Course Objectives

Poor sampling, compounded by poor laboratory subsampling, leads to questionable geostatistics, and generates severe conciliation problems between the geological model, the mine, and the plant estimates. These problems also affect the price of commodities and the validity of environmental assessments. The result is a huge money loss for the company involved, evolving later in likely litigation. It is of key importance for geologists, miners, metallurgists, chemists, and environmental specialists to extract maximum information from the available data, as large investments and crucial decisions depend on it. False evaluations lead to devastating scenarios such as:

- Abandonment of viable properties,
- Exploitation of unprofitable properties,
- Mismanagement of viable properties, and
- Incompetence in fraud detection.

It is critical to quantify the heterogeneity of important constituents in any new property. Failure to do appropriate testing leads to invalid sampling and subsampling protocols, excess drilling, and a biased database that would later lead to false geostatistics. The following sequence is part of inescapable practice:

- How is the constituent of interest distributed in the material to be sampled?
- Conduct Heterogeneity Tests to quantify the sampling characteristics of the constituent of interest.
- Optimize sampling protocols and the way they are implemented, according to the results from the Heterogeneity Test.
- Implement protocols using valid sampling equipment: 75% of the sampling equipment available on the market will never do the job.
- Implement a comprehensive, systematic quality control program to monitor sampling precision and accuracy.

The staggering cost of irrelevant data variability is not easy to detect, quantify, or correct. A strategy for effective management of variability will enable managers to identify and minimize annoying conciliation problems between theoretical models and reality: Your decisions are only as good as your samples!

The course offers simple ways to quantify money losses for a given sampling precision, and it provides a good strategy to prevent sampling inaccuracy for which there is no statistical cure. Unless sampling precision and accuracy are clearly connected to economic issues, it is unlikely that managers would understand the need to improve sampling protocols and the way they are implemented. At the end of the course, attendees will be better equipped to present the economic advantages of good sampling. Thus, the course is pre-requisite for bank investment: Bankers must listen, and trust the Sampling Theory.

Fees & Registration

The registation fee is US $3,650 through August 31st and $3,800 thereafter. The course registration fee includes a limited 1-year license for the software used in the workshop:

- EMPV (Effective Management of Process Variability)
- OSP (Optimization of Sampling Protocols)
- OGC (Ore Grade Control)
- AA (Agreement Analysis)

Registration fees must accompany enrollment forms. Attendees who enroll by September 7th will receive a free USB containing Pierre Gy's *Theory of Sampling* and C.O. Ingamells' *Poisson Process Approach*.

The sponsor reserves the right to cancel the course and return registration fees if enrollment is insufficient. Cancelations by registrants will be assessed a $275 service fee. No refund will be made to registrants who fail to substitute or cancel five working days prior to the start of the course. Personnel substitutions may be made at any time without cost penalty. Short Course participants will receive 3.5 Continuing Education Units (CEUs) upon completion of course.

Travel & Lodging

Registrants are responsible for making their own lodging and travel arrangements. A list of accommodations is available at **www.csmspace.com/static/accommodations.html.** SuperShuttle provides transportation between Denver International Airport & Golden **www.supershuttle.com.**

Technical Information

Dr. Francis Pitard at 303-451-7893 or fpsc@aol.com

www.fpscsampling.com

Registration Information

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October 5-9, 2015
Software Workshop Included

Sampling Theory, Sampling Practices

and their Economic Impact

- Sampling of Copper, Gold, Coal & Iron Ore
- Sampling of Industrial Minerals
- Sampling in the Chemical Industry
- Sampling for Monitoring the Environment
- Practicing the use of Sampling Software — Integrated in Lectures as the Course Progresses

COLORADO SCHOOL OF MINES

Taught by Francis Pitard Sampling Consultants

www.csmspace.com

Course Topics

Who Should Attend

This course is designed for individuals responsible for optimizing the performance of mines, metallurgical plants, chemical plants, and environmental assessments. The course also applies to many other areas where someone must collect samples to make important decisions. The course is highly recommended for managers to optimize their operations. You should attend this course if you are:

- Exploration and ore grade control geologists
- Presidents, Vice Presidents, and operations managers
- Geostatisticians and laboratory supervisors
- Miners, metallurgists and chemists
- Quality Assurance and Quality Control managers
- Environmental engineers & pollution control specialists
- Concerned investors and company shareholders

