

November 25, 1994

Mr James A Thomas, President  
American Society for Testing and Materials  
1916 Race Street  
Philadelphia, PA  
USA 19103

Subject : **D5549-Standard Guide for Reporting  
Geostatistical Site Investigations**

Dear Mr Thomas:

Reference is made to my letter of April 19, 1994, and our telephone conversation on October 18, 1994. I urge you to peruse the terms *kriging* and *kriging variance* in the above draft. Please examine the formulas on page 99 of Practical Geostatistics, Isobel Clark (D5549, Reference 11). The first formula shows that the kriged estimator is a function of a set of independent variables. Set theory dictates that two independent variables in a linear sample space have only one arithmetic mean but an infinite set of distance weighted averages. Probability theory and applied statistics dictate that covariances and variances of functionally dependent variables are invalid.

Please examine page 3 of *Theory and Problems of Statistics* (Schaum's Outline Series) where Murray R Spiegel explains what functional dependence is all about. Please examine my notes on *Neostatistics in Geoscience* to find out what happens when degrees of freedom become irrelevant. Any variant of statistics that violates the requirement of functional independence and ignores the concept of degrees of freedom makes a mockery of science.

Please visit ASTM's library and try to find a book on applied statistics that does *not* refer to degrees of freedom, and that does *not* contain statistical tables in which critical values are listed as a function of degrees of freedom. If you do find one, it is probably Srivastava's *Introduction to Applied Geostatistics* (D5549, Reference 11). If you want him to have a copy of this letter, please let me know and I shall deliver it in person. I was amused when I found out that Mr Morgan's response to my letter of April 19, 1994, was to send it to Srivastava who, I assure you, is not quite ready to recant geostatistical dogma.

Srivastava and authors of similar cerebration want the Members of ASTM Committee D-18 to believe that covariances and variances of functionally dependent variables make sense but no amount of wishful geostatistical thinking will make degrees of freedom vanish.

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The degrees of freedom cancel when calculating the covariance but are needed when testing for statistical significance the degree of associative dependence. Spatial dependence between independent variables in n-dimensional sample spaces gives a significantly higher degree of precision for the expected value if the degree of associative dependence is statistically significant.

It is extremely ironic but entirely predictable that kriging enhances spatial dependence and creates it where none exists. It is popular in mineral exploration, if only amongst the enforcers of geostatistical doctrine, because drilling holes is expensive and kriging makes a few holes go far. In data acquisition kriging is on a par with perpetual motion but in abuse of computers and statistics it is unparalleled.

Mr R S Ladd, Chairman of D18, was kind enough to give me the name and mailing address of Professor Dr Daniele Veneziano. With your permission I shall send to her copies of our correspondence and a paper in which I show how to derive the formula for the variance of the weighted average, a homologue of the formula for the variance of the arithmetic mean (that ubiquitous Central Limit Theorem). Yet it is a formula that the geostatistical theorist frowns upon because every distance weighted average in the infinite set has its own variance so that selecting only one is a daunting task indeed. How much simpler it is to select, either randomly or systematically, a subset of distance weighted averages, and to calculate its covariance or variance!

One might surmise that mathematical purity and statistical soundness in ASTM Standard Methods are conditions sine qua non. I appreciate Mr Morgan's sense of humor. However, I respectfully suggest that one of the eminently qualified statisticians on ASTM Committee E-11 be entrusted with the validation of geostatistical treatment of data. Please let me know which course of action you plan to pursue, and do not hesitate to contact me if you require more information or further clarification.

Yours truly,

J W Merks  
President

Miscellaneous Enclosures