ISO 10303 – STEP

A key standard for the global market

By Howard Mason, Chair, ISO/TC 184, *Industrial automation systems and integration,* SC4, *Industrial data*

The growth of electronic commerce for simple buying and selling over the Web is well documented, but it represents only part of the potential impact of electronic business. This article explores an area of electronic business which is far more challenging and has the potential to bring much greater reward to the global economy. As manufacturing and construction industries become more global, there is a growing demand to exchange the digital definition of products themselves between different organizations as the product moves from design through manufacture to long-term support.

ISO 10303, STEP – the STandard for the Exchange of Product model data – is a comprehensive series of documents which provides industry with a major capability to exchange and share the information used to define a product, throughout the supply chain to the end customer and throughout the entire life cycle of the product. It is already in use to share simple CAD (Computer Aided Design) information, product models, complete product structures and technical drawings, as well as the underlying analysis information in industries such as aerospace, automotive, shipbuilding and construction.

The business context for STEP

Major industrial products such as aircraft, ships, buildings and industrial plants have a lifetime measured in decades, or longer. These products are becoming more and more complex as they deliver increased functionality, with embedded software systems.

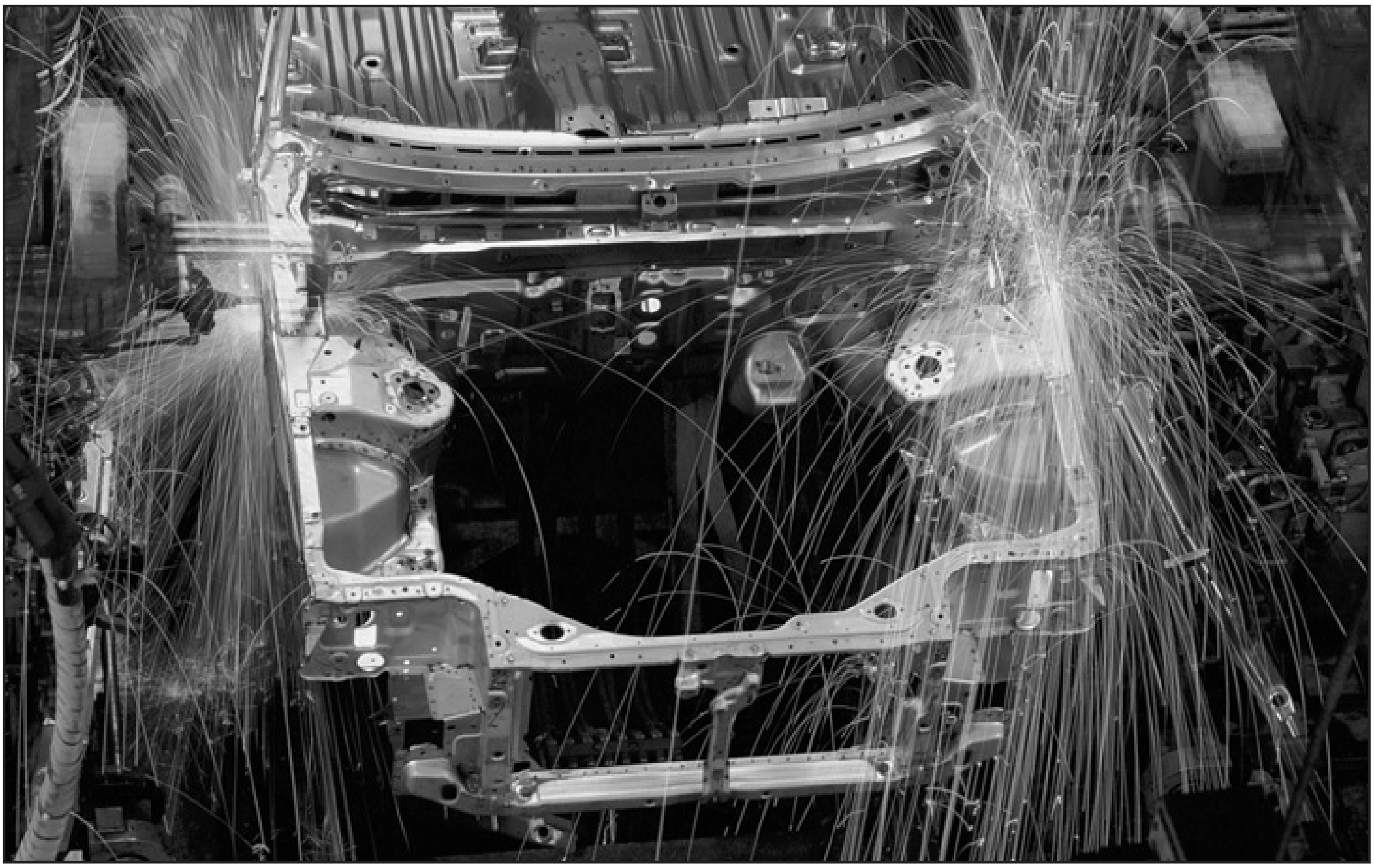
Today's global enterprises are seeking to deliver such products to market more rapidly, with a higher degree of quality and reliability, and higher levels of customer and product support in order to enhance customer satisfaction. The global nature of business and its markets demands the ability to rapidly create alliances of enterprises to deliver a particular product, whilst seeking to drive down the cost of production and support.

