Bentley OpenPlant

At the Forefront of Interoperability

Schnitger
Corporation

Contents

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Executive Summary

Designing even a moderately sized process plant is a complex endeavor that can involve dozens of firms and generate millions of documents. Managing the design, construction, handover and ramp-up to minimize cost, confusion and the time to plant profitability requires an improved way of tracking all of this information. ISO 15926 is a globally recognized standard for data integration that improves the interoperability of design applications. This leads to better visibility and control for owners and operators that result in faster project completion and more efficient plant operations.

Bentley's OpenPlant engineering and design solutions use ISO 15926 to capture, exchange and present plant information throughout the design, construction and handover processes. In this paper a number of users share their thoughts about OpenPlant, ISO 15926 and the benefits they hope to gain in their implementations.

Introduction

Today's industrial landscape is all about subtraction: reducing inefficiencies, eliminating rework and decreasing waste. In a green fields plant project, this subtraction serves to minimize the time to a profitable operating plant; in a brown fields project, the goal is to lose as little uptime as possible. The reality is that there will never be enough time, trained workers or capital — everyone must do more with shrinking resources. For the asset operator this means having access to the relevant information for plant operations and maintenance, in the format that is most useful to the professions involved. The engineering, procurement and construction (EPC) teams that design and build these assets must manage the massive amounts of data needed to build a modern plant and access, collaborate and revise plans as needed.

To put this problem into perspective:

- A $1 billion plant (not enormous by today's standards) may have a million documents at handover from the engineering and construction firm to the asset operator.

- The design process may involve half a dozen major EPCs, dozens of subcontracting EPCs and hundreds of equipment suppliers and fabricators around the world.

- To complete a project efficiently, the EPCs may draw on staff in offices around the globe. This enables them to leverage expertise and availability but also creates a need for control, collaboration and coordination tools.

- The EPCs involved in the project may use a combination of software tools to carry out design, reporting, construction planning and project management. One EPC reports that his firm has 1500 software tools currently in use, an unmanageable number.

- A plant may contain thousands of different physical objects such as pipes, valves, pumps, compressors and instruments. These may be situated on a concrete pad, inside a building or on an offshore oil rig. Each item goes through its own concept design, detailed design, procurement, installation and maintenance cycles, with different information required at each stage.

Informing the Vision

The typical plant starts with a vision: a chemical producer forecasts the need for more plastic somewhere in the world and wants to build a plant to capitalize on that need. A request for bid is sent out to engineering firms and the vision becomes increasingly detailed. The location is selected, the chemical process is designed and engineers begin to lay out the plant. As the design moves through its conceptual stages to detail engineering and, eventually, construction planning, more and more information is generated about the plant but not all of that detail is needed by every one of the hundreds of people involved in the project. Each must be presented with the right type of information, as accurate and current as possible, in a way that is easy to understand.

A typical plant project may involve Aspen Tech's process simulation tools, Bentley Systems' software for engineering design and drawing production, SAP's applications at the operator's plant and enterprise level and Meridium products for operations and maintenance. Each of these solutions has a different data model, making it difficult to transfer basic information such as asset tags, equipment names and equipment attributes.

- At the end of construction, the plant is tested by the EPC and a handover team from the plant's operator. Once the plant is proved ready for production, the operator takes possession and begins to ramp up to "nameplate" levels. This process can be difficult, as operators need to be trained on the plant's unique characteristics. It can take months to years to get the plant to 70% maximum operating capacity, the level at which a plant is likely to be profitable for its owners.

  At each step, data is created using tools customized for that task and must be transmitted in a form that is appropriate for downstream uses. Managing all of this and moving only the correct data forward is complicated by the fact that many of the tools do not interoperate, losing valuable information in translation.

