Technology Spotlight


Sponsored by: Dassault Systèmes

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IN THIS TECHNOLOGY SPOTLIGHT

Large capital projects are often plagued with severe time and budget overruns, which can vary from 10% in the best case to 50% in the worst case. Significant improvements are achievable, however, with the right combination of both IT tools and business processes.

This Technology Spotlight shows the Multi-D methodology developed by NIAEP-ASE. The baseline idea has been successfully experienced in engineering and construction management by NIAEP’s projects, based on Dassault Systèmes Industry Solution Experiences and its 3DEXPERIENCE platform. The jointly developed solution enables engineering, procurement, and construction (EPC) companies to create and manage information, including 3D data, resources, and time and financial data related to large capital projects, to deliver on time and on budget. Multi-D technology is an integrated and extended project management system for the construction of complex assets, for instance nuclear power plants, oil and gas plants, and thermal power plants. It combines multidiscipline activities (such as civil work, structures, piping and equipment, cable trays, and HVAC), design, and data with 3D modeling, 4D simulation as well as cost and resources, enabling a digital connection with project execution and material tracking. Multi-D enables engineers to optimize resources by simulating power plant construction processes, based on a 3D model, before actual construction. Engineers can validate the process planning and detailing in a dynamic model of the power plant, allowing them to analyze and optimize the plant layout virtually – where changes can more easily be made – prior to the physical build.

IDC Energy Insights believes that the future of asset design, construction, and operations is rapidly changing to a point where 3D and 4D simulation is going to be expected and not just a "nice to have." These tools will not only be a part of design but also of everyday operations.

Note: Multi-D and 3DEXPERIENCE are trademarks of NIAEP-ASE and Dassault Systèmes respectively.

ON TIME AND ON BUDGET — JUST A DREAM?

The goal of delivering on schedule and on budget seems to be very difficult to achieve when large capital projects are concerned, whether it be a new nuclear power plant, an offshore drilling or production platform, a gas pipeline, a petrochemical plant, or any other critical asset in the utilities, energy, and process industries. Many studies indicate that the technical complexities of these projects – together with the number of parties involved in the different project stages, the level of safety, and the overall quality that must be achieved – often translate into deliveries that are actually lengthier than planned or require additional financial resources. These overruns vary from...
10% in the best case to 50% in the worst. Additionally, these projects are so large and require so much capital that they can directly create or destroy company shareholder value. Reducing commissioning times or the capital required for these projects can have a very positive impact on the return generated.

There are many issues typically encountered during the engineering and construction phases of these complex projects. Often design does not provide all the construction details, as they may be implicit or taken for granted, especially when industry standards are available for reference. Hence, the design could be incomplete, and this can create uncertainties or potential problems when the project moves into construction. On top of that, there can be errors in design or a lack of constructability caused by different teams and disciplines working on the different components of the large capital project, such as equipment design versus structure or civil building design, electric design, and so on. Very often, collaboration and communication among teams, specialists, and contractors is not managed effectively and problems are only discovered when construction starts. Also, these players do not always share a common execution platform or system, and project management might fail to optimize the supply chain or set the right sequence of construction activities. This is even more important when delays start impacting the planned timeline and, for instance, critical construction facilities (such as vessels for offshore builds) need to be rescheduled or waited for. Overall, the construction processes might not be fine-tuned before work begins on actual activities on site. Workers in the field may not have the right tools and information at their disposal. All this increases non-productive time, which is already generally very high in large capital project constructions.

What can be done to improve this situation? Is it possible to deliver on time, on budget, and on quality? Despite the statistics and based on concrete examples and the consensus among energy and utilities companies, EPC firms, professional services and IT companies, IDC Energy Insights believes that while it is not an easy task, it is possible.

Significant improvements can be made with the right combination of both IT tools and business processes. Energy, process, and utility industries can make huge business benefits by leveraging advance digital tools to redefine the way they execute plant design, construction, commissioning, and operations. Companies, for instance, can take the best from the digital experience of the aerospace industry and from manufacturing execution best practices and IT solutions, especially when leveraging virtual reality.

**THE POWER OF THE VIRTUAL UNIVERSE FOR DESIGN AND CONSTRUCTION MANAGEMENT**

Among large capital projects in the utilities industry, the construction of nuclear power plants stands out in terms of complexity, duration, and the required capital. Quality and safety are imperative, and compromise is not an option. EPC companies have shown that, by adopting the right IT tools, they can deliver on time and on budget — as, for example, in Russia with the Rostov nuclear power plants (Units 3 and 4) and the South Ural GRES fossil power plant (Units 1 and 2). The latter is the result of a collaboration between NIAEP-ASE and Dassault Systèmes that started in 2010 and led to the creation of vertically specialized IT solutions and project management methodology for complex capital projects.

