Report to IPGSA on WCSB11

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DOI: 10.62178/sst.002.010

1. Overview of WCSB11: Diversity and Application of the Theory of Sampling

The Eleventh World Conference on Sampling and Blending (WCSB11) was held at Misty Hills Conference Centre, Muldersdrift in Johannesburg, South Africa from the 21-23 May 2024. This is the second time the conference took place in South Africa, the first being the WCSB4 in Cape Town, 2009. WCSB11 was attended by approximately 150 delegates from 18 different countries, each bringing insights and understandings of the way sampling in general and the Theory of Sampling (TOS) in particular affects our lives. In addition, there were approximately five on-line attendees who were unable to travel to South Africa, but who participated and made excellent on-line presentations of their research. The overall level of attendance was above average and may be considered a proxy for the measure of success of the Conference. In the three days of the Conference, fifty-four presentations were made by delegates, and five sponsors were given an opportunity to share their expertise with delegates. The theme of the conference "Diversity and Application of the Theory of Sampling" was to examine and explore the significant implications and inroads the Theory of Sampling has made into such diverse fields as economic, mineral, industrial, food and feed, agricultural, and pharmaceutical activity in which sampling is an important basis for making far reaching, important decisions.

Although many of the concepts affecting the accuracy and precision of particulate sampling were developed as early as in the period between the mid-1800s to the mid-1900s, it was Pierre Gy, a French chemist and engineer who began his work on sampling in 1949, who laid the foundation and formalised our understanding of sampling theory in full measure. What we now know and refer to as the Theory of Sampling was a work in progress between 1950 and 1975 and led to the 1967 publication in French entitled "L'Échantillonnage des minerais en vrac: Théorie générale" (Sampling of Particulate Materials: Theory and Practice) which was Gy's first comprehensive exposition of his theories. Gy's contributions were seminal in forming the theoretical framework for sampling of particulate materials in general, which includes the formulation of key principles and mathematical models to address the inherent variability and errors in sampling of heterogeneous materials and processes.

2. Theme and Scope of the Conference

The series of World Conferences on Sampling and Blending was initiated by WCSB1 in Esbjerg, Demark in 2003, and has subsequently been held in Brisbane, Australia (WCSB2 2005), Porto Alegre, Brazil (WCSB3 2007), Cape Town, South Africa (WCSB4 2009), Santiago, Chile (WCSB5 2011), Lima, Peru (WCSB6 2013), Bordeaux, France (WCSB7, 2015), Perth, Australia (WCSB8 2017), Beijing, China (WCSB9 2019), and Kristiansand, Norway (WCSB10 2022).

These World Conferences have become the cornerstone for fostering international collaboration amongst the sampling fraternity and interested professionals. The aim is to share knowledge about standardising practices within the scope of the Theory of Sampling, to minimize variability and uncertainty, and to enhance the reliability and accuracy of sampling methods. WCSB meetings provide a forum that bridges the gap between the Theory of Sampling and the Measurement Uncertainty, and thereby create a unifying foundation that will lead to the development of more universally accepted practices and standards.

Although TOS is a cornerstone for modern society's pursuit of sustainable processes and products, full acceptance and implementation across all the sectors of industry and society, it is still a work in progress. WCSB11 extended and amplified the efforts to reach the scientific and technological involvement of other industries besides mining and minerals, including applications in technology, industry, society, commerce, and trade. These areas include food, feed, agriculture, pharmaceutical production, with particular emphasis on Process Analytical Technologies (PAT), environment, and sustainability.

Additionally, the conference underscored the importance of representative sampling in quality management and with respect to the environment, as well as the optimization of natural and renewable resources while considering environmental impacts. WCSB11 specifically aimed to address the UN Sustainable Development Goals 9 and 12, focusing on sustainable industry, innovation, infrastructure, and responsible production and consumption.

3. Aims, Objectives, and Goals

The aims of the World Conferences on Sampling and Blending (WCSB) are principally to preserve, promote, and advance the Theory of Sampling by providing a platform for researchers and practitioners to collaborate, share knowledge, and develop standardized methodologies and best practices.