Often the biggest problem is that useful information is stuck inside a proprietary application and is in a form that is not useful to downstream users. As one EPC put it, "we need to leverage people's knowledge. The problem is that their work is typically stashed on computer hard drives in offices all over the world. We may control it all in a document management system but the relevant piece is still somewhere among hundreds of millions of documents and probably not in a form the next person can use. That's where ISO 15926 comes in."

ISO 15926: A Universal Translator

The International Organization for Standardization (ISO) is the world's premier developer and publisher of international standards, a non-governmental organization that forms a bridge between the public and private sectors. It has developed nearly 20,000 standards for quality, environmental impact, safety, reliability and

efficiency. ISO also works to create standards for data exchange and integration for a number of software categories.

One such data-related standard is ISO 15926, a globally recognized standard for data integration, sharing, exchange and handover between the computer systems involved in designing, building and managing process plants. According to the ISO 15926 primer[1], the standard addresses the need to “exchange complex plant and project information and ... mitigate the high costs of rekeying and reformatting information to move it from one proprietary system to another."

ISO 15926 describes neutral formats through which data from various computer systems can pass without having to know anything about the data configurations at either end. As a result, information moves directly from system to system without human intervention, removing the errors that can be introduced, for example, by reentering information from a spreadsheet into a database.

In order to create an operating environment for the plant and to build up a knowledge database for future projects, the owner must move data from these disparate systems into its master system, typically using some combination of manual and automated mechanisms. Many asset owners are starting to see ISO 15926 as a way of easing this flow of information, enabling them to leverage the digital asset for the operation of the plant today, for future maintenance work and for the design of follow-on plants.

A group of owners, operators, EPCs, application vendors and other organizations formed the iRING User Group to implement sections of ISO 15926. Their goal is to take the schema and refine it to provide interoperability within the process plant space.

Bentley Systems OpenPlant is one of the first of the next-generation plant design products that was built specifically to take advantage of the ISO 15926 standard.

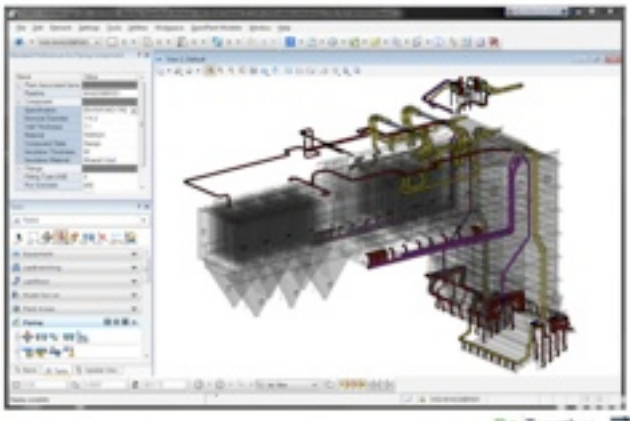

Image courtesy of RAFAKO S.A.

OpenPlant: Native ISO 15926

Bentley has been working with ISO and the iRING community to take ISO 15926 from theory to practice. It is the first independent software vendor to provide solutions using ISO 15926 as a data model rather than as an electronic data interchange filter on top of otherwise proprietary tools. Bentley’s OpenPlant engineering and design solutions use ISO 15926 to capture, maintain and present information in the right format to engineering, construction and operations staff throughout each phase of a plant’s lifecycle. OpenPlant today includes:

- **Bentley OpenPlant PowerPID,** a process and instrumentation diagram solution for creating intelligent PIDs stored in an ISO 15926 compliant data model.

- **Bentley OpenPlant Modeler V8i,** a 3D plant modeler based on the ISO 15926 schema that supports project workflows for engineering, tracking and management at the component (data) level while also accepting and producing

[1] https://www.posccaesar.org/wiki/ISO15926Primer

file-based work packages. OpenPlant Modeler V8i uses the highly regarded MicroStation platform for 3D modeling, a critical decision factor for EPCs and owners seeking a tool that it easy to learn and whose DGN format is already in widespread use. OpenPlant Modeler V8i natively supports workflows that combine software standards such as DGN, RealDWG, LIDAR point clouds and PDF.

