New business models driven by data integration and open platform economies

The scope of, prerequisites for, and Aucotec's contribution to a comprehensive, affordable digitalization of E & C firms' engineering.

To our picture: Digital Ecosystems and platform economies will change every industry in many ways. The Fraunhofer Institute for Experimental Software Engineering (IESE) works on central questions concerning digital ecosystem scenarios

1. Key trends in engineering and construction markets

1.1 Market outlook

EPC firms (EPC: engineering / procurement / construction) as part of the engineering & construction (E & C) industry are extending their footprints across the whole value chain by leveraging new Industry-4.0-enhanced capabilities. This added value can help merge assets, people, processes, engineering, and construction sites on one 'platform', optimizing industrial plant infrastructure / assets usage, and gaining better visibility into operations, last but not least to reduce carbon footprint.

In a recent survey by Deloitte, 43 % of E & C executives said they will invest more heavily in new planning processes, such as a focus on building information modeling (BIM). In 2022, connected construction is likely to be seen as a 'panacea' in the sometimes painful digital transformation journey. The goal is to achieve digital continuity across the entire value chain through a smart, (cloud-supported) IT infrastructure (1).

E & C companies want to gain faster access to new digital capabilities, in software, electronics, technology consulting and services, and even in media such as motion pictures. In addition, venture capitalists are investing in startups in construction technologies, among other things to establish knowledge-sharing, with adaptable digital ecosystems being enabled to react as quickly as possible to changing requirements.

In particular, EPCs rely on extended value networks in terms of the gathering complementary competences. Together with their clients, the owner/operators, and their supplier networks, a 'dynamic complex of stakeholders' comes into play, which also can be referred to an 'ecosystem running on a platform' (or: 'digital ecosystem') with the claim to end-to-end transparency (also: 'digital thread') in all value contributions.
No doubt, a lot of tuning has to be done to be able to run such a digital ecosystem. The efforts can broadly be divided into elements relating to technical functionality and network effects. Since the willingness to disclose and exchange data with other stakeholders has been established, a great deal of effort needs to go into the cultivation of ecosystems (2).

However, great progress can be reported from the power distribution sector: Moderated by Aucotec, an interest group has been exchanging information on engineering IT requirements for more than 30 years. As an ongoing process, plant operators and suppliers have been sitting together at the table and defining data quality standards. One thing they have agreed on is that not only a power distribution system will be delivered, but also the complete as-is data set bundled in the form of a data model.

Backgrounder
The lifecycle of substations for power distribution commonly lasts around fifty years. It is characterized by a number of conversions and extensions. Keeping the plant documentation up to date is a huge challenge, especially when using file-based systems. The technology for protection and control is usually clearly separated, each in its own, usually document-oriented system, although all primary devices and their designations naturally reappear in the other technology, too. This means that relevant data must be transferred either via Excel lists or manually from one system to another.

Whether the owner/operator, manufacturer, EPC, or supplier: with 'PTD Plant', the cooperative platform based on Engineering Base (EB), provides a comprehensive solution for all users in power transmission and distribution who want to accelerate their processes and prepare for the future. Thanks to data centering and object orientation, EB can be used to design high-voltage primary technology devices effectively. The plant model allows objects to be developed before even the first circuit diagram is drawn. Error-prone double entries are eliminated. A pilot project has already shown how easy it is to use plant design information in EB. It was developed in cooperation with Primtech, whose software covers the primary design. The data can be automatically transferred to the secondary engineering, where EB turns it into a corresponding single-line representation. It is the basis for the further detailing of the plant model.

Changes to the primary technology are immediately apparent to the switching experts, just as they are to the protection and control technology. EB also enables their specialists to enter all IEC 61 850-relevant information for the high-voltage devices. Primary, secondary, safety, and control technology thus use EB's digital twin of the substation as a 'single source of truth'. This allows them to view and further edit the planning status at any time.

However, such close collaboration and culture of information exchange is not a matter of course. It is not uncommon for both the O/O and the EPC to use EB, even over several project phases and to link different disciplines, but when it comes to a data hand-over the EPC only delivers PDFs. PDFs are just a little bit digital, but not much more than what used to be handed over on paper. Note: Most sophisticated internal digitalization is lost (and thus not shareable in the ecosystem) if not all stakeholders are included.

1.2 Digital twins as an enabler of data-driven business models and digital ecosystems

Under the impact of ongoing digitalization, E & C firms should rethink their business models in the direction of offering 'plant / service / systems' (PSS) as hybrid service bundle deliveries. While the focus is currently still on the sale of capital goods ('assets'), a platform economy demands sharing of information based on digital twins to create business-oriented outcomes from the EPC clients' view.

