# Introduction – **Sylvere/Marion**

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## Statement of Industry [Business] Needs

Digitization of knowledge, promoted by recent advances in the information and communication technology field, has led to a digital revolution of manufacturing. While paper-based information artifacts (such as 2D drawings) are being replaced by their digital twins, unstructured data sources (spreadsheets, text documents, email, …) are slowly being replaced by structured data models embedding different types of information (design, manufacturing, inspection, …). This digitization supported by a formal representation of the data is a key enabler of the Model-Based Enterprise paradigm, in which information management is digital and can be automated.

Through this new paradigm, manufacturing data processing can now leverage modern computing techniques and be made faster, consistent, and more accurate, offering a better insight and leading to a Smarter Manufacturing. This new approach requires that structured digital product data be shared and exchanged among numerous engineering and business software applications, and information systems[ref]. Through its entire lifecycle, a product generates an enormous amount of data in response to different processes (e.g., design, manufacturing, distribution) and needs (e.g., technical, commercial, regulatory). This data is often critical to every organization that plays a role in the product lifecycle. This is where the organizational contribution and value reside.

Due to the complexity of a product and its lifecycle, the interoperability of the software applications and information systems involved is key to support the organizational collaboration required to successfully design, manufacture and support a product. A lack of interoperability is not only costly in term of time and money [ref to NIST report] but can also impede this organizational collaboration and hinder future work and opportunities.

For Model-Based Enterprises to collectively and collaboratively achieve Smart Manufacturing and support the full (and often decade long) product lifecycle, an open and harmonized representation of the information must be used and shared through the supply chain. One of the main responses of this new product data management strategy is the use of product information standards. These information standards are a key to integrating, exchanging, and accurately interpreting the different product models and data produced during the product lifecycle across multi-disciplinary systems. The different IT systems consuming and generating product data need a common language to exchange information and understand each other. Information standards provide an agreed upon data format and definitions to exchange and share knowledge about a product and its lifecycle.

## Information Standards and how they support of Business Needs

### What are they [and examples like ISO 10303 and?] [I.C]

Today, organizations are more aware of the importance of the digital integration and exchange of information assets. Hence, information standards are developed to ensure an optimal interoperability and compatibility between information assets in order to exploit and process these assets in a consistent fashion. An information standard is a formal definition, agreed upon by a community of experts, on how to represent and process domain-specific information. This agreement can be represented as information models, a computer-interpretable representation. Thus, information from different providers can be represented, exchanged and integrated together, seamlessly. Information standards are used in many domains, such as healthcare, security, or manufacturing.

One of these standardization efforts is the ISO 10303 *Automation systems and integration – Product data representation and exchange* standard series, informally known as STEP[ref].  STEP started in the early 90s and is one of the information standards that enables product lifecycle collaboration. It includes a set of product data representations and implementation methods to exchange product data. Each of these product data representations is domain-specific and developed by industrial experts to enable standard-based product data exchange. To support its requirements, the STEP community developed its own data modelling language ISO 10303-11 *Part 11: Description methods: The EXPRESS language reference manual* and a file format to represent STEP data, called ISO 10303-21 *Part 21: Implementation methods: Clear text encoding of the exchange structure*. As XML emerged as a common file format for data exchange, ISO 10303-28 *Part 28: Implementation methods: XML representation of EXPRESS schemas and data, using XML schemas* was developed as another way to represent STEP data.

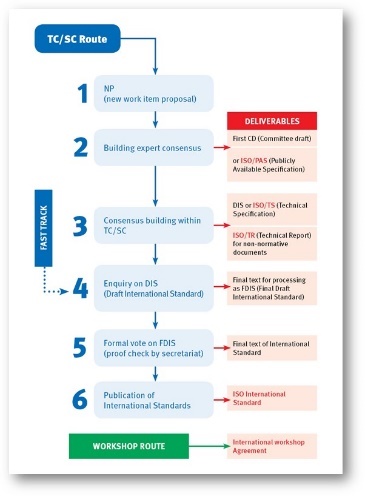
It aims to provide a complete and unambiguous description of manufacturing products, usable throughout their life cycle, regardless of the IT support used. The scope of STEP is much broader than other existing computer-aided design (CAD) data exchange formats. It is intended to handle a wide range of product types (electronic, mechanical, fiber composites, ships, architectural, process plant, furniture,...) and cover all life-cycle stages (design, analysis, planning, manufacture,...). [1]

