**“Introduction to the Theory and Practice of Sampling”.**

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Review:

Investment decisions in the mining industry, or raw material delivery prices, depend critically on reliable knowledge of content of the substances that determine the value of the products and goods. In this industry sector, it has since long been known that the precision of an analytical result, whether in the exploitation of a deposit or the characterization of a ship's cargo, is less dependent on the analytical modality (e.g. high-precision gravimetric methods or high-resolution, accurate analytical instruments) than on the question of whether it is based on representative samples. For this reason, representative (accurate and precise) sampling and sample processing techniques have been developed by the sampling community, specifically by the Founder of the Theory of Sampling (TOS) **Pierre Gy**. This development started no longer ago than in 1950.

In the second half of the previous century, a large proportion of the valuable substances in geogenic deposits has been extracted and are now to be found in the material inventory of industrialized countries, whether it be in infrastructure, consumer and investment goods (sometimes characterised as “Urban Mines”). On the other hand, our modern, highly-developed society demands ever more complex products with more and more components; these include not only valuable, recyclable materials e.g., precious metals, rare earths, but also increasing amounts of new, potential pollutants, often also toxic e.g. flame retardants, nanomaterials. It is therefore not surprising that waste flows out of these mines contain both potentially hazardous substances and potentially recyclable materials that warrant development of new technologies for their utilization. In this contemporary waste management context, in essence quite similar to geogenic raw materials, these resources should be explored and characterised using suitable analytical procedures, and the finished preparation products derived therefrom (such as metal fractions from municipal solid waste incineration plant MWIP bottom ashes) should absolutely be considered for emerging commercialization, while hazardous substances should get destroyed or immobilized. In this challenging field of interrelated urban mining, sorting, refinement, recycling and safe waste deposition representative sampling play a critical key role also in the emerging paradigm of circular economy.

Surprisingly, in the global waste management sector, the Theory of Sampling has yet barely been considered or applied consistently. The Danish Standard DS 3077 for representative sampling, the facto international standard, is not known or applied in practice in this sector so far. Combined with potential errors due to incorrect sampling techniques and inadequate sample preparation (as may arise from "simplifications" in both steps), this will unavoidably lead to unnecessary errors in the determination of the quantities of pollutants, toxic components or recyclable materials, and will thus hamper optimal estimation and assessment of both ecological risks and economic opportunities. Applying TOS approaches it has recently been demonstrated that highly significant, but quite unnecessary, uncertainties accumulate along the “lot-to-aliquot” pathway, which is extraordinarily complex within waste management and circulatory economy.

Prof. Esbensen's new comprehensive book “Introduction to Theory and Practice of Sampling” closes an important general gap, also for users in the waste management sector. This book is critically necessary for application of professional sampling procedures concepts and techniques in modern waste management systems - and beyond. This book shows in an unusually refreshing, simple and clear way all the relevant concepts and connections between the General Principles of sampling and the powerful concept of Sampling Unit Operations, and it demonstrates the often large quantitative influences on the final uncertainty of the tiny analytical samples that ultimately are delivered to the laboratory. A very useful principle is that all mass-reduction, sample splitting, sub-sampling and sample preparation operations can be treated identically as primary sampling, only at smaller and smaller scales. This understanding helps building a necessary overview of TOS.

One of the book’s major advantages is the lavish use of carefully designed didactic diagrams which help the reader to form his/her own understanding of what turns out not to be so ‘complex’ subject-matter as many claim. The many practical examples are vivid and valuable with which also better to understand TOS’ systematic interconnections.

I am convinced this book will find great interest and application among individual actors, companies, organisations and other stakeholders in many application sectors in science, technology and society.

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