Backgrounder
The digital twin exists at the interface between the physical reality and virtual representation. Both the physical and virtual entities are part of the digital twin. Unlike other virtual representations of assets, the digital twin explicitly contains physical-virtual and virtual-physical references that enable 'twinning', i.e. the updating process of the corresponding virtual or physical counterpart. Incidentally, physical processes or process environments in which a real entity operates can also be very well mirrored in a digital twin.

Digital twins are created with varying levels of detail and do not have to contain all the data and information from the lifecycle of an asset. Therefore, an asset may be represented by more than one virtual entity and thus may be part of multiple digital twins. For example, there may be different digital twins for different lifecycle phases, e.g. a digital twin for engineering, erection, and operation (from 'design to operation' (5)). Another option is to have separate digital twins for different stakeholders and use cases, such as pieces of a plant for upfront HSE studies or virtual commissioning. Different stakeholders independently create their own digital twins of the same asset to meet their different business needs. It could also be beneficial to have reduced models for use within some virtual processes, as this can improve runtime performance.

In the context of Industry 4.0's cyber-physical systems, the concept of a 'cyber twin' has been proposed as a type of digital twin where the asset itself is part of the cyber space, i.e. a virtual environment.

The core function of a digital twin is 'twinning' (permanent synchronization between the real and virtual worlds). This requires actuators and sensors to implement and document changes to the asset. It leads us into the world of the Internet of Things, or better: Internet of Objects. Why IoO? 'Things' don't have any logic. As long as you have things, you have dumb documents for them. As soon as you have objects, they themselves have the intelligence embedded in them – in the sense of cyber-physical systems that means knowing what to do next in a certain process (6).

The 3D model of a plant is just one aspect of the digital twin. 3D models are not only used in design of plant layout and related calculations such as weight, pipe, and cable lengths and so on but also are intensively used in the training of operators and maintenance. Aucotec's strategy in terms of dealing with 3D data management is quite unique. First of all, Aucotec runs a strategy of 3D CAD agnostic, meaning the vendor is fully open with respect to the integration of different 3D CAD tools – EB acts as a single source of truth. That means Aucotec's clients don't have to integrate their different 3D tools by means of point-to-point connections with all the challenges described above, they just integrate their tools with EB, something they really appreciate.

The reasons for Aucotec not to go into the 3D design business are diverse. Just one example: Many different 3D models are needed, for piping, mechanical design, for plant layout, or for cabinet design. However, there is no software vendor that covers all these different disciplines. Therefore a lot of different 3D tools are in use that have to be connected.

A digital ecosystem is a distributed, adaptable, open socio-technical system with properties of self-organization, scalability, and sustainability that are inspired by natural ecosystems. Also the E & C sector can benefit from those approaches
Picture: Pixabay

1.3. (Semi-)automated generation of digital twins — benefits of modularization and standardization in plant design

Generally speaking, a configurator can help to create parts or the whole digital twin of an asset in an automated process. The digital twin is created during the runtime as part of the configuration process. From a data point of view, this has a number of advantages. For one thing, the instance-specific documentation is complete for all components installed. In addition, the underlying data model is consistent in itself, since the necessary data objects and their relationships to each other are defined via the configurator ruleset based on interpretations of requirements.

2. Pillars of Aucotec's strategy

Aucotec's approach rests on three pillars:

A single source of truth for complete plant data model is crucial to the digital twin ecosystem.

All the auxiliary data contained in other orbiting data sources should provide an open data communication protocol.

It is absolutely counterproductive if one or more stakeholders within the value chain use a self-contained approach.

2.1 On the role of openness

Aucotec's vision is that when the plant is delivered as a whole or in pieces, the complete corresponding data set is also handed over in the form of a digital twin. Of course, this has to be contractually regulated in detail, with provisions, for instance, on how IP protection is to be guaranteed. Protectionism, lock-in and non-open systems haven't any place in a platform economy, and they have not paid off in the past, as the following example proves.

Backgrounder

digital

At its best years in the late 1980s, Digital Equipment Corporation (DEC) was the second largest computer manufacturer in the world and had over 120 000 employees. During this period, the commercially successful MIPS system architecture was launched. However, within just eight years, its economic decline was sealed — the reason: The management board had turned their back on openness.

Although DEC's software products were well thought-out and implemented, they were difficult to integrate because they had been developed with a focus on DEC's own hardware. This led to the software being ignored by many potential clients, who then purchased software from other vendors instead. This problem was compounded by company founder Ken Olsen's aversion to advertising and the idea that well-designed software sells itself. Blinded by the success of the proprietary VAX/VMS products, the competition from Intel-based personal computers (PCs) and the fact that commodity hardware and standards-based software were gaining acceptance were overlooked.