For example, big aerospace projects today typically involve a number of major international partners, with up to 10 000 suppliers and hundreds of customers around the world. The product may be in service for 30 years or more, and the customer demands accurate information on delivery and throughout the life cycle.

In order to meet the challenge, industry has increasingly employed computer systems to develop digital definitions of the product, offering improved accuracy and quality, greater speed, reduced costs of rework and the ability to perform additional analyses of the model before moving to production. Such systems have also permitted the development of new business processes such as concurrent engineering.

One of the results of this trend is that the digital data is becoming the sole design authority for the product, and product data held in digital form represents a major investment for the manufacturing industry. Digital product data can be used where and when it is needed throughout the extended enterprise and throughout the life cycle of the product. It can also be delivered to the end customer. As a consequence, product data needs to be accessible to a wide range of different computer systems.

Barriers to communication can easily arise because different computer systems hold data in different forms, and even the same system can be used in different ways by different individuals. In addition, the length of the life cycle of many of the industrial products spans multiple generations of hardware and software technology, so there is a major requirement to read legacy information from new systems.



STEP (ISO 10303) is already in use to share simple CAD information, product models, complete product structures and technical drawings, as well as the underlying analysis information in industries such as aerospace, automotive (above), shipbuilding and construction. Current development activities include suites of application protocols to support the shipbuilding and furniture industries and the construction of process plants such as oil refineries.

Re-creation or duplication of product data between systems leads to inconsistencies and does not add value, so there is a large and growing demand for accurate and unambiguous translation of product information between different systems. The business need for more partnerships and more flexible subcontracting, as well as internal business improvement programmes, further reinforce this demand.

One solution would be simply to develop interfaces between systems as required, but this rapidly produces a large number of translators which are expensive to maintain. Four systems require 12 interfaces - for 10 systems, this number grows to 90 and the problem rapidly spirals out of control, since a change in one system may require changes to be made and tested to all the interfaces to the system.

The STEP architecture

A more cost-effective solution is to link each system to a common data "backbone", which requires each system to have only two interfaces, translating information between the native format and the neutral form of the backbone, and isolates changes to those interfaces.

The role of the STEP standard (ISO 10303) is to provide that data backbone for product information. The standard defines an integrated information model which supports multiple views of product data for different applications. The integrated model is documented in the STEP Integrated resources (currently Parts 41-50) and Application resources (currently Parts 101-108), which are extended as necessary to support additional information requirements as they are discovered.

