SAMPLING SPECIAL SECTION

Sampling expertise for the accounts department, CEOs and board members

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Money out the window—either way

Here is a perfect example of how everything works out at the accounting level, where value is measured in monetary units. Picture a business selling a commodity under the contract specification that the product contains 27.45 % of a critical compound (this is measured by the seller's own "home" laboratory). For the sake of argument, let us assume that this is exactly what is reported for a consignment in question. So, the seller is apparently in the clear, and the buyer will, therefore, get exactly what is stipulated on the product specification sheet. This is the ideal case for both parties: the seller does not give away a higher concentration of the valuable commodity than promised, and the buyer only has the correct amount of valuable goods paid for.

However, the buyer wishes to exercise his testing privilege (relying only on his own preferred laboratory of course)… The whopper: before the day is out, the seller is being sued by the buyer's lawyers—since the control laboratory reports a concentration of 23.40 % *only*. Is the seller employing an inferior laboratory? Or, is this newly discovered disparity a result of the buyer's laboratory inferior performance? Or worst, should the seller be suspected of trying to swindle the buyer? Suddenly both stakeholders experience uncertainty and doubt—who, what is to blame? Today's tradition is overwhelmingly to look for *causes* to such control differences only *within* the realm of analytical laboratory performances (both *could* be wrong in principle, but this conclusion has only a snowman's chance in Hell, since both laboratories are, no doubt, properly certified, so this conclusion will be ignored). Nevertheless, with today's most often used approaches, what happens instead is a totally unnecessary amount of *extra* laboratory work (see Example 2 above).

Most unfortunately, in the overwhelming number of such cases, the root cause lies miles away from the certified analytical laboratories. The sampling + analysis spread is the real culprit!

Because of the inevitable sampling + analysis spread, Figures 1–3, which was reported as 27.45 % *could* alternatively (from a second sampling) just as well have turned out as, say, 23.20 % in the case of significantly heterogeneous materials. A difference of 4.20 % in concentration of the valuable analyte will very likely be unacceptable. But less can be equally bad, if the intrinsic value of 1 % point is higher. Depending on the intrinsic % point value, the magnitude of the concentration difference, and the so-far ignored weight determination uncertainty as well (yes, there is also a weighing spread lurking in the wings, but more on that later), as one ranges over all the World's traded raw materials, commodities and volumetric goods sooner or later there will be a threshold on the other side of which such differences will not be acceptable because of the accumulated *value losses* (loss in material, loss of revenue, loss of reputation…).

Here is the principal situation, in terms of the money lost for the one party… or gained for the other. For the sake of argument, assume a nominal commodity price: EUR 850 / 1 % point / ton: 4.20 % deviating concentration is equal to EUR 3570 / ton; if tonnage is, say, 250 ton, **EUR 892,500**.

(It should be factored in that industrial weighing is most certainly also fraught with measurement errors, just as is analytical determination, which will only add to the sum-total uncertainty. However, the weighing uncertainty influence(s) will be treated specifically in its own right in several examples below.)

The intrinsic value of raw materials, commodities and goods as characterised w.r.t. composition and the value by volume (mass) of course display an extreme range. For the "lower end" of things, the consequences of analytical differences will not constitute major deviations—while as soon as the *ICV* is *higher* and/or the tonnages involved are, the accrued loss of revenue for the seller (or the "extra commodity received at no payment" for the buyer) will meet with severe disapproval at accounting and management levels.

For the sake of argument, assume a constant tonnage of 250 ton, with changing intrinsic commodity value per % point (*ICV*) and changing analytical difference (*AD*), the gross economic consequence in the form of the resulting *value gain or loss* (*VGL*) for this example commodity is shown in Table 1.

This tally will, of course, take on quite other manifestations, some less drastic, others very much more so, depending on what *your* commodity *ICV* is, *your* tonnage involved and what the operative between-laboratory analytical difference

Table 1. How it always adds up...

AD	*ICV*	*VGL* (EUR)
1.00 %	850	212,500
1.00 %	1700	425,000
2.50 %	850	531,250
2.50 %	1750	1,002,500
5.00 %	850	1,062,500
5.00 %	1750	2,125,000

DOI: 10.1255/sew.2021.a50

(*AD*) happens to turn out to be. There is no need to insult anybody's intelligence by producing *similar* tables as the one above for a slew of other materials, lots and products (some less valuable, many very much more so). Anybody on the business side of the principal transaction used in the example above, will have got the picture long ago:

WHY do such hidden discrepancies occur within our business?

WHY has nobody told management about this risk long ago?

WHO is accountable for this lack of due diligence w.r.t. proper risk management?

WHAT can we do about this?—Immediately!

Traditionally, knee-jerk reactions and solutions to the above desirability has been to pour a lot of new money into improved analytical performance, either upgrading one's own lab or finding a better commercial laboratory with a better reputation etc. Alas, as has been made abundantly clear above, that this will very likely *not* solve the issue, Figures A–D in the Editor's Introduction.

This is the very reason the TOS *has* to be invoked. This is the fundamental reason a minimum of the TOS understanding *must* be mastered at all relevant levels, including those formerly only responsible for the business side of operations. Of course, that should also include proper **risk management**.

Conclusion

There are ample economic, pure business-related reasons to make sure that TOS knowledge is part of your operations, company, corporation and organisation—and absolutely no reasons not to…

"The costs of sampling errors and bias in the mining industry"

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Abstract. "South Africa's mineral commodities generate approximately R420 billion per annum from export earnings. Of that amount coal (28.1%), gold (15.2%), iron ore (14.5%), and platinum (21.7%) account for 80%, and together with chrome and manganese account for 88% of the earnings. Payment for these products is based on the metal content, and in the case of coal, the energy content. Traders rely on the analytical results from samples of the products to obtain a fair price and true value of the sale. This paper covers three main issues. Firstly, the thrust of interest in sampling of particulate materials is shown to be primarily due to the financial implications of poor sampling and the vibrant trade in these mineral and metal products in the USA between the 1850s and 1940s. The importance of correct engineering for cutter operation and good maintenance of cutters in general in the sampling of bulk commodities is emphasised. Secondly, simulation of a low-grade iron ore deposit demonstrates that the principal offending factor in sampling events is the sampling bias, rather than the sampling error. Whereas sampling error may account for as little as 0.0016% error in the mean grade, sampling bias, which can be positive or negative, may affect the mean grade by as much as 10%. Thirdly, the contribution of individual particles of iron ore, particularly those in the larger fractions of the size distribution, is investigated. Relatively small changes in mean grade of about 0.106%Fe can result in losses to the supplier of about US$11 600 per 100 000 t shipment of iron ore, a substantial amount of nearly seven million dollars per annum. Together the three aspects, principles of correct cutter operation, the effects of bias on the mean grade of samples, and the effect of size distribution on sample extraction error, contribute to potential financial losses in the bulk commodities trade."

Reference

1. R.C.A. Minnitt, "The costs of sampling errors and bias to the mining industry", *J. S. Afr. Inst. Min. Metall.* **118(8),** 767–798 (2018). https://doi.org/10.17159/2411-9717/2018/v118n8a1