Continuance of the WCSB series will ensure that the principles of representative sampling, as laid out in TOS, are understood, regulate, and penetrate the worldwide practice of sampling. In general, the key aim is to improve the knowledge about heterogeneous materials, which arise in industrial and industrial contexts. The Conferences act as a knowledge exchange forum for the convergence of scientific inquiry and industrial practice, enabling the dissemination and exchange of insights and innovations in sampling and blending.

Interdisciplinary collaboration and exchange of knowledge is fostered in a collaborative environment where academia, manufacturers, engineering firms, and professional practitioners can interact and benefit from shared expertise and experience. The support and involvement of Original Equipment Manufacturers (OEM) responsible for promoting technological advancements and quality assurance in sampling practices highlight the need for this symbiotic relationship.

The technical program and high quality of papers and presentations form a strong, scientifically verified basis for the global sampling community to move towards analytical excellence, emphasizing the importance of both detecting and mitigating sampling errors. In this way a global appreciation and international recognition and application of TOS-based sampling practices is strengthened. Publication, availability, and accessibility of the proceedings in digital format promotes the wide dissemination and historical preservation of the knowledge shared at the conferences. Through these aims, the WCSB conferences strive to uphold and propagate the importance of sampling science and technology, ensuring its continued relevance and application across various industries and academic disciplines.

The WCSB11 was promoted and marketed by the SAIMM well in advance of the conference. Workshops and keynote speakers were promoted once they had been fixed in the program. An outstanding outreach was the "Crucible" podcast (https://iono.fm/e/1408876), which was hosted by the SAIMM, and is available on the SAIMM homepage and on Spotify. During the conference the SAIMM marketing team continuously posted content from the highlighting speakers and sponsors on LinkedIn. Even weeks after the conference, the posts still receive attention in this community. Access to the photos taken at the conference and at the evening events has been made available via the conference Dropbox (see below).

4. Organising Committee and Sponsors

Gratitude is extended to the dedicated members of the Organising Committee, including the Secretariat of SAIMM who acted as the host and organizing entities led by Camielah Jardine, Gugu Charlie, Patricia Takalimane, Nazli Mamdoo, and Sam Moolla. Members of the WCSB11 Committee included Mariska Reyneke, Willem Slabbert, Letisha Smal, Sandra Ratsoma, and Kim Esbensen, Sheryl Tittlemier, Chris Robben. The Chairpersons were Terance Nkosi and Richard Minnitt.

Sponsors and supporting organizations of WCSB11 included the following:

Headline Sponsor

- Rand Refinery – were the leading sponsor and sponsored all the awards and gifts and had a 10-minutes sponsor presentation slot at the conference. RR also had an exhibition stand.

Premium Exhibitors

- HERZOG Maschinenfabrik GmbH & Co.KG set up an exhibition stand and made a 10-minutes sponsor presentation slot (but they did not take up any of these benefits)
- Rocklabs set up an exhibition stand and made a 10-minutes sponsor presentation slot at the conference
- Multotec set up an exhibition stand and made a 10-minutes sponsor presentation slot at the conference

Corporate Sponsor

- Fl Smidth made a 10-minutes sponsor presentation slot at the conference

Exhibitors

- Block 10 set up an exhibition stand
- ITECA SOCADEI – set up an exhibition stand
- Qingdao Yosion Intelligent Technology set up an exhibition stand, and sponsored the delegate bags

Banner Sponsor

Measurement Process Solutions set up promotional banners displayed at the conference Qotho Minerals and displayed promotional banners at the conference

Figure 1: Thank you to all WCSB11 sponsors.

4.1 Scientific Committee and Reviewers

The conference's success is also attributed to the rigorous peer-review process conducted by a competent corps of reviewers:

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5. Conference Programme

Pre-conference workshops: Three workshops were offered:

- Introduction to the Theory and Practice of Sampling (TOS) in Science, Technology, Industry, Commerce and Society (Kim H. Esbensen);
- Sampling Theory, Sampling Practices and Their Economic Impact (Francis F. Pitard & Dominique François-Bongarçon);
- Sensor-Based Ore Sorting and Sampling (Christopher Robben)

The post-conference feedback points to broad satisfaction with this educational opportunity.