For each application area covered by the standard, a standardized Application protocol (Parts 201-238) is defined which describes the scope of the information required by the application in terms that are familiar to application users. The use of the information may be illustrated by a supporting activity model, which shows the processes that the Application protocol can support. The Application protocol then defines the mapping between the users' view of the information and the integrated STEP information model. The resulting standardized definition of information can be used to develop and validate translation software for different computer systems serving that area of application. For some application protocols, the market has supported the development of standardized testing information, which may be applied for conformance testing of different implementations of the standard (parts 31-35 and the 300-series).

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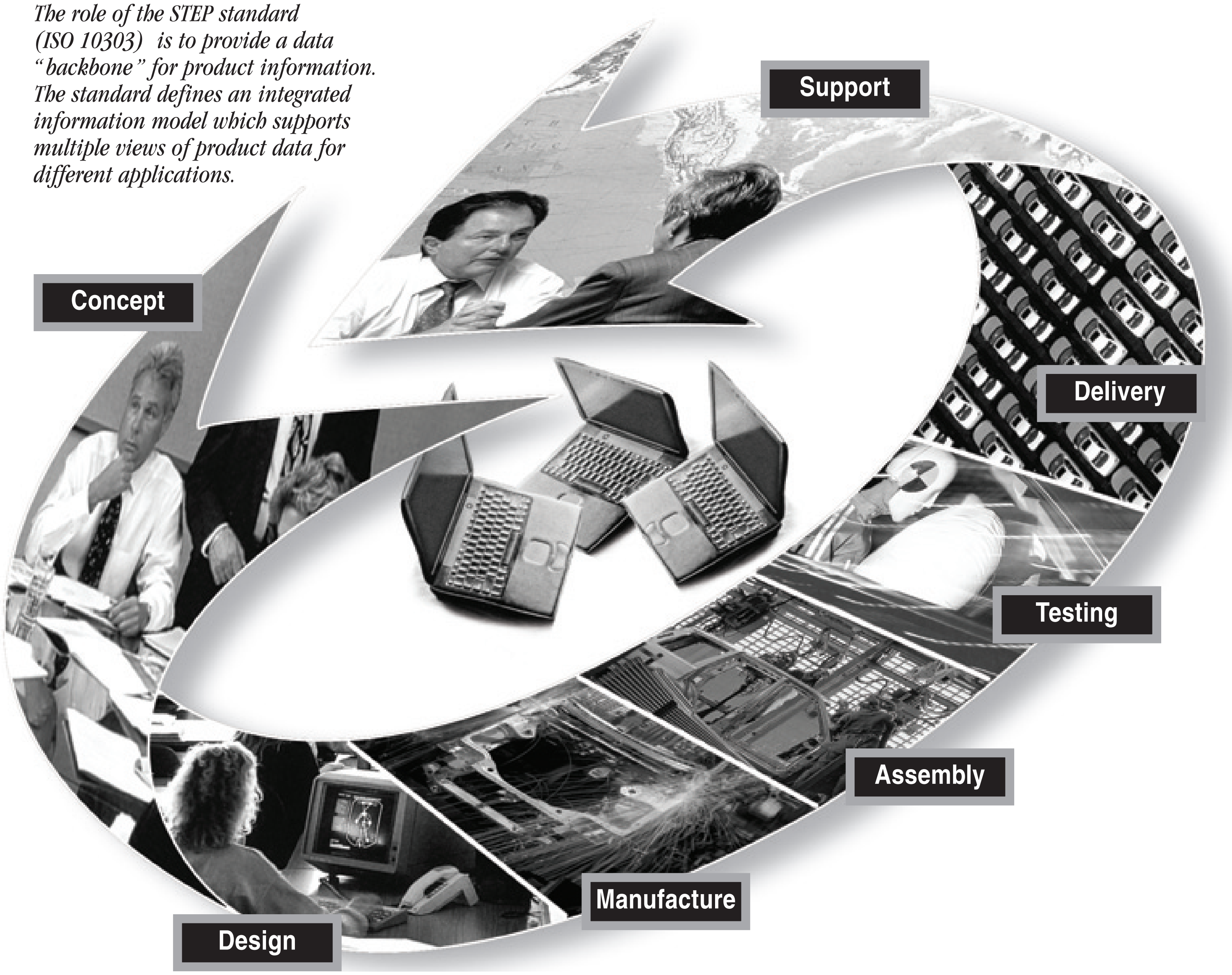

