Standardizing Modeling of Relevant Parameters for Data Preparation and Exchange in Smart Battery Cell Production

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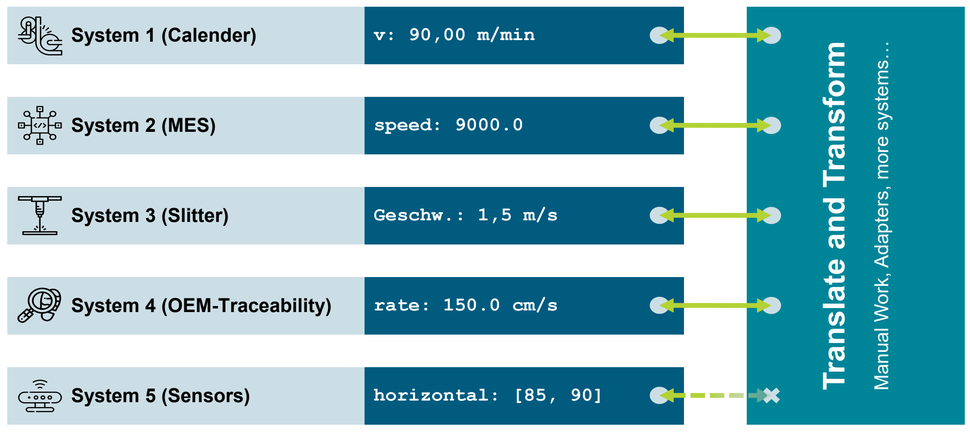
Battery cell production is a key technology for the tackling of major global challenges like the climate crisis. Still, the **cause-effect relationships** of parameters and their impact on quality indicators and resulting process stability are only limitedly identified and published. Those cause-effect relationships are target of highly active research. Knowing and leveraging the cause-effect relationships **enables data-based analytics and optimizations** of the whole battery cell production line.

Data Preparation and impact on workload

To gain insights into the machines, processes, and effects, Data Scientists use data-based approaches. These experts often do not perform the actual beneficial analysis and optimization. Instead, preparing and cleaning the data takes up most of the work. This preparation and cleaning is necessary to address several data quality issues, including missing values, different naming schemes, plausibility issues, asynchronicity, and incorrect data types.

The need for Standardization

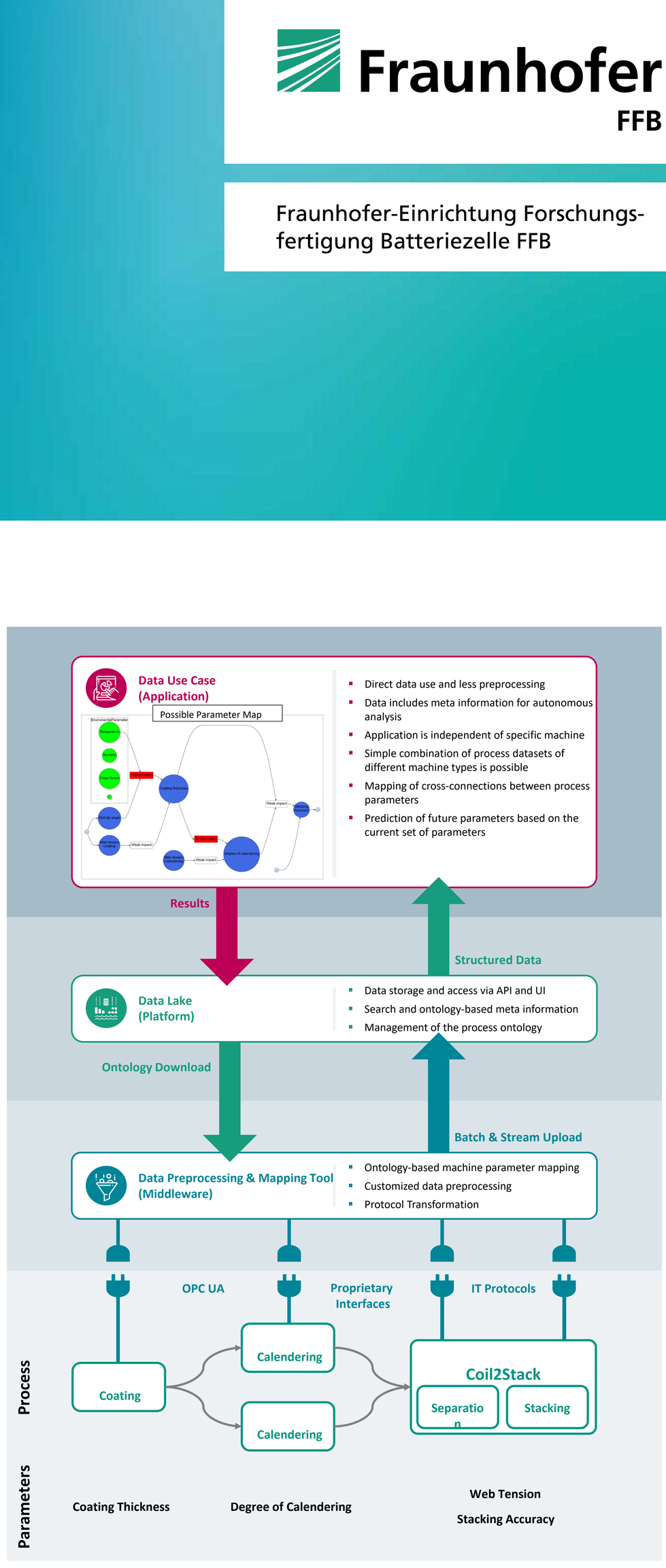
Multiple of the data quality problems can be tracked down to **missing standards for data in the field of battery cell production**. In order to use the data from different machines, the raw data must be translated and transformed.



Using a standard would directly make the "Translate and Transform"-step significantly smaller or obsolete, **allowing faster analytics** and **exchanging data** or even the **fast swap of machines** in production.

Our Approach: Ontologies and OPC UA Companion Specifications

For the description of the data, their format and the relationships, we **use and extend existing ontologies** like BattINFO[1], EMMO[2], GPO[3] and BVCO[4] to describe the data from machines, their format and relationships. By this, any system and user can download the definitions and use this standard for data naming or fast transformation and data quality assessments.
Another standardization approach is used since ontologies are not widely used in production and machining. The general standardization for interfaces and data descriptions in the last decade lead to the rise of OPC UA. Still, an **OPC UA Companion Specification** for the Battery Cell Production is missing. Using the results from the ontology approach **we and our partners create such specifications**.



With the availability of the ontology-based approach and the upcoming Companion Specifications in the battery and production domain, a significant **reduction of the work** for data preparation and therefore **increase of analytics efficiency** as well as **easier exchange of machines and systems** is achieved.

Our partners help us achieve standardization:

- RWTH Aachen University
- Karlsruhe Institute of Technology
- Fraunhofer FFB, IPT, IPA
- Schuler Pressen GmbH
- FFT Produktionssysteme
- ELABO GmbH
- Verband deutscher Maschinen- und Anlagenbauer VDMA
- European EPC Competence Center GmbH (EECC)
- Siemens (ass.), Sick (ass.), NanoFocus (ass.), Saueressig (ass)

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1 BIG-MAP: Battery Interface Genome, 2021, https://www.big-map.eu/dissemination/battinfo
2 EMMO: Elementary Multiperspective Material Ontology, https://github.com/emmo-repo/EMMO
3 Simon Stier, General Process Ontology (GPO), 2023
4 Simon Stier, Lukas Gold, Battery Value Chain Ontology (BVCO), 2023