**NIAEP-ASE and Dassault Systèmes Collaboration**

NIAEP-ASE, a joint venture between Nizhny Novgorod Atommengoproyekt Engineering and Atomstroyexport, is an international engineering, procurement, and construction management and project management consultancy company which designs and builds nuclear reactors, thermal energy facilities, and other complex engineering projects; manages and supervises nuclear
construction projects; prepares nuclear units for commercial operation; acts as general contractor under projects to build and start up; and supplies materials and equipment for nuclear construction projects. NIAEP-ASE provides project management contractor works as well as services for nuclear waste management and construction. In terms of nuclear waste management technology, NIAEP-ASE is among the 10 largest players in the world.

NIAEP-ASE's projects account for about 30% of the global nuclear power plant design and construction market. The company has branches in 15 countries around the world, with almost 80% of its portfolio coming from projects abroad.

Dassault Systèmes is noted for its work in product life-cycle management (PLM) and the virtual universe space. 3DS has evolved to become the 3DEXPERIENCE Company. Its 3DEXPERIENCE platform is a business experience platform that provides Industry Solution Experiences, based on 3D design, analysis, simulation, and intelligence software in a collaborative interactive environment.

Driven by the needs of the development of MULTI-D technology of its customer NIAEP-ASE, Dassault Systèmes has implemented key enhancements in its 3DEXPERIENCE solutions for Energy, Process and Utilities industries. Multi-D enables the creating and managing of information, including 3D data, resources, time and financial data related to large capital projects. Multi-D enables engineers to optimize resources by simulating nuclear power plant construction processes, based on a 3D model, before actual construction. Engineers can validate the process planning and detailing in a dynamic model of the nuclear power plant, analyzing and optimizing the plant layout virtually – where changes can more easily be made – prior to the physical build. The technology simultaneously reduces construction time and project costs while increasing labor efficiency, work quality, and safety.

**Effective Management of Engineering and Construction with Multi-D**

Multi-D technology is an integrated and extended project management system for the construction of complex assets. It combines multidiscipline activities (such as process engineering, civil work, structures, piping and equipment, cable trays, and HVAC), design, and data with 3D modeling and 4D simulation. The main capabilities are related to plant life-cycle management, including configuration management, and construction simulation. Benefits enabled by Multi-D technology include:

- **3DEXPERIENCE platform powers NIAEP MULTI-D technology to prepare and monitor NPP construction**
- The ability to create detailed technical requirements for 3D models carried out not only by Dassault Systèmes CAD
- Engineering data and technical data from 3D integration based on ISO 15926 in one system
- The ability to merge any 3D models from any international CAD systems

Additionally, NIAEP-ASE facilitates civil engineering. All rebar (reinforcing bars) for concrete are designed from 3D-based templates with the Dassault Systèmes CATIA brand application. Rebar drawings for steel part preparation are then automatically generated.

NIAEP-ASE’s nuclear power plant life-cycle management system is based on Dassault Systèmes’ ENOVIA brand application. It contains features for design management, most importantly 3D model creation and modification, for construction management, field engineering, procurement

"We actively put Multi-D technology into practice to reduce the period of construction and cost of projects and at the same time improve the efficiency of labor, quality of works, and safety level of facilities."

Valery Limarenko, CEO, NIAEP-ASE
management, commissioning, operation, and commissioning. With ENOVIA, NIAEP-ASE created a unified information model which aggregates all engineering data coming from different CAD systems. NIAEP-ASE also developed a unified nuclear industry catalog of equipment and materials based on ENOVIA. NIAEP-ASE also automates the creation of civil engineering documentation, and creates the source data for the Multi-D construction optimization process.

FIGURE 1

3DEXPERIENCE Platform approaches improved technical support for MULTI-D technology developed by NIAEP-ASE for construction management purposes

The simulation of the plant construction is done with Dassault Systèmes’ DELMIA brand application. Using the unified information model, the simulation of the construction is carried out before actual activities start in the field and before the design is too advanced. By doing this, inconsistencies are detected in advance and engineering rework is minimized. In a 3D virtual environment it is possible to simulate the movements of parts, use of tooling kinematics such as cranes, and manikins to simulate workers.

The 3D system enables companies to make sure there are no discrepancies between process design and civil design, and to check safety distances and worker operation feasibility. It makes it possible to define the best sequence of works to reduce non-productive time. In fact, it helps limit time waiting for material and equipment, and travelling to the construction area, and identifies conflicting tasks among teams and solves them in a collaborative manner. It enables the optimization of the supply chain and the movement of the material required for the construction. For instance, by simulating their offloading and storage area occupancy and taking into account their volume, it is possible to evaluate area occupancy constraints in the planning phase.
Overall, it is possible to create a preverified construction schedule, and on the basis of Multi-D design, work execution plans are generated and weekly daily tasks for contracting agencies are formed. During work execution it is possible to monitor actual construction, and in this way the plant is constructed "as designed" and "as planned."