From around 1990, DEC pursued a lock-in strategy, because hardware and DEC software had to be maintained together in the case of a maintenance contract, thus heralding the end of its 41-year company history. Due to the new — today we would call it 'non-open' — strategy, all third-party vendors were locked out of the DEC market owing to a lack of software knowledge. Many clients who wanted to use the technical concept of PDP hardware, but at the same time wanted to stock up on peripherals at low cost on the alternative market, could no longer be addressed as DEC clients.

The rigid attitude with regard to service as well as dealer support caused many companies that until then had acted as resellers to withdraw from DEC. Furthermore, a discussion about the increasing operating system (VMS) and network complexity (DECnet) flared up — employees split off and founded the company Apollo Computer. With convincing Ethernet services, Apollo continues to set the standards for technology today. In 1998, the remaining parts of DEC were sold to the PC manufacturer Compaq, which in turn was taken over by Hewlett-Packard in 2002.

Openness should not be understood narrowly as free access to software source codes. In an overarching concept, openness is characterized by an emphasis on transparency and collaboration — it can be described as the opposite of closedness in the sense of a lock-in strategy (3), which, however, is still popular among vendors in the engineering IT environment.

Backgrounder

Lock-in prevents, for example, PLM data from one business unit from being made available to another without elaborate point-to-point APIs. The problem with providing such APIs is that for each point-to-point connection, at least two IT experts from the systems are involved as well as an expert from the business unit who explains the importance of the information flow to the IT experts. This procedure can easily take many months (4).

At the core of openness is the seamless data exchange of context-relevant information and the possibility of data-driven collaboration (4). This is usually done via standard formats such as the unfortunately forgotten ISO 15 926 or the OSLC (Open Services for Lifecycle Collaboration) recently promoted by the OASIS consortium and prostep ivip association in order to connect various PLM backend systems in the discrete manufacturing industry. Of course, it is much easier when all project partners have agreed on one backbone like EB, because of the significant reduction of data management issues.

Backgrounder

Distributed control systems (DCS) steer industrial plants to the smallest detail — the more complex the system control, the more complex the DCS coding. Up to now, multi-stage data transfers and a lot of manual work have been required to transfer the necessary logic information to the DCS. The lack of seamless data exchange between different engineering systems is a tiresome source of error and has long been identified as the costly 'bottleneck' for engineering efficiency. This also makes the commissioning of a system considerably more difficult.

In order for the signals from the sensors to trigger the intended effect on the actuators, the DCS must know the corresponding logic. It is informed by the function plan or logic diagram, which is fed from the specifications in the individual objects in the flowchart (P&ID). The function plan (FBD) is the basis for generating the code that configures the desired manufacturer's control system. However, the transfer of the logic to the appropriate automation system is still mostly done manually and in several stages: From the P&ID to the FBD and on to the DCS. If devices, signals or other circumstances change, the effort for data maintenance is enormous. With EB, however, these logic connections can be easily defined as an object in the database and the control system programming can be derived from this.

Oil platform Statfjord A *Picture: Øyvind Hagen / Equinor*

In Scandinavia's oil and gas sector, where Aucotec's clients such as Kongsberg Maritime (KME) and Equinor (formerly Statoil) are at home, DCS logics have long been designed in so-called SCDs (system control diagrams). A SCD is essentially a P&ID broken down into controllable elements, which maps the logical functions and connections. An AutomationML library was created for these diagrams according to the NORSOK standard. The data created with EB in the SCD, including logic and connections, can be transferred to the DCS via an AML library. The prerequisite for this is EB's universal data model, which allows DCS-relevant logic to be mapped in the CAE in the first place.

The understanding of AutomationML is only one of the many languages that EB has learned. EB's DCS portal offers other bridges to systems such as ABB 800xA, Siemens PCS 7 and IEC 61 850 and can also be freely adapted thanks to its generic approach.

2.1.1 Threats from openness?

What does openness mean in concrete terms in the context of IP protection when data is handed over from one EB system to another? Is it to be feared that this will lead to a drain of know-how? Certainly not, because only specific information is transferred, such as mechanical connection dimensions, electrical performance characteristics or operating conditions, but not company secrets, such as how a pump really works inside. Basically, it is information like that written in a data sheet, but formatted in a way that it is machine-readable and, if necessary, also the spatial context is visible (such as the bounding box).

