effectively to changes in technology, environment and customer demand with efficient, high quality products and services. Innovation is all about new ideas, new products, new processes, new services and new customers.

The objective of this conference is to bring academic researchers, government and business leaders and professionals together to discuss and promote ideas in the areas of quality and innovation.

Submissions are invited on the topics of:

- Innovation management
- Quality management and continuous improvement
- Strategic quality and innovation planning
- Quality culture and business ethics
- Organizational learning and development
- Understanding and management of business excellence
- Creativity
- Leadership for innovation
- Managing change
- E-business
- Knowledge creation and management
- Supply chain management
- Customer focus and satisfaction
- Performance measurement

Papers in related topics will also be considered.

Please submit your proposal for consideration by June 28, 2002 and include:

- 2-3-paragraph abstract, summarizing your topic
- State type of forum - paper, case study or workshop
- Key objective of your topic and benefits from your session
- Length of sessions to be 30/60 minutes

Tel. (519) 888-4593 ◆ Fax. (519) 746-5524 ◆ E-Mail. iiqp@math.uwaterloo.ca

To submit a proposal or for more information, please visit our website:

www.iiqp.uwaterloo.ca/Events

INSTITUTE FOR IMPROVEMENT IN QUALITY AND PRODUCTIVITY

our website has a new look

Please provide us with your e-mail address so we may keep you updated frequently.
iiqp@math.uwaterloo.ca

www.iiqp.uwaterloo.ca

IIQP Newsletter
University of Waterloo
200 University Ave. W.
Waterloo, ON N2L 3G1 Canada