doi: 10.1255/tosf.3

The World Conference on Sampling and Blending (WCSB)—achievements and possibilities

Personal reflections by Francis F. Pitard

TOS forum has received many responses to the first call for contributions, some of which are published in this first issue, others will follow as soon as possible. The very first submission received, presented here, was from the extraordinarily active *éminence grise* of sampling, Francis F. Pitard, in the form of personal reflections on the achievements and prospects of the series of World Conferences on Sampling and Blending.

Introduction

At the event of WCSB6 I want to put some thoughts together, so as a Pierre Gy Gold Medallist I would bring my experiences and reflections on TOS, and contribute to making sure TOS grows in a rational way—in spite of its many distracters. Looking at recent comments made around the world, it is clear that many statisticians and empiricists promoting "Measurement of Uncertainty" (MU) strongly believe that the "Theory of Sampling" is something they can live without. Such antagonism is misplaced, unjustified and very unfair and I am aware of a heroic attempt to bridge the chasm between TOS and MU, which is on the verge of being crowned with success.[1] I also strongly believe the MU promoters need TOS, and vice versa, and perhaps, through WCSB if we could communicate in a more friendly way, we would be able to create the necessary foundation of many, better standards around the world. In this search for "peace" it would be perhaps advisable to go back to history.

A long time ago

We live in a heterogeneous world and all attempts to reach homogeneity are most certainly an exercise in futility. This was the starting point for the entire life's work by Pierre Gy that can be dated pretty accurately to the year 1950. But before Gy's work there were many authors, empiricists and theorists, who came up with good ideas and remarkable work. Gy's mission was to spend 10 years (late 50s early 60s) to make a monumental search of the existing literature on the subject of sampling particulate materials. In his historical documents[2–4] Gy always carefully referred to all the positive work he had found from theoreticians. Along the way he had been mostly impressed by the American school of thought, such as the remarkable works of D.W. Brunton, Kassel, Guy and especially R.M. Becker, and many others from other schools around the world. He also discovered the work of empiricists, such as Richards from MIT. It is fascinating to see that today empiricists still have a strong hold on how sampling problems should be approached and resolved. Gy's work is an integrated and comprehensive approach naturally based on ideas of many of these preceding workers. To this day, he is the only author who has created a complete coverage of what a Theory of Sampling must contain. All subsequent work carried out outside this framework rarely cover all sources of sampling errors in a logical way, and if they do, it is only an attempt to try to explain *how* Gy's theory is working.

Irrefutable facts

Gy breaks the total uncertainty manifestations down into eight sources of sampling variability which he called *sampling errors* (i.e., short-range errors FSE, GSE, IDE, IEE, IWE and IPE, plus a long-range error and a periodic error for dynamic measurements), to which other sources of uncertainty should be added such as laboratory analytical measurement error and the *in situ* nugget effect (e.g. for geologists and geochemists). MU experts and empiricists seem to resent such classification as they think the conventional statistical analysis of data alone is enough to detect sampling problems; in this there is a firm belief that all variability can be modelled by a systematic component (bias, acceptable or not) and a stochastic variance (precision, acceptable or not). However, detection is not cure, so MU should welcome TOS because it effectively pinpoints where problems are, and this is the cardinal issue, gives irrefutable solutions for minimising each source of excessive sampling uncertainty. As a quick reminder, TOS makes a clear distinction between *uncertainty* (i.e., **after** all sources of sampling biases have been minimised to a negligible level, and **after** precision has been reduced to an acceptable level relative to a pre-selected Data Quality Objective), and *error* when no attempts to minimise sampling correctness problems and unacceptable precision are made. The word "error" was selected by Gy because at the time, early sixties, in an overwhelming amount of cases sampling incorrectness and excessive precision problems were the rule of the day. These definitions in TOS may bother some MU experts, but I do not think they are totally incompatible with their ways of thinking either... So, let us negotiate together… within WCSB would be advisable.

Matheron's introduction of Gy's work

In the preface to Gy's historical publication (dated 15 January 1967),[2] released in *Revue de l'Industrie Minerale* (which only very few of today's sampling experts know of—and far less have read), the famous originator of the discipline of "geostatistics", G. Matheron stated (translated from the French by Francis Pitard):