A summary of benefits related to Multi-D technology across the asset life cycle, from design to construction and operation, is shown in Table 1.

**TABLE 1**

**Multi-D Technology: Advantages**

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<tr>
<th></th>
<th>Typically</th>
<th>Multi-D Technology</th>
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<tbody>
<tr>
<td><strong>Design</strong></td>
<td>Only a technological model and a lot of disparate design models.</td>
<td>Ability to create a unified information 3D model of the object (process + design + construction) on the basis of the 3D models created in leading vendors' CAD tools.</td>
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<td></td>
<td>Analysis of interferences done only in a visual way, and only in the process model.</td>
<td>Managing interferences with automated notification of project participants, including the customer.</td>
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<td></td>
<td>Configuration management only in individual design models.</td>
<td>Built-in configuration management functionality with the ability to meet IAEA standards.</td>
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<td></td>
<td>Working documentation often not available from a model. Model is used for major layout assessment.</td>
<td>Electronic interaction with the site and the customer for working documentation approval. Export working documentation directly from model.</td>
</tr>
<tr>
<td><strong>Construction</strong></td>
<td>Only the technological part of the object is used for construction simulation.</td>
<td>Simulation of all major construction processes on the basis of a unified information model, including kinematic models.</td>
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<td></td>
<td>Construction schedules are made separately from the modeling system.</td>
<td>Creation of a detailed schedule of the construction from the Multi-D model.</td>
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<td></td>
<td>There is a gap between the model in a computer and the real processes on site.</td>
<td>Improved onsite field engineering with the use of the Multi-D model in the field (iPad, self-service kiosks, human resources management, etc.).</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>&quot;As-build&quot; model either doesn't exist or created at the end and only for the process part of the model.</td>
<td>Almost-real-time &quot;as-build&quot; model formation.</td>
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<td></td>
<td></td>
<td>Option of using Multi-D technology for upgrading and maintenance.</td>
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<td></td>
<td></td>
<td>Set of additional services for the use of information models in the operation stage.</td>
</tr>
</tbody>
</table>

Source: NIAEP-ASE and Dassault Systèmes, 2014

**Considering NIAEP-ASE Multi-D and DS 3DEXPERIENCE Platform**

To help energy, process, and utilities industries keep their large capital projects under control in terms of time, cost, and quality, NIAEP-ASE, through its partnership with 3DS, offers project management consulting services and engineering services to constructors of any type of large capital project, including projects outside Russia and in non-nuclear industries. The offering focuses on:
- Project management consulting:
  - Assessment and recommendation for engineering and construction process improvement based on Multi-D modeling
  - Management of a Multi-D implementation project
  - Training users in Multi-D technology
- Engineering services:
  - 3D model integration and synthesis from various CAD systems
  - Plant model interference analysis
  - Technical requirements development for 3D models
  - Optimization of construction schedules with 4D models

The adoption of a multidiscipline approach, 3D visualization, and synthesis of the plant, as well as 4D construction simulation, would allow energy, utilities, and process industry companies to:

- Share and normalize data between engineering, design, procurement, construction, and operation
- Create a full digital plant mock-up
- Produce a life-cycle configurable asset design during construction and later for operations
- Pinpoint design conflicts between disciplines before starting construction and then improve the construction process
- Reduce risks in construction
- Enable construction planners to simulate the construction process down to details such as moving components and cranes or tooling, leading to significant schedule and cost optimization

Alternatively, EPC companies could consider directly leveraging 3DEXPERIENCE solutions from Dassault Systèmes which power the NIAEP-ASE service offering and implement their own solutions. Here, 3DS has created two vertically specialized Industry Solution Experiences: Safe Plant Engineering and Optimized Plant Construction.

Safe Plant Engineering focuses on the engineering phase and offers components for multidisciplinary design data integration, visualization, and configuration management. Optimized Plant Construction focuses on the construction phase and offers the components for construction project execution management, 4D simulation, and 3D instructions.

The solutions support EPC companies in handling the following business activities: requirement-driven project management and monitoring; plant system 3D design and civil engineering; multidisciplinary design data integration and visualization; plant system engineering; multiphysics simulation and test life-cycle management; and plant life-cycle and configuration management.

Meeting the Challenges Ahead

The Multi-D offering may face a number of challenges in the very competitive EPC market. According to the World Nuclear Association, there are 73 reactors under construction around the world – 10 of these are in Russia and 23 are in China, as well as 172 that are planned and 309 that are under proposal. NIAEP-ASE already has a strong market share in the nuclear market; it is also using Multi-D for fossil thermal generation plants and is in the process of preparing it for oil and gas large capital projects.