Openness in the sense of data exchange is to be regarded as complementary to the use of licenses, for example, to be allowed to run certain patented chemical manufacturing processes. The Danish company Topsoe, for example, licenses its back-end shift partial conversion hydrocracking process (BES) that significantly reduces the distillation temperature. To put it in a nutshell: More efficient commissioning of a plant is enabled by a consistently lived openness, while IP protection is provided based on a licensing model.

2.2 Highly scalable data model

All engineers want to be supported by a working environment that enables them to get their jobs done as quickly as possible. A modern digital environment should therefore adapt itself to the needs of engineers, meaning the process of creating a plant data model should follow their design intents, not the other way round. This is part of the basic concept of EB (6).
Another requirement is the reduction of the complexity of IT administration when more digitalization is implemented in engineering-related areas. After all, accessing certain data is usually a question of effort. IT administrators want to manage tools with the lowest maintenance demand, in every respect. Thus, for them it is really important that they can rely on stability, scalability, and openness – this is guaranteed by EB. Moreover, Aucotec focuses on minimizing customization costs. You can do the adaption of EB during project execution instead of investing upfront in six or twelve months just to do the configuration.

Openness and scalability are basically synonyms. In this way, partial models from other disciplines that have been created with other tools can be seamlessly integrated into EB. Because every tool from the supply chain stands for a special domain and thus only represents a part of the digital twin — results about pipe voltages, about the current load, pump design and much more. This means a collection process is necessary that ultimately leads to a complete digital twin.

Backgrounder
Aucotec's developers have used the openness of EB to further simplify the import of data to EB. The new, open XML-based EBML format can be transferred to the EB database without any special knowledge.

EBML simplifies the configuration of data transfer. The transfer itself also takes only about a tenth of the time compared to transfer via API. This is a significant advantage, especially in the case of inventory data transfers. If millions of pieces of information, which also usually represent millions of parameters, are to be transferred to EB in one go, then time reduction is valuable in itself! If there is already information about devices, containers or similar from a second source in EB, EBML can identify it and fill attributes of the objects with content or add partial or sub-objects.

In this way, the digital twin of a system or machine can be intelligently assembled from a wide variety of sources. The EBML interface also recognizes discrepancies, but can be configured in such a way that they are only documented so that data transfer does not have to be restarted each time.

EB allows mapping on different levels, on the level of objects, types, attributes, even structures. New object classes and references can be created in EB with little effort, so that the data model remains future-proof — it is the most comprehensive data model available on the market. With the help of EB, the digital thread becomes reality.

The digital thread is defined as a communication network that enables a connected flow of data as well as an integrated view of an asset's data across its lifetime through various isolated functional perspectives. This concept promotes transmission of the correct information, to the correct place, at the correct time (7). The digital thread is also used to refer to the lowest-level design and specification for a digital representation of a physical item. It is a critical capability in the foundation for a digital twin.

3. Insights into a leading vendor for industrial plant design

Aucotec is not a small software vendor at all. If you count the number of software engineers and consultants per product, Aucotec actually is one of the biggest vendors providing a cooperative digital platform for plant design. There are around 75 developers working on EB. Aucotec's clients prefer an agile, professional, and innovative vendor over a big one-stop-shop player.

Backgrounder
Apropos innovation: Aucotec has announced two new concepts at this ACHEMA fair 2022: One is to make it much easier for owner/operators and their contractors to communicate and transfer data and documents. The second will create a new level of sharing and of the use of asset data. Both solutions are based on EB.
The new so-called 'EB Alliance' for more efficient communication will include two topics: Seamless data exchange between operators and their — sometimes a hundred — suppliers who have each set up their own EB environments, and the outsourcing and consistent reintegration of the digital twin of rebuild projects of a running plant, no matter how complex. EB Alliance allows all data to be mapped to the configuration state of the recipient, so that errors or misunderstandings do not occur. And handing over the digital twin of a plant section to be rebuilt or extended, as well as integrating it consistently into the new as-built state once the work is done, will also significantly speed up rebuild projects. The new approach also makes the exchange across the whole cascade of suppliers very efficient and transparent.

The second concept includes a comprehensive navigation solution that shows operators all the interrelationships of an asset. The digital twin in EB is much more detailed and intelligent than any information that document-based systems can provide for plant maintenance. Where previously only the main assets with their properties were known, EB's data model also knows all the subordinate objects down to every nozzle in the process area, every terminal connection in the electrical system and every signal in the automation system. Moreover, complete object dependencies for these objects are also modeled.

30 years of pure networking and setting standards for PTD plant development: Aucotec's EVU working group

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