- **Bentley OpenPlant ModelServer V8i**, the layer that manages components on a ProjectWise server for distributed team collaboration; and migrates Intergraph PDS models, piping catalogs and specifications to ISO 15926 so that PDS data can be shared with other applications. OpenPlant ModelServer V8i makes it possible for project teams to work across design environments that include Intergraph PDS as well as Bentley's own AutoPLANT and PlantSpace.

- **ProjectWise PDx Dynamic Review Service,** which extracts PDS project data into the open ISO 15926 format managed in ProjectWise and, ultimately OpenPlant.

- **Bentley OpenPlant Isometrics Manager,** which extracts isometrics in an ISO 15926 format so they can be modified and tracked outside of design systems such as OpenPlant and PDS.

Bentley has also developed the i-model, a container for open, bidirectional infrastructure information exchange. An i-model can describe just about anything—an Autodesk Revit model or a Microsoft Excel spreadsheet—that can be accessed using the ISO 15926 standard. This extends the reach of OpenPlant into the many other domains that are crucial to the complete design of a plant such as architecture, civil engineering, procurement and construction workflow products.

Owners are looking at OpenPlant and ISO 15926 to create mechanisms that leverage much of this data for the lifecycle of the plant. EPCs are interested in ISO 15926 and OpenPlant because a standards-based workflow will allow them to better control the millions of documents created during the design and construction of a plant and enable them to more effectively collaborate within their enterprises and with owners and partners.

Both owners and EPCs continue to look for ways to get the plant to nameplate capacity as quickly as possible because that's when the owner starts to make money with the asset. OpenPlant is in evaluation and early-stage use at a number of EPCs and owners around the world. Several of these users have shared their thoughts about OpenPlant, ISO 15926 and the benefits they hope to see in their implementations.

Scalable, Flexible Information Exchange

CH2M HILL, an employee-owned consulting, design, design-build, operations, and program management firm, sees ISO 15926 as a way to improve the effectiveness of its operations and to streamline communication with partners and clients. Its 5,000 engineering desktops around the world serve the energy and water, facilities and infrastructure, and government, environment and nuclear sectors.

Rob Brawn, director of Automation Systems Integration, states that the firm's operating divisions use whatever tools are most appropriate for a given job. With this in mind, he discusses the value of open systems:

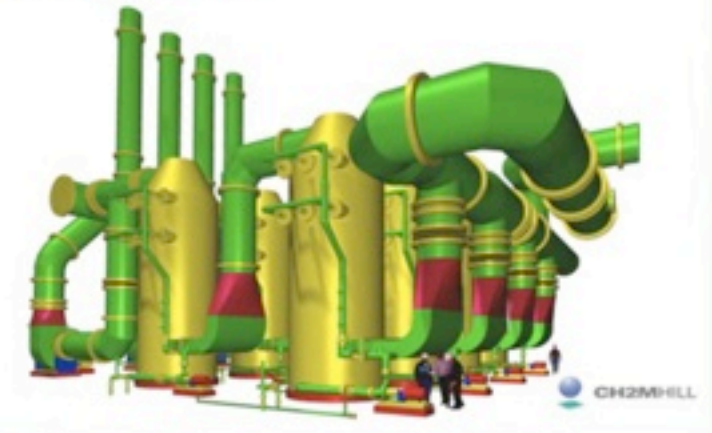

Image courtesy of CH2M HILL

"An open-data model based on ISO 15926 is very attractive for us. Open systems are essential to exchanging information in context so that we can assess the quality of the information. ISO 15926 lets us map our internal terminology to the appropriate ISO 15926 terms; if each organization does this, they can then expose that information in the iRING interface and we can exchange information in a rich format, in context.
"We select software based on their adherence to industry standards. We need to be scalable from

small to very large projects and flexible in how we adapt software tools to each project's environment.