In a bold new step, the Organising Committee decided to select a range of younger and newer entrants to the sampling community as Keynote speakers and as Session Chairpersons, meant as an educational challenge for the younger cadres. The keynote speakers were: Ana-Carolina Chieregati, Rodolfo Romanach, Claudia Paoletti, Jean-Sebastien Dubé, Stephane Brochot. Oscar Dominguez Gonzales was also invited as a keynote speaker, but was unfortunately unable to present orally; however, his lecture is included in the conference Proceedings. See online proceedings for information on their presentations.

The scientific value and relevance of the accepted papers at the World Conference on Sampling and Blending (WCSB) are substantial, given the context and aims of the conference. The value and relevance of the papers contribute to the development and refinement of the Theory of Sampling (TOS), addressing both theoretical foundations and practical applications. New innovative methodologies and techniques that improve accuracy, efficiency, and reliability in various industrial and analytical contexts are presented. Interdisciplinary research findings and technological innovations with applications across multiple industries, from mining and pharmaceuticals to environmental studies and food safety, demonstrating the broad applicability of sampling techniques are now on record in the approved collection of papers. Industrial applications, enhanced decision-making, standardization and best practices, sustainability and environmental impact, the educational value, and the importance of global collaboration are emphasised. Overall, the accepted papers at the WCSB conference help setting high standards that benefit both academia and industry.

6. Papers and Proceedings

A call for the submission of papers for the WCSB11 was issued in July 2023 with a notice of acceptance being sent to authors on 6th October 2023. Papers accepted for the conference were subjected to peer review and the date for final paper submission was 29th January 2024. Reviewing criteria included scientific value and showcasing the current state of sampling and blending. The author deadline for revised papers was 12th February with final acceptance or rejection of the papers was issued on 19th February 2024. Papers were published as proceedings of WCSB11 in a convenient and readily available electronic format, which is distributed in a SAIMM Dropbox facility with a link provided to delegates 2-3 days before the conference.

The conference proceedings were professionally edited by Annette Thompson through SAIIMM and produced in a modern format, facilitating rapid submission, review, and publication. After each WCSB conference, the proceedings are the only tangible scientific evidence left for posterity.

SAIMM has given permission for the WCSB11 Proceedings to be available and downloadable as open access at both the SAIMM as well as the IPGSA webpages [https://www.saimm.co.za/Conferences/files/wcsb11-2024/WCSB11%20Proceedings%20Book.pdf; https://intsamp.org/], documenting the current state of sampling science and technology, furthering the opportunities for future developments and advancements. The IPGSA owes SAIMM a great debt of gratitude for this opportunity.

7. Awards and Recognitions

7.1 Pierre Gy Sampling Gold Medal:

Dr. Ana-Carolina Chieregati and Dr. Claudia Paoletti were awarded the Pierre Gy Sampling Gold Medal for: "Excellence in Teaching and Dissemination of the Theory of Sampling." (see separate "Award Justification" in this issue).

7.2 Distinguished Service Award

For the first time the award was presented by the IPGSA Council to Prof. Kim H. Esbensen (by kind courtesy of Rand Refinery donating a Gold Kruger Rand medal). Prof. Esbensen was awarded for his sustained and distinguished contributions to the organisational activities of the Association and its WCSBs over 20 years, including steadfast leadership of the committees involved behind "DS3077 Representative Sampling - Horizontal Standard", the world's only de facto international standard on this important topic (see separate "Award Justification" in this issue).

7.3 Young Authors Awards

Also, for the first time, four awards in the form of specialised commemorative coins by kind courtesy of Rand Refinery, were presented to Young Authors, to the organizing committee, and SAIMM secretariat team that facilitated for the success of the conference. The Young Author Awards are made for the most outstanding papers presented by young authors at WCSB conferences to encourage their participation. To qualify, the author must be less than 35 years of age at the date of the conference. These awards are made at the discretion of the Organising Committee.

- The Best Paper Award made to Killian Berelsmann of Herzog, Germany, for his outstanding paper entitled "Quality criteria in sample preparation – how to ensure full reproducibility and fully homogenization?" co-authored with Martin Lischka.
- The Best Presenter Award made to Hulisani Esra Madima of Multotec, for his presentation entitled "The case for using five-times particle nominal top-size cutter width for dry material primary increment sampling at 0.6 m/scutter speed" co-authored with Willem Slabbert.
- The Best Presenter Award made to Charles Tonongei, of Anglo-American Platinum, for his presentation entitled "Variographic analysis of a concentrator plant feed slurry stream data before and after replacement of the intermediate sampler hopper".
- The Best Presentation Award made to Debra Samuel of the Rand Refinery, for her paper entitled "Comparing sampling techniques for gold bullion to find the most effective sampling method".