This approach is designed to provide interoperability between different application views of the integrated model, and is further enhanced by the standardization of collections of data which are common to multiple application protocols. The additional standardization of Application interpreted constructs (as parts 501-520) and Application modules (Parts 1001 upwards) facilitates implementation of translators and reuse of software. For example, the PDM schema provides a common information model to support product assembly structures and bills of material for multiple applications.

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All STEP information models are defined using the EXPRESS data definition language (Part 11) which was developed at the start of the project in the mid-1980s to provide the necessary information modelling constructs to support the complex relationships of product information. The use of the EXPRESS language is supported by a range of software tools which can assist the process of modelling and developing translators.

The information in EXPRESS data models can be represented in a simple physical file form as a text string (part 21), or mapped into any other form of representation. It is completely independent of the representation format.

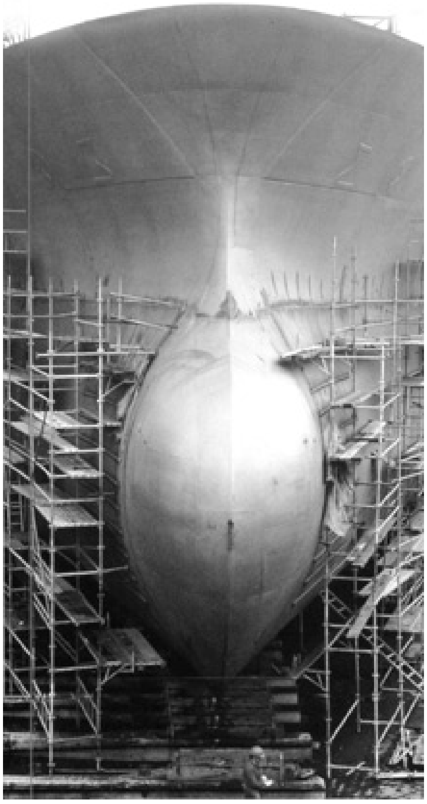
An extensively implemented standard in aerospace, automotive and other industries

First published in 1994, the initial scope of STEP covered geometry, product structure and technical drawings. Since that date, the standard has been extensively implemented on major industrial projects in the aerospace, automotive and other industries.

Typical implementations use STEP to combine the information on the shape and other characteristics of individual parts with assembly structures to form a single integrated representation of a complex assembly or product. This information is gathered from a range of application systems and consolidated into a STEP file which can be transferred to other companies and unloaded into their corresponding systems. The advantage from combining this data is that it guarantees consistency for information deliveries, and avoids the administrative cost of ensuring that data is consistent between multiple systems.

Landmark examples include:

- the use of STEP to support the exchange of digital mock-ups between Boeing and its engine suppliers in the process of integrating engines and their complex plumbing into an airliner, replacing expensive physical mockups;
- the use of the PDM schema to communicate design and build assembly structures between the four national partners of the Eurofighter project;
- the AIRBUS use of STEP standards for CAD-PDM exchange for the A380 programme, and its intent to use them more intensively in the near future;
- the use of the STEP Draughting application protocol for the exchange of technical drawings between Japanese companies and the Ministry of Construction.