“OpenPlant is based on ISO 15926, which gives it a lot of flexibility. We can configure it to suit the needs of each client or business group. We can work connected to a database or not; we can set up project specific infrastructure for very sensitive projects and can integrate with other applications as needed. OpenPlant is compatible with many other systems and supports the many disciplines that we need on a typical project: piping, HVAC, structural, site work.

“We're on our first project with OpenPlant Modeler and have five projects using OpenPlant PID. We have dozens of users for OpenPlant right now but are building master schemas and developing ways of deploying it more broadly using ProjectWise, possibly to hundreds or thousands of users over time. We're being intentional during initial deployment because of the need to train people and develop support to ensure project success.

“OpenPlant’s scalability lets us transfer and share work between locations. As a company we're also looking at OpenPlant as a way of consolidating tools such as PlantSpace, AutoPLANT, and possibly others. If we do this consolidation, we can better respond to client requirements because we're using an open data format and can deliver information as required. We can also deepen our expertise, streamline setup and support, and reduce cost if we use fewer products. Our back-office tools won't change, but the front-end design tools can be what's best for each project.

“One misconception about ISO 15926 is that it was created by larger organizations and only addresses the oil and gas, chemical, or other mega-industries. ISO 15926 also applies to other markets such as water and wastewater because there's a lot of commonality in the way we build and use catalogs and share information with design and modeling tools. This will become more apparent as we deliver more projects with tools based on ISO 15926.

“OpenPlant lets us offer an integrated set of offerings to our clients, whether that be design, construction, operations, or program management.”

Delivering Business Value

Another of the companies leading the movement to deliver business value through interoperability is Hatch, an employee-owned firm supplying engineering, project and construction management services, process and business consulting, and operational services to the mining, metallurgical, energy and infrastructure industries. Hatch's staff of 10,000 people in 65 offices carries out projects in 150 countries around the world. With so many people and projects, it is imperative that Hatch continue to search for improved knowledge management capabilities to meet client expectations. According to Peter Blake, Director of the Project Delivery Group, Hatch Chile, project timelines continue to shrink even as projects grow more complex, compressing learning curves even as skilled workers become scarce.

Image courtesy of Hatch

Mr. Blake has been with Hatch since the early 1970s and has been involved with every aspect of Hatch's implementation of computer-aided design technology, including the company’s early adoption of MicroStation, PlantSpace and other tools. Today, says Mr. Blake,

"We're seeing significant labor shortages in North America and Europe for engineers and a shortage of craft labor (pipe fitters, welders, and so on) on a global basis. For many reasons, we’ve decided it makes the most sense to take the jobs to craft labor, not move labor to site. That means doing modular construction in South Korea, Philippines or China and transporting the finished modules to the job site. To do this well and with high quality demands very good engineering drawings, done

in 3D, in an integrated fashion. We use less craft labor and that requires us to make use of more technology in the engineering hub. To give just one example, Hatch needs to have a well developed supply chain management system because we need to weigh countless "buy or build" decisions—build costs so many millions, buy costs another amount—and then track and integrate all of the information that went into the decision.

"Once we've got the facility built, the next challenge is starting it up. We're constantly trying to decrease time to handover, since that's when the client starts to make money. How quickly that happens is governed by the transfer of information from the engineering group to construction, commissioning, operations and maintenance.

“We're trying to solve problem of n! connections —between the different teams of designers and engineers, from design to construction, from one partner to the other—and only an approach like ISO 15926 can work to make data accessible to the right people in the right format.

"When the plant operator wants to maintain a pump, they need to have all of the manuals, how to do maintenance, information about spare parts and so on available in a database. We need to do a wholesale transfer of information to the operator. By using software compliant with ISO 15926, we can use systems that make sense for the project and transfer that information in a way that they can import into their own systems, without losing any of the knowledge that went into it.”