Terance Nkosi and Richard Minnitt were awarded commemorative plaques by the IPGSA for their sustained efforts in the co-chairman ship of the WCSB11 Conference.

Figure 2: Terance Nkosi (left) and Richard Minnitt were awarded commemorative plaques by the IPGSA.

Figure 3: A 'random sample' from the Misty Hills venue auditorium – is it representative?

8. New Initiatives and Future Outlook

The next World Conference on Sampling and Blending WCSB12 will take place in Exeter, Cornwall UK in 2026, to be co-chaired by professors Hylke Glass and Simon Dominy. (NB. Bids for future conferences must be submitted to the IPGSA no later than one month before commencement of the next WCSB; bids must follow the guidelines published by the IPGSA Council).

The conference was given an extensive report on the current work aimed at concluding with the fully revised DS3077 (3rded.), to be published autumn 2024, and subsequently to be proposed as an ISO standard. This ISO process is likely to take a year or two, facilitated by participation by dedicated TOS-competent future members of the committee to be organised.

9. Special Panels and Discussions

A recurrent program element at WCSB conferences is a panel discussion, this time chaired by Dr. Ralph Holmes and Dr. Kim H. Esbensen. This was an open forum debate about teaching and training of TOS, inviting thoughts, ideas and experiences from conference delegates about training and education in the field of sampling. This point was initiated by a sponsoring OEM whose concern was the importance of the fundamental principles in the Theory of Sampling and the ways and means that such education can penetrate industry and society at large. The importance of establishing a single-source document on TOS, that can be made universally accessible, and on which the teaching and training of TOS can be stabilized and based, was emphasised. It was pointed out that this goal is actually in the midst of being realised through the sustained work behind the DS3077 national standard, which for 10 years has served as a de facto international standard supplying a first attempt at this objective.

10. Exhibition, Poster Sessions, and Networking

The exhibition featured 10 exhibitors, including five South African and five foreign exhibitors.

Participants engaged in fruitful discussions during coffee breaks, a wine tasting event, and poster sessions. Exhibitors from Rand Refinery, Iteca Socadei, Kingyosion, Block 10, Multotec, SAIMM, and Rocklabs showcased the latest in representative sampling, sample preparation and analysis, while poster sessions covered a wide range of topics in industry and academe. Networking opportunities: Coffee breaks and poster presentations facilitated networking among delegates, and many participants shared positive feedback, highlighting the conference as a prime opportunity to interact with the growing community of diverse-industry sampling professionals and the excellent organisation of both in-person and virtual components.

11. A sample of highlights

Figure 4: Ulrik Thisted presenting at WCSB11 from a very remote site in Norway, Elke and Ulrik Thisted's IT-equipped summer cabin – What's not to like with hybrid conferences?

Figure 5: Newest TOS R&D enthusiast from beyond traditional application fields: Jean-Sebastien Dubé (Canada) on the left and to the right steadfast industrial process expert from Pharma, Rodolfo Romanach (Puerto Rico).

12. Post-Conference Tours

Delegates visited Rand Refinery the headline sponsors of the Conference, and the OEM Multotec, a Premium Exhibitor at the Conference.

The technical visit to Rand Refinery, world-leading precious metals refinery "just around the corner", was commented on by participants who commended the company and hosting team, who, even though the Rand Refinery at the time of this visit was in the process of stock accounting, dedicated valuable time to ensure the visitors had an enriching experience. "From the moment of arrival, the team welcomed us warmly, providing a delightful breakfast, lunch, and thoughtful gifts, ensuring our comfort throughout the visit.

Figure 6: One of the pre-conference courses: "Sensor-Based Ore Sorting and Sampling" was conducted by Dr. Christoffer Robben (right) for a small, very enthusiastic group of participants.