"In this work that Pierre Gy asked me to present to his readers, we may see the characteristics of a accomplishment of reason and an intelligent synthesis trying to satisfy at the same time the necessary rigour of theoretical thinking, unity and coherence and the necessary efficiency in complex conditions often poorly defined in industrial practices. It is the first time it seems that such a synthesis is provided in the world of sampling, a domain where, as Pierre Gy mentions, some medieval practices from alchemists still remain. Such statement may be surprising, especially considering that the "Ratio Occidentalis" from the very

day it gave itself the mission of conquering the world, changed all the old ways of living and thinking, then radically transformed the way the planet where we live looks like; it is then difficult to comprehend the reasons why all techniques relative to the subject of sampling escaped, just by themselves, this new imperial order. Perhaps we would say that it is because too many difficult questions, for which too many inextricable factors may interfere with logical answers, are nearly impossible to be clearly expressed. Therefore, a fortiori *it is nearly impossible to submit these questions to the rigour of scientific analysis. This is why common sense, guided by experience and intuition, found their way for too long inside such a labyrinth… It is very clear that a theory that sits on an empty space will produce only chimerical thinking; but, inversely, common sense and experience do not have the right to dismiss reason as a dishonest servant."*

Identifying the theory of sampling (TOS)

Misconceptions

For TOS there are only so many fully initiated champions to go around, and sampling teams without one are doomed to bide their time on the treadmill of mediocrity. The fortunate teams have the duty to give guidance to sampling practitioners around the world, helping to establish operative, practical standards… However, such standards are not always open to new ways of thinking: too much conservatism, too much status quo and unwillingness to stand for what is right instead of simply following what the entire world is doing... is often the rule.

Many people around the world today think the TOS is the work of Pierre Gy alone; there is nothing further from the truth, however! TOS is the work of D.W. Brunton, Kassel, Guy, R.M. Becker and many others, sorted out in a logical way and, of course, significantly augmented by Pierre Gy. Later new works were brought to TOS by François-Bongarçon, Minkkinen, Holmes, Minnitt, Lyman, Esbensen and Pitard who integrated the valuable works of Visman and Ingamells in his 2009 doctoral thesis. Here it is shown that several of these individual theories are not necessarily incompatible, in fact, in this particular case they are indeed beautifully complementary.

A dynamic body

TOS is a dynamic body in a permanent state of flux and it is critically important it remains that way. WCSB would appear to be just the right platform to deliberate suggestions for new additions… I emphasise the word *additions*, because a lot of people think of subtractions, replacements, negative arguments—born in a complete ignorance of the valuable works done during the last 50 years. My advice to many of those ready to voice criticism of Gy's work is, spend some years to understand his work **in depth**, including many essential French publications, then and only then, we may talk again. I have little tolerance for those who read a short paper in diagonal and are already on a mission of critique. Einstein said "I have little patience with scientists who take a board of wood, look for its thinnest part, and drill a great number of holes where drilling is easy".

WCSB: A powerful meeting place for science and industries

TOS, through WCSB, brings together a forum of people who is interested in sampling theory, practice, experience, implications and standards, and these meetings offer powerful tools to academics, manufacturers, engineering firms and practitioners, so essential for many industries; this is our mission at WCSB. Equally important, at WCSB there is also a need for MU experts to be present; proponents of MU are very welcome and their ways of thinking should be respected because their work is important and necessary. MU is welcomed in the spirit of corporation laid down by Esbensen and Wagner.[1]

Main accomplishments of WCSB

The theory: attracting academics

University institutes that do not teach TOS have a huge handicap and it is fair to say they are managed with a deficient vision. Since WCSB was created, the academic world has been gaining momentum, however, both to learn about and to teach, and spread TOS. Along this slow process there are many obstacles; the new generation of teachers, professors and consultants often believe they can become experts overnight… We should accept such mistakes because they are the only ways for them to get better at what they are doing… and we all went through these steps ourselves.

Some young participants who faithfully participated to the WCSB conferences are now making huge progress; some prepared masters, doctorates and even post-doctorates on the subject of sampling and closely related subjects. Now, we have new teachers of the TOS in Denmark, Brazil, Mexico, South Africa and probably many other countries.

Pierre Gy's Gold Medallists, identified at each WCSB conference, are those who have been most effective and successful around the world to disseminate and promote TOS. This group of champions constitutes a formidable asset today as a unified body that is capable to teach, promote and make positive suggestions for a bright future as it was never done before.

Implications: Helping manufacturers and engineering firms

Manufacturers of sampling equipment are usually good engineers and excellent entrepreneurs: they know how to build good machines and sell them to the world. However, a good machine may easily transgress the most elementary rules of increment delimitation and increment extraction correctness, making it totally useless as a sampler as it is incapable of providing accurate and precise enough information. Actually, this problem is exactly where the word "uncertainty" should be replaced by the word "error"; it should be regarded as an *error* to produce machines that are obviously wrong (in TOS' sense), indeed outcomes from such "sampling" have no place in the world of "uncertainty" either. Several manufacturers of sampling equipment around the world found enormous value and guidance from WCSB to the point that they are willing to be valuable sponsors of the conference, which says it all…. For example, at WCSB4, Multotec, a well-known manufacturer from South Africa, allowed several of the best sampling experts to review their sampling systems and accept criticisms so they could greatly improve the correctness of their equipment. In a more discrete way, other manufacturers such as Essa FLSmidth, Ludowici FLSmidth, TecProMin and Rocklabs did the same and they undoubtedly, today, manufacture the best sampling equipment in the world.