Vyacheslav Alenkov, Deputy Director, Moscow branch, of NIAEP-ASE, Head of Enterprise Architecture & System Engineering, NIAEP-ASE
oil and gas large capital projects. Nevertheless, it will have to move outside its traditional business and execute internationally in the broader energy, utilities, and process industry space.

At the same time, if 3DS solutions can handle the complexity and safety requirements of nuclear power plant design and maintenance, they can handle any power generation plant, as well as any chemical or oil and gas large capital project. Nevertheless, less complex construction projects may face more challenges in proving return on investment with such powerful solutions. The widespread and successful adoption of product life-cycle management solutions in manufacturing industries is promising in this regards.

Finally, energy, process, and utility industries need to manage the entire life cycle of their assets, from design to construction, operations, and decommissioning. The effective adoption by these industries of a virtual universe and these types of solutions is still a challenge in maintenance activities related to existing plant operation. 3DS will need to make a strong case to the industry about how it differentiates or complements other vendors’ offerings in the asset management space.

CONCLUSION

IDC Energy Insights believes that the future of asset design, construction, and operations is rapidly changing to a point where 3D and 4D simulation is going to be expected and not just a "nice to have." These tools will not only be a part of design but also of everyday operations. The Dassault Systèmes Industry Solution Experiences based on the 3DEXPERIENCE platform in particular, with its emphasis on collaboration to address complex assets, should be of interest to asset owners/operators – not just EPCs. Whether or not the energy, process, and utility industries will widely adopt these technologies is a matter of commitment from the industry as a whole. It will not be for lack of technology.

Essential Guidance

The execution of large capital projects in the energy, process, and utility industries is critical to positively impact company shareholder value and optimize total return on asset across assets' entire life cycle. IDC Energy Insights believes EPC companies in particular should consider the following:

- **Do it right from the beginning.** There is strong evidence that the ability to improve the overall performance of large capital projects is greatest during the early planning stages of a project, and that the cost of change to address problems escalates as the project progresses. More emphasis should be put on project planning and asset design phases, anticipating inconsistencies, recognizing and fixing gaps in constructability, and optimizing the supply chain.

- **Take advantage of the virtual universe to reduce non-productive time.** Many industries, such as aerospace and more broadly manufacturing, are effectively using manufacturing execution solutions to simulate and prototype their future products. EPC companies working for energy, process, and utility industries should take advantage of these technologies to simulate their plant and asset construction before actual construction starts and before the design becomes too advanced. This "virtual preparation" would enable them to anticipate issues and problems, improving planning and better organizing work execution, significantly improving project performance and increasing the likelihood of delivering on time and on budget.

- **Move from new builds to maintenance.** EPC companies should consider 3D execution platforms not only for new asset construction but also to maintain existing plants and infrastructures. Starting from major plant revamping or asset upgrades and moving down
to less complex maintenance activities, companies should evaluate the return on investment in these technologies and look at improving performance and introducing new and more effective engineering, maintenance, and supply chain processes.

- **Simplify collaboration among stakeholders.** Large capital projects in these industries involve an increasing number of parties. This is also true for complex asset maintenance projects. Collaboration among stakeholders poses a huge challenge, but also offers significant potential to improve project performance. Improved collaboration is critical during the design, construction, and commissioning of projects because it directly impacts execution timeframe and budget. It also impacts the subsequent phases of operations and maintenance of assets. Companies should provide all relevant stakeholders with consistent, secure, and up-to-date access to project content, including drawings, documents, and data, as well as a master data management scheme based on standardized semantics and coding.

- **Do not forget the cloud option.** The 3DEXPERIENCE platform is already available on cloud, and Safe Plant Engineering and Optimized Plant Construction solutions should soon be delivered as a service by Dassault Systèmes. Even if these industries as a whole are very cautious about the cloud delivery option, this should not underestimate its value. A cloud delivery model generally reduces capital costs and implementation time. Also, in an area where continuous product enhancements are expected, it reduces the risk of staying with old product releases. The cloud also enables EPC companies to test the virtual reality in pilot projects, evaluating the benefits of it in the field, and eventually moving into a broader adoption, on premises or as a service.

**REFERENCES**

Interviews with:

- Vyacheslav Alenkov, Deputy Director of the Moscow branch of NIAEP-ASE, Head of Enterprise Architecture & System Engineering, NIAEP-ASE
- Alexey Sachik, Head of Multi-D Marketing and Research Laboratory, NIAEP-ASE

Additional References:

- *Complex and Large Plant Construction Excellence with 3DEXPERIENCE*, Alexander Troppi and Anton Goldovsky
- *Perspective: Dassault Brings a Platform to Utilities* (IDC Energy Insights #EI250047, July 2014)
- *Perspective: Dassault, PLM, 3D, and Oil and Gas* (IDC Energy Insights #EI250568, August 2014)
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