The tour was informative and well- organized, covering key stages of the refining process:

- Receiving: How raw materials and deposits are received and logged.
- Sampling: Detailed explanation of the many stages of the Rand's unified sampling process.
- Preparation: Steps for sub-sampling and preparation of materials for analysis.
- Analysis and Research: Insight into analysis techniques and ongoing research. The Rand Refinery is a LBMA reference laboratory.

Our knowledgeable guides shared numerous interesting factoids, making the tour both educational and engaging. The visit to Rand Refinery was highly insightful, offering a rare look at its complex operations. The hosting team's dedication and hospitality made the experience memorable and valuable, deepening understanding and respect for the precious metals industry".

The theme for the technical visit to Multotec Process Equipment was: "Where the Theory of Sampling comes to life". The visit was hosted around an in-depth tour of Multotec's sampler workshop.

The in-person event allowed participants to evaluate, touch, see and interact with live sampling equipment and the detailed features refined into these machines to allow metal accounting precision sampling. The range of wet and dry sampling equipment on display included: linear launder samplers, radial vezin samplers, slurry handling hoppers, cross stream belt end cross-cut samplers, cross belt hammer samplers, control panels and ancillary sample storage equipment.

The attendees themselves were inspired by the theme and were enthusiastic, engaging and full of eager questions – even after attending a rewarding 3-day sampling conference packed with knowledge!

One of the attendees posted on LinkedIn: "A big thank you to the Multotec team for hosting us in a technical visit at the end of the World Conference on Sampling and Blending 11 at their Spartan facilities near the Johannesburg airport, and for sponsoring the conference. I enjoyed learning about Multotec's multiple products to support the mining industry, and the important role that the Theory of Sampling plays in day-to-day operations."

13. Conclusion and Future Conferences

In summary, the achievement of the World Conferences on Sampling and Blending (WCSB) has significantly contributed to the advancement and dissemination of the Theory of Sampling (TOS). TOS addresses the complexities of particulate sampling and its inherent errors, providing systematic methods to minimize sampling uncertainties.

The conferences serve as a vital platform for researchers, academics, and industry professionals to exchange knowledge and improve standards in sampling theory and practice. The conferences have facilitated truly global teaching and understanding of TOS, leading to its inclusion in postgraduate courses across various countries including the US, Denmark, Brazil, Mexico, South Africa, and Australia. The WCSB series have fostered dialogue between proponents of TOS and total Measurement Uncertainty (MUtotal), emphasizing their complementary nature.

TOS effectively identifies and minimizes the effect of sampling errors, while MU primarily identifies and reduces analytical variance. The conferences have invigorated research and development in TOS, ensuring continuous improvement and innovation in sampling methodologies.

This has been particularly crucial in maintaining the relevance and application of TOS in various industries. Forward-leaning Original Equipment Manufacturers (OEMs) have benefited from the theoretical and practical insights provided at WCSB, leading to improved sampling equipment design that adheres to TOS principles.

This collaboration has resulted in generous sponsorship from OEMs for the conferences. The conferences honour significant contributors to TOS with the Pierre Gy Sampling Gold Medal.

Since the first conference in 2003, held biennially (with a delay in 2021 due to the Covid-19 pandemic), WCSBs have played a pivotal role in advancing the theory and correct application of sampling, ensuring it remains a vital scientific discipline in both academic and industrial contexts.

There is every intention to continue on this global path, also laying the foundation for a current crop of complementary regional sampling conferences in South America, Australia and South Africa. This significantly increased activity is a tribute to the highly successful role and achievement of the eleven WCSB conferences to date.

ACKNOWLEDGEMENTS

Technical Support: A special thank you to the managers of the IT aspects, who impeccably ensured seamless high-quality integration for online participants.
Venue: Appreciation goes to the venue Misty Hills, which handled all logistical challenges efficiently, providing a conducive environment for the conference.

Post-conference Resources

- Master-link to Conference presentations, proceedings, and photos available at: https://www.dropbox.com/scl/fo/olv2w12xue84yzy8uy4c4/AONrHivlaEubxE_kz4QdSKE?rlkey=hojx73q356kotbuds9x6m45gf&e=2&st=mart7fyv&dl=0
- Link to a "Crucible" podcast: https://iono.fm/e/1408876