Experience

To the empiricists: experience teaches nothing if you are not capable of a continuous and iterative learning process, and this is exactly why a dynamic and continuously updated TOS is important to all of us. We long passed the time when TOS was Gy's

product alone; today TOS is a scientific patrimony based on the talents and experiences of many experts worldwide. But TOS and its practitioners has its good and bad moments, as it should be, justifying the regular gathering at WCSB where, together, we may find the pathways to logical new breakthroughs.

Documentation, references and standards

Proceedings from WCSB conferences are extraordinarily valuable documents and many contributions herein can indeed be the object of new studies, new research and new breakthrough leading to additions that would allow standards committees to create dynamic, progressive iterative standards for industries and academics. As a first step, it is imperative that all WCSB Proceedings are easily available at all times, irrespective of whether this comes in the form of books or journals. Should other formats be decided upon, all proceedings papers must be freely, and easily available to the entire sampling community—especially to those who could not attend a specific conference. Without this option, the intended inter-communication will fail.

Making a united community from WCSB

Six WCSB conferences have taken place in the period 2003—2013. An enormous amount of valuable presentations have been featured and scores of Proceedings documents have been created and communicated to practitioners all around the world. Yet, there was no attempt to take all this information and *integrate* it in a logical way into TOS, as it was in 2003, prior to the creation of WCSB. This is perhaps understandable, as everybody was more than happy that the institution WCSB became firmly established. But this shortcoming must soon be corrected for otherwise the mission of WCSB will fade away and ultimately fail. One of the reasons for this status quo is because too many authors of good papers are far more interested in promoting themselves than helping to make TOS grow in a logical way, indeed there is a certain amount of grandstanding at every WCSB (perhaps unavoidable—but very nearly always counter-productive). Worse, too many are apparently interested in creating *their own* TOS, which is highly unfortunate as this goes nowhere in the broader perspective. Were such eager beavers only able to stand back a little, take a deep breath and refrain from such egocentricity, WCSB would be a forum ten times more powerful…

Figure 1. Three surviving Pierre Gy's Sampling Gold Medallists—very much aware of the responsibility to guide TOS along to grow in a united, rational and logical way. Left to right: Francis F. Pitard, Pentti Minkkinen and Dominique François-Bongarçon.

Publications

There are thousands of worthwhile references that can be found in all WCSB proceedings and this is precisely the point: how do we integrate all that knowledge into a single, dynamic, iteratively updated *oeuvre* of the greatest value for all, industries and academics alike?

Concluding remarks

Figure 1 allows me a few final reflections aimed at the future. There are today three survivors from a group of the five first Pierre Gy's Sampling Gold Medallists (Dominique François-Bongarçon, Pentti Minkkinen and Francis F. Pitard). We deeply regret and miss dearly our two friends and colleagues who have passed since the penultimate WCSB, Pedro Carrasco Castelli and Allen Royle—their contribution to the promotion and teaching of TOS were of the highest value; they will be forever remembered with fondness and love.

But we are not alone—this is our joint responsibility, the entire sampling community. There is no better way to ensure success for this endeavour than by contributing constructively to the series of World Conferences on Sampling and Blending (WCSB) and to the new *TOS forum*.

References

1. K.H. Esbensen and C. Wagner, "Theory of sampling (TOS) vs. measurement uncertainty (MU) – a call for integration", Trends in Analytical Chemistry (TrAC) submitted (2013). Also included in C. Wagner, *Non-Representative Sampling versus Data Reliability – Improving Monitoring Reliability of Fuel Combustion Processes in Large-scale Coal and Biomass-fired Power Plants*. PhD thesis, Aalborg University, Denmark (December 2013).
2. P. Gy, "L'chantillonage des Minerais en Vrac. Volume 1", *Revue de l'industri Minérale*, St Etienne, France **(Numéro Spécial)** (15 janvier 1967).
3. P. Gy, "Modele General de l' Echantillonnage des Minerais (General Model for Sampling Mineral Ores)", *Revue de l'Industrie Minerale* 53(2), 77–99 (1971).
4. P. Gy, "L'chantillonage des Minerais en Vrac. Volume 2", *Revue de l'industri Minérale*, St Etienne, France **(Numéro Spécial)** (15 septembre 1971).