Collaborating with OpenPlant

RAFAKO S.A., a 60 year-old Polish company, is a long-time PlantSpace customer that is now converting its design process to use OpenPlant because of its modern user interface and open architecture. RAFAKO designs and manufactures boilers and environment protection plants for Polish power generators. It is the biggest boiler producer in Europe.

According to Zbigniew Harezlak, RAFAKO Engineering IT Manager, RAFAKO's project work typically involves collaborating with plant owners and contracting partners, making openness a critical requirement of its plant design solutions. RAFAKO has used MicroStation for 17 years and PlantSpace for the last 7, managing data with ProjectWise for the last 10 years.

Mr. Harezlak says that RAFAKO is "keen on OpenPlant because it enables us to work better as a group internally and to work in cooperation with our external partners. OpenPlant and the i-model framework enable us to exchange data with partners that use Bentley's or other plant design solutions. We also see the openness of Bentley's solutions in general as very important because no one tool is good for doing everything. We use a number of CAD and other programs, such as analysis tools, during our design process. We need to have a single platform where we can gather all of the different types of data to perform collision detection and optimize equipment arrangements. The 3D plant design is only part of the whole solution."

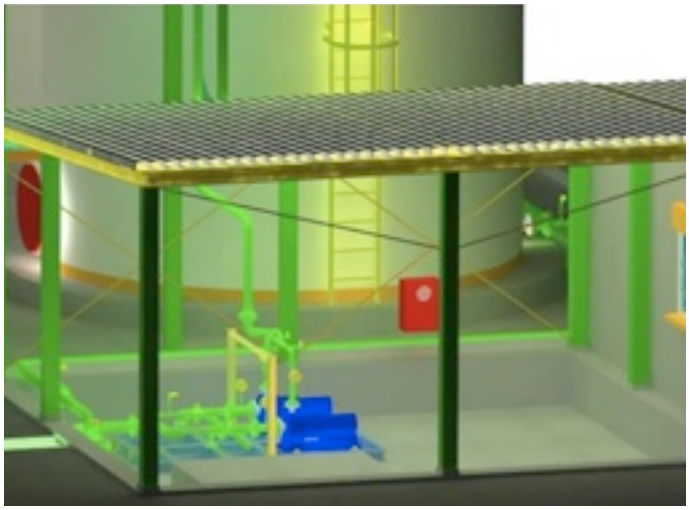

Image courtesy of RAFAKO S.A.

He highlights OpenPlant's modern user interface, which makes it easier to learn than PlantSpace, and its compatibility with other Bentley solutions as drivers for the company’s growing implementation. Mr. Harezlak's team is currently using OpenPlant and PlantSpace in parallel on a "live" project, with about 50 pipelines designed in OpenPlant. RAFAKO will finish basic engineering and prepare these lines for detailed engineering in OpenPlant; all other pipes in the project are being designed in PlantSpace. Mr. Harezlak says that his team decided on this approach because "both systems can coexist in a single project. We can create DGN data and i-models to use both systems. For new projects, we will evaluate

whether to use OpenPlant or PlantSpace. We plan to migrate to OpenPlant as quickly as possible and as OpenPlant's functionality becomes more complete. It will be better for us to use only one piping solution. When we decide that we can do everything we want in OpenPlant, we will be able to design faster and more consistently."

RAFAKO is also very pleased with the support it has received from Bentley during its implementation of OpenPlant. Mr. Harezlak is in frequent contact with the OpenPlant developer team and says that "the product is much better and a more complete solution than it was just one year ago. It is really more and more ready to meet our specific needs. Other products on the market, including PlantSpace, were focused on the needs of the chemical and petrochem industry. Power generation has slightly different needs and we worked with Bentley to explain what we needed. Bentley prepared this system according to our guidelines." During the pilot phase, RAFAKO relied on Bentley for assistance with training and customization, although Mr. Harezlak also notes that many aspects of creating catalogs and adding specifications are simpler in OpenPlant than in PlantSpace and that OpenPlant can readily work with existing catalogs and specifications from AutoPLANT, PlantSpace and PDS, so there is no need to start completely from scratch.

