ISO/IEC 81346 Series

Discussion with Mr. Henrik Balslev
Meeting report

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1. Background and Mission

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Mr. Henrik Balslev, has a background in electrical engineering and has been involved in the development of ISO and IEC standards since 1996. His mission is to establish a "Common Language for Engineers". This concept is inspired by how musicians can perform in a large orchestra through the common language of sheet music (notes and symbols) even if they do not speak the same spoken language. He aims to create an environment where engineers from different disciplines can collaborate seamlessly based on a mutual understanding through a standardized reference model.

2. Basic Principles of ISO/IEC 81346

2. Basic Principles of ISO/IEC 81346 (Reference Designation System: RDS)

The core of this standard is rooted in "Systems Thinking," where complex products and facilities are divided and organized into manageable "systems".

- Structuring Principles (The Triangle Philosophy): Systems are classified using a three-level letter code hierarchy:
  - 1-letter code (Prime systems): High abstraction level. Examples include an aircraft's Navigation system or Communication system.
  - 2-letter code (Technical systems): Intermediate abstraction level. Examples include a Body structure system or Fuel distribution system.
  - 3-letter code (Component systems): Elementary abstraction level, such as flow transmitters, pumps, or doors. This level serves as a common library shared across all industries.
- These codes can be combined like "LEGO bricks" to represent unlimited complexity, such as a "ONE-TWO-TWO-THREE" combination.
- Organization by Aspects: To organize information effectively, the following prefixes are used to designate different views:
  - Function (=): What the object does.
  - Product (-): What the object is (physical entity).
  - Location (+): Where the object is.
  - Type (%): The category of the object.
  - User-defined (#): Open for specific user needs.
- Reference Model: This is a discipline-neutral model that serves as a "hub" or "gateway" to synchronize data between different design tools like CAD, ERP, and document management systems without requiring them to use the same internal data structures.

3. Evolution and Structure of the Standard

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The standard series began in 1971 and has expanded from its origins in electrical engineering to construction, energy, and manufacturing.

- Part 1 / 2: Basic rules and classification of objects.
- Part 10: Power supply systems (2022).
- Part 12: Construction works and building services.
- Part 14: Manufacturing systems (the latest version).
- Part 20: Vehicles (including aircraft and safe-driving vehicles).
- Part 8: Property management. This simplifies existing, overly complex property management systems.
- Part 50: Processes (sequences of actions performed by systems or organizations).

4. Case Study: AIRBUS

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Airbus has adopted this standard as the "Airbus Common Language (ACL)" within its Digital Design, Manufacturing & Services (DDMS) transformation program.

- Scale and Impact: A single A350 aircraft consists of approximately 4 million parts. By applying tags for attributes, functions, and suppliers, Airbus manages about 100 million tags to realize a full digital twin.
- Efficiency: During real-world application, a team of three created 60 million tags in six weeks, equivalent to a rate of 10 million tags per full-time equivalent per year.
- Realizing the Digital Thread: Thousands of models and billions of elements are linked using common semantic tags.
- Utilization of AI (Machine Learning): To automate the massive data classification task, Airbus developed tools where AI (trained on legacy data and standards) suggests class definitions. Human experts then verify and approve these suggestions.
- Practical Benefits:
  - Co-design: Functions can be tested even when only a specific section of the aircraft is manufactured, allowing for earlier discovery of issues.
  - Design-to-Cost: Tools and consumables required for specific work orders can be instantly retrieved, providing accurate recurring and non-recurring costs.

5. Case Study: Aarhus ReWater

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This project involves the construction of the world’s most resource-efficient wastewater treatment and energy plant in Aarhus, Denmark.

- Interface Management (N2 Diagram): Correlations between approximately 50 prime systems are managed using N2 diagrams (matrices representing inputs and outputs). This clarifies system boundaries and identifies "blind spots" in the design at top-level.
- Requirement Management: Every system element is directly linked to its requirements, allowing for structured verification that all project demands are met.