What you will Learn

- The nine kinds of sampling errors, how they take place, and how to minimize them; most people can list only two!
- Sampling correctness, so you can reject sampling systems that will never perform a satisfactory job.
- Become familiar with necessary tests to be performed at mines and plants to optimize all your sampling protocols.
- To select appropriate Data Quality Objectives for operating parameters, which are worth continuous monitoring, to minimize your operating cost.
- To better appreciate the value of existing chronological data that allows you to better control any process. This data is valuable for management in identifying structural problems that lead to unnecessary financial losses.
- Variography is the key to identify the various sources of variability affecting routine chronological data. You will discover the power of Chronostatistics.
- Using existing data, variability from sampling and measurement must be clearly separated from process trends and cycles. Unless this is well done, continuous process improvement will remain elusive.
- The careful use of the Moving Average and especially its auxiliary functions can greatly help you to minimize the effect of poor sampling and measurement precision.
- Relative Difference Plots can clearly show the presence of conditional biases from sampling and from laboratories.
- Realize the weakness of today's standards on sampling: They are obsolete and not in line with the Sampling Theory.
- Get updated on sampling developments exposed during five World Conferences on Sampling and Blending.
- **Workshop with Software** *included in progressing lectures.*

Introduction

- Fundamental statistical concepts used in sampling theory and sampling practices
- Nine kinds of sampling errors: You must address one at a time, otherwise sampling is almost always invalid.
- Heterogeneity of major and trace constituents
- Examples of common financial losses due to poor sampling practices
- Definition of Data Quality Objectives
- Presentation of a new quality strategy based on Data Quality Objectives
- Synergy between Data Quality Objectives and sampling protocols
- Definition of basic terms and symbols

Sampling Theory & Practice

- Errors generated by sample weights
  - Optimization of sampling protocols
  - Description of Heterogeneity Tests, for a normal case, and for a difficult case
- Errors generated by segregation
- Practical implementation of sampling protocols
  - Complete review of sources of sampling biases
- Exploration of the Nugget Effect
- Selection of realistic, economical cutoff grades
- Detailed review of existing sampling systems:
  - During exploration (diamond core, RC, …)
  - At mines (blastholes, …)
  - At plants (cross stream systems, in-stream probes, augers, …)
  - At laboratories (splitters, crushers, pulverizers, shovels, spoons, spatulas, …)
  - For sampling commodities at shipping facilities
  - For sampling the environment
- Monitoring precision and accuracy at the laboratory
- Monitoring precision and accuracy of sampling and subsampling protocols
- Quantifying the awesome cost of sampling precision
- Suggestions for better sampling standards

Reconciliation problems between the geological model, the mine and the plant

- The myth of reconciliation
- Identification of major sources of reconciliation problems
- Capitalize on existing data: A gold mine of opportunities
- Understand the different kinds of heterogeneity and the variability they generate
- Become proactive through effective statistical thinking

Management must set priorities

- Find causes of problems and structural properties you must live with
- Invest in minimizing causes of problems
- Find effects of problems and circumstantial properties you cannot control
- Save money by spending less on effects of problems
- Managing visible cost:
  - Historical priority placed on visible cost
  - The accountant's point of view
- Discovering invisible cost:
  - The staggering cost of constituents grade variability
  - Reconciling statistical and accounting points of view

Introduction to Chronostatistics

- Critical review of sampling and measurement modes: random systematic, stratified random, and random
- Introduction to variography
- Advanced variography
- Introduction to variographic statistical process control

The Moving Average, a pragmatic, simple but delicate tool

- How much averaging is appropriate
- The random noise
- The corrected data

The Relative Difference Plot: The best tool for QC monitoring

- Detection of a conditional bias as a function of time
- Detection of a conditional bias as a function of of increasing constituent content

An Improvement Strategy for Effective Sampling

Workshop using sampling software

Progressive workshops included in several lectures as the course progresses so attendees can take full advantage of what they learn and apply important principles as they return to their operations. Participants will learn about:

- Installing the software packages
- Getting comfortable with the Help file of each program
- Getting familiar with the many options in each program
- Preparing the necessary data from an Excel worksheet
- How to import the data to each software package
- How to customize the data analysis
- How to make a thorough interpretation of the results
- How to initiate or suggest new possibilities for sampling protocols

Instructors

Dr. Francis F. Pitard is a consulting expert in Sampling, Statistical Process Control and Total Quality Management. He is President of Francis Pitard Sampling Consultants (**www.fpscsampling.com**) and Technical Director of Mineral Stats Inc. (**www.mineralstats.com**) in Broomfield, Colorado, USA. He provides consulting services in many countries. Dr. Pitard has six years of experience with the French Atomic Energy Commission and fifteen years with Amax Extractive R&D. He taught Sampling Theory, SPC, and TQM for the Continuing Education Offices of the Colorado School of Mines, the Australian Mineral Foundation, for the Mining Department of the University of Chile, and the University of Witwatersrand in South Africa. He has a Doctorate in Technology from the Aalborg University in Denmark.

Max Pitard (Software Instructor) is the founder and CTO of HonuaTek LLC, a company focused on developing digital solutions for the mining, manufacturing and utilities industries. He holds a B.Sc. in Mathematics and Computer Science from the Colorado School of Mines, and has over 20 years of experience in IT consulting where he has engaged customers ranging from technology startups to fortune 50 companies. His areas of interest include developing innovative solutions to complex analytics problems by employing the latest advances in information integration, aggregation and processing technologies.