### Who Creates them [1.B.1, I.B.2]

Developing a standard involve different stakeholders. There are four major types of stakeholders : the Sponsor, who is the entity that creates a request for standardization; the Standards Development Organization (SDO) that supervises the standard development process and, supports the publication and the maintenance of the standard; the Standard Board, which consists of members of the SDO, reviews and approves standards projects before their publication; and finally the Working Group that is composed of domain experts, implementers, end users, standards experts and technical solution experts. The role of the WG is to support the development of the standard by writing the standard draft, working on the standard maintenance and developing products that implement the standard. For example, STEP is developed and maintained by ISO and more precisely, by the ISO technical committee TC184 that deals with automation systems and their integration, and the sub-committee SC4 that manages the industrial data. The STEP working groups are composed of experts from government agencies, the automotive industry, the aerospace industry and the nautical industry for instance. All of these experts work together to meet the specific needs of their industry.

### Development Lifecycle of Model-Based Standards [1.B.3]

The model-based standard development process consists of six stages: proposal (10), proposal (10), preparatory (20), committee (30), enquiry (40), approval (50), and publication (60). multiple stages. These different stages tightly control the development process as well as the entry and exit criteria. The process begins at proposal stage (10) when a new work item proposal is submitted by an individual or an entity, called Sponsor, to a Standards Development Organization (SDO). If the proposal is accepted, a collaborative team of experts, called the Working Group (WG), is assembled. This WG works on the development of a committee draft during the preparatory (20) and committee (30) stages. Once this draft finalized, the enquiry (40) stage began during which the draft is reviewed, changed if necessary and approved first by the WG and then, by a balloting group created by the Sponsor. After that, the final draft is submitted to the SDO Board for final approval at stage 50. Finally, in publication (60) stage, the standard is published and maintained over the years. In parallel of the standard publication, members of the WG work on developing, testing and implementing tools, methods, and models to support the standard application.



### Who Uses them and how they satisfy the business needs [1.B.1]

Information standards play an important role in businesses by facilitating trade and business interaction, and by supporting interoperability between new and existing technologies. Information standardization also helps to save time while reducing costs: indeed, because of the interoperability of the different information assets, there is no need to adapt the information formats, which saves both time and money. The use of information standards in businesses increases in performance, competitiveness, and transparency because they facilitate the accessibility of information to all stakeholders. Standards also appear as strategic tools to advance innovation. Indeed, the lack of standardization causes a multiplication of information formats that are not necessarily compatible with each other, which can prevent the exchange and sharing of information between stakeholders. For example, Original Equipment Manufacturers (OEMs) need to communicate the full content of Model-Based Definition (MBD) data with their suppliers. Current limitations in the implementation of standard formats such as STEP result in critical information being lost. Part geometry is correctly exchanged but the tolerances and annotations are lost. This often requires that the native CAD model be sent to the supplier and the burden of interpretation is borne by the suppliers. Another approach is to use STEP to exchange the part geometry augmented by a lightweight geometry for viewing the annotations and notes. Add to this the number of OEM-to-supplier interfaces and supplier-to-supplier interfaces and the problem propagates exponentially throughout the supply chain. Furthermore, collaboration between design partners requires the exchange of geometry, materials, and functional interface data. Geometry needed for spatial analysis may not require the exact fidelity of native CAD geometry. Often a lightweight tessellated representation is better suited to spatial analysis methods such as interference detection and fit analysis. Additionally, the volume of data exchanged is often much larger than in the certification and supply chain use cases. Rather than exchanging parts and assemblies, design integration often exchanges collections of parts by spatial volume up to and including the entire aircraft

### Why are they complex [1.C.1, 1.C.2]

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The development of standard is a relatively long process and it includes a lot of people from different organizations working together. As mentioned before, the members of a standard WG work for different organizations and their contribution to its development is voluntary. Therefore, the resources available depend on the experts’ schedules and their organizations’ needs, which makes the standards development process long, irregular and difficult to plan. Moreover, some standards are complex due to their architecture and application domains. In the case of STEP, its development is one of the largest projects that ISO has ever carried out and six hundred people from many different countries have been involved for the last thirty-five years [1]. STEP is a product-centric standard that covers so many areas which has created a big and multi-disciplinary community and needs. STEP covers a lot of domains that need to collaborate and a lot of subjects that need to be combined. In course of its development, the STEP architecture has changed. The objective of this new modular architecture is “to enable the more efficient implementation and deployment of STEP standards without changing the fundamentals of the current technical architecture” [2], i.e. to create new modules by reusing, integrating and extending existing Application Protocols (APs). Thus, APs are “more interoperable, easier to understand and manage, and quicker to develop” [3].