6. Q&A (1/2)

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6-1. Difference from Legacy Systems (KKS/RDSPP) and Significance of International Standards

- The KKS system used in power plants was described as merely a "numbering" system based on an outdated standard (IEC 60750).
- KKS and its successor, RDS-PP, are proprietary labels owned by private German organization VGB, requiring purchase for use. In contrast, ISO/IEC 81346 is a public international standard available to everyone.
- 81346 is a "modelling technique" that can accurately represent complex 1-to-N relationships, such as one physical component performing multiple functions—something impossible with older systems.

6-2. Reverse Engineering and Knowledge Continuity

- A case was shared regarding 40-year-old medical devices where original designers had retired, leaving the internal structure as a "black box." Using 81346, the team performed reverse engineering to model the current structure.
- When a sensor needed replacement, the RDS-linked model allowed the team to identify which functions and original requirements would be affected in months, a task that previously took years.
- Modelling existing facilities highlights missing information, allowing organizations to identify and fix project weaknesses.

6. Q&A (2/2)

6-3. Automated Tagging using AI (Machine Learning)

- With 4 million parts and over 100 million tags in the Airbus A350, manual tagging by humans is impossible.
- Tools have been developed where AI, having learned from standards and previous data, suggests the most suitable RDS codes from BOM or drawings.
- A demonstration showed a system where two different AIs predict codes, and a third AI validates if they agree.
- AI only provides "suggestions"; the final approval must be made by a human expert to ensure the accuracy of the definition.

6-4. Integration with Existing IT Environments (Leveraging Silos)

- Companies can continue using their existing CAD, ERP, and document management systems (like SharePoint or Google Drive).
- By registering RDS codes and Common Unique Identifiers (UUIDs) as an additional layer on objects within existing tools, data synchronization across different systems becomes possible.
- Rather than trying to break down disciplinary silos, the standard maintains them while providing a "car" (common language) to move data between them, achieving a digital thread.

6-5. Model Maintenance and Engineering Discipline

- A reference model is not a one-time creation; it must be kept under revision control.
- Establishing a clear procedure for who approves changes and how the reference model stays synchronized with individual tools is a critical engineering discipline.
- The primary driver for Airbus in promoting this standard was not just maintaining current fleets, but scaling down the development time for next-generation aircraft by using a precise knowledge system (ontology).

7. Questions in advance (1/2)

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7-1. I’m appreciated if you could share your thought about the advanced roles of SysML and other symbol-based models and crucial technology to drive these roles.

I ask this question based on my background as a researcher of function modeling and reasoning.

References: A framework for computer-aided conceptual design and its application to system architecting of mechatronics products (Computer-Aided Design, 2012;44(10): 931-946, doi.org/10.1016/j.cad.2012.02.004);

A review of function modeling: Approaches and applications (Artificial Intelligence for Engineering Design, Analysis and Manufacturing. 2008;22(2):147-169. doi:10.1017/S0890060408000103) "

Answer:

Thank you for your question. SysML is a model language used in the context of systems engineering. ISO/IEC 81346 is a reference designation system used widely in all disciplines. There is no conflict between SysML and 81346, in fact 81346 can provide designations (i.e., references) to the systems modeled by SysML. 81346 is easy to use for most people and gives a comprehensive overview. SysML offers detailed modelling and analyzes of systems.

7. Questions in advance (2/2)

7-2. The Purdue Model is commonly used in control systems, especially for cybersecurity. I believe that combining it with ISO/IEC 81346 could enhance communication and shared understanding among different stakeholders. Have you seen any examples of this?

Answer:

No, not yet. But I am in favor of this proposal, and I do not see any conflict in it.

7-3. Are there any use cases or pilot projects involving the application of ISO/IEC 81346 in industrial data spaces that you could share?

Answer:

We do have such data however they do not belong to us but our client(s) and therefore they are confidential. Only data we can share are date we have created ourself, for example the coffee machine, which does not include the requested data for the moment.

7-4. Are you considering any measures to promote the adoption of ISO/IEC 81346?

Answer:

I think our company incl. the homepage www.81346.com is promoting the 81346 as much as we can possibly do. In Europe the 81346 is spreading fast and in many new industries. We are happy to offer free webinars often. Please sign up for our newsletter on 81346.com to get notified of such events.