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A number of nations have set up their own STEP Centres to support industrial exploitation of the technology. These Centres regularly cooperate to advance progress and promote successes in implementation of the standard. Their Web sites contain many more examples of successful STEP implementation – see **http://isc.aticorp.org**

The latest release

TC 184/SC 4 has recently completed a major extension to STEP which offers a broad range of new functionality. The capabilities in the initial release have been extended to cover geometry for process planning of manufactured components, sheet metal dies, finite element analysis, design and manufacture of printed circuit assemblies, electrical wiring harnesses and integrated electromechanical systems. Other extensions include building, construction and process plant information.

These new capabilities build on the established core model of STEP, which has been extended to support the additional information requirements.

As new IT capabilities for information exchange have emerged, TC 184/SC 4 has also standardized database access interfaces, language bindings and most recently, a mapping to XML (part 28), all

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of which use the common EXPRESS data models. An XML schema mapping is under development, and the use of the EXPRESS language guarantees that the STEP data models can be supported by further innovations in information technology as they rapidly evolve. This provision for extensibility is essential to protect the investment of industry in its information.

Future developments in industries from shipbuilding to furniture

The current development activities include suites of application protocols to support the shipbuilding and furniture industries and the construction of process plants such as oil refineries.

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The extension of the STEP standard to support the information required for life cycle support of products demonstrates an innovative approach to standardization. Having agreed the requirements within the ISO community, the PLCS consortium was put together with industry, governments and vendor partners to rapidly develop and test the necessary standards in a realistic environment prior to standardization. This approach brings together the most effective elements of the ISO consensus process and the speed of development offered by consortia, resulting in rapid development of an international standard. The first major demonstration of PLCS took place in September 2001, showing how field maintenance reports could be fed back to the manufacturer, problems assessed, design changes evaluated and modifications deployed throughout the fleet.

A further innovation comes from the use of the XML language to develop the components of standards so that scripting tools can be used to generate from a common source the formal ISO documentation and other computer-interpretable representations which can be directly implemented. This approach eliminates non-value-added transcription and duplication of information.

TC 184/SC 4 is also planning to extend STEP to support the information requirements of Systems Engineering, material properties and a more integrated approach to process planning for manufacture. In cooperation with TC 184/SC 1, it is developing STEP-NC, which will allow fully detailed STEP models and the associated process planning information to be delivered directly to new-generation numerically-controlled machine tools for automated manufacture, eliminating the need for manual process planning. These new capabilities directly exploit the results of major research and development activities in Europe and the USA.

About the author
Howard Mason

The author works for BAE SYSTEMS in the United Kingdom, and is responsible for Engineering and International Standards in the Grouo Information Systems organization. He has been involved in industrial automation standards for ISO/TC 184/SC 4 and its parent YTC since they were launched, and became Chairman of SC 4 in August 2000. Howard Mason also chairs the European mirror committee to ISO/TC 184, CEN/TC 310, and the industrial consortium developing the PLCS extension to STEP. He is an active member of the Management Group of the Memorandum of Understanding on e-Business between ISO, IEC, ITU and UN/CEFACT, and a founder member of the Board of BSI/DISC.

A proven standard, based on sound principles of information modelling

STEP is a proven standard for the exchange and sharing of digital product information throughout the product life cycle. It is based on sound principles of information modelling, and is continually expanding to cover new areas of functionality and new information exchange technologies. It provides organizations with the capability to exchange information between different computer-aided design, manufacturing and support systems independent of the industry sector.

STEP technologies are already being exploited by other ISO technical committees which have the need to exchange digital product information. Good examples are provided by TC 29, *Small tools*, on the definition of cutting tools and TC 172, *Optics and optical instruments*, on optical equipment. STEP technology is available for other groups to use to support their need for exchange of technical drawings and other product information, and it provides an easy route for migrating traditional ISO product standards into the information age.

The use of STEP to support the exchange of digital mock-ups between Boeing and its engine suppliers in the process of integrating engines and their complex plumbing into an airliner replaces expensive physical mockups.

Please contact the Chair or the Secretariat for additional information, or see our new Web site at **www.tc184-sc4.org.**