In a nutshell, says Mr. Harezlak, "OpenPlant is a modern, open solution with bigger possibilities now and in the future. We can do our jobs better with this system than other plant design systems."

Leveraging the Digital Asset

DuPont was one of the first US asset owner/operators to recognize the potential of ISO 15926 and has been involved in the standard's development from the beginning. In 2012, DuPont celebrates its 210th year of "putting science to work", as the company says, to deliver innovative products for agriculture, communications, electronics, safety, construction, transportation and apparel. DuPont currently has more than 150 manufacturing plants in 90 countries. The need to manage these plants for optimum efficiency led to the company's vision of a seamlessly integrated environment across all phases and processes of the capital project life cycle, where all information is available where and when needed, without the barriers that can be created when software systems do not communicate easily or well.

Image courtesy of DuPont

The benefits of interoperability are many, says Chris Schwander, Engineering Systems Competency Leader, DuPont Engineering:

"Asset owners don't necessarily do an entire engineering project in-house. They frequently engage contractors to do the production design and construction.

"We want the contractor to use whatever engineering and design tools they want. Specifying which tools the contractor must use leads to surcharges and delays when they don't have trained people available. But this means that we receive data in all sorts of formats at handover.

"DuPont sees ISO 15926 as crucial in making use of design deliverables to maintain and operate our plants. We need to do a "handshake" from whatever tool the EPC is using; can we put it into an i-model to get it into our systems? We are going to be exploring this to improve the amount of intelligence in the data we get at handover. Right now the fabrication drawings may come to us in a MicroStation or PDF format or on paper. This means all intelligence in the model has been dumbed down to a basic electronic 2D vector CAD file. We can update this but lose a lot of valuable information and have to do a lot of manual data entry to recover what we already knew about the items from the earlier phases. It's a horrendous amount of redundancy — had we preserved all of the essence of the deliverable, we wouldn't be doing all of this.

"We can do better at defining to the EPC what deliverables we expect to get back—electronic, ISO compliant, an i-model or DXF, data output to .csv or Excel for material take-off, ERP plant stores, valve reports, line lists, etc.—so that we can process this data and use it across our systems. DuPont values the deliverable and its interoperability value as a digital asset and will put into their contracts what electronic deliverables it wants."

Getting to Nameplate Production

In the end, all the work of engineering and designing a plant, planning for its construction and working towards handover must be geared to getting the plant operational as quickly as possible. The EPCs working on the project must create and manage their design data, documents and drawings with a view towards handing over all of this intelligence to the asset owner in a form that can be used for plant maintenance and operations. This information will be accessed, shared and modified throughout the operating life of the plant, some 30 to 50 years.

As Peter Blake of Hatch said, he doesn't think his job is finished when the last concrete is poured but when the plant is producing:

"We need to look at how long it takes a plant to start up and begin to produce at capacity. That's governed by the transfer of information from the engineering group to construction, commissioning, operations and maintenance. That needs to be as simple and transparent as possible — we need to plug that information right into their database so that it can be displayed on an iPad or wherever makes the most sense for the operators."

Of course, said another EPC,

"EPCs need to ask owners how important data is to their overall concept of managing a plant. If they see engineering and construction data as important, OpenPlant and its data-centric approach has significant downstream applicability over the life of the plant."

As Chris Schwander of DuPont made clear, some owners, at least, are starting to realize the value of the digital assets created during the design of their plants. They see how this information can more quickly get a plant to nameplate production levels and streamline production thereafter. ISO 15926 facilitates data sharing and transfer, so that all stakeholders can use the most up-to-date information in a form that is suited to their needs. Bentley Systems is seen by many asset owners and EPCs as a leader in defining interoperability standards and in creating open, scalable products like OpenPlant